NATIONAL IMPLEMENTATION PLAN FOR STOCKHOLM CONVENTION ON PERSISTENT ORGANIC POLLUTANTS

HANOI, 2017

ABBREVIATIONS

AFTA	ASEAN Free Trade Area
APEC	Asia-Pacific Economic Cooperation
APC	Air pollution control
ASEM	Asia-Europe Meeting
BAT/BEP	Best Available Techniques/ Best Environmental Practices
BOF	Basic oxygen furnace
DDT	[1,1,1-trichloro-2,2-bis (4-chlorophenyl) ethane]
DBDE	Decabromodiphenyl ether
DOIT	Department of Industry and Trade
DONRE	Department of Natural Resources and Environment
EAF	Electric Arc Furnace
EEE	Electrical and Electronic Equipment
EVN	Vietnam Electricity
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse Gas
HBB	Hexabromobiphenyl
HBCD	Hexabromocyclododecane
HCB	Hexachlorobenzene
HCBD	Hexachlorobutadiene
MARD	Ministry of Agriculture and Rural Development
MEA	Multilateral Environmental Agreement
MIC	Ministry of Information and Communication
MOC	Ministry of Construction
MOF	Ministry of Finance
MOH	Ministry of Health
MOD	Ministry of Defense
MOIT	Ministry of Industry and Trade
MOLISA	Ministry of Labor, Invalid and Social Affairs
MONRE	Ministry of Natural Resources and Environment
MOST	Ministry of Science and Technology
MOT	Ministry of Transport
MPI	Ministry of Planning and Investment
MPS	Ministry of Public Security
OCP	Organochlorine Pesticide
PBDEs	Polybrominated diphenyl ethers
PCA	Framework agreement on comprehensive partnership and cooperation
PCBs	Polychlorinated biphenyls

PCD	Pollution Control Department
PCDDs	Polychlorinated dibenzo-p-dioxins
PCDFs	Polychlorinated dibenzofurans
PCNs	Polychlorinated naphthalenes
PCP[1]	Pentachlorophenol
PeCBz	Pentachlorobenzene
PFAS[2]	Per- and polyfluorinated alkylated substances
PFOA[3]	Perfluorooctanoic acid
PFOS[4]	Perfluorooctane sulfonic acid
PFOSF	Perfluorooctane sulfonyl fluoride
POPs	Persistent Organic Pollutants
PPC	Provincial People's Committee
ppm	parts per million
PPP	Public Private Partnership
SCCP	Short chain chlorinated paraffins
SCP	Sustainable Consumption and Production
SDG	Sustainable Development Goal
TEQ	Toxic Equivalent
TPP	Trans-Pacific Partnership
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNIDO	United Nations Industrial Development Organization
VEA	Vietnam Environment Administration
VND	Vietnamese Dong
WB	World Bank
WEEE	Waste Electrical and Electronic Equipment
WTO	World Trade Organization

[1] In the Convention the listing includes PCP, its salt and esters. In this NIP for simplification, PCP represents the listing of these substances

[2] Only PFOS and related substances are listed in the Stockholm Convention. However, PFAS is a SAICM focal topic.

[3] PFOA is not listed in the Stockholm Convention but currently assessed in the POP Review Committee.

[4] The listing of PFOS, its salt and PFOSF includes the listing of all approx. 165 PFOS related substances and precursors. For simplification in the text of this document, only PFOS is used but representing all PFOS related substances.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

EXERCUTIVE SUMMARY

This document represents the National Implementation Plan (NIP) for management and phase out of Persistent Organic Pollutants (POPs) in Vietnam, compiled in accordance with Article 7 of the Stockholm Convention (SC) on Persistent Organic Pollutants.

The Socialist Republic of Vietnam ratified Stockholm Convention on 22 July 2002, becoming the 14th Party of the Convention, which became enforceable on May 17, 2004.

The Stockholm Convention imposes a worldwide ban on the production, use and trade in eight pesticides (aldrin, chlordane, DDT, dieldrin, endrin, heptachlor, mirex and toxaphene), two industrial chemicals (hexachlorobenzene and PCBs) and two byproducts of incineration processes (dioxins and furans) from 2004 onwards.

In 2009 and 2011, the Conference of the Parties (COP) listed ten new POPs with pesticides (Chlordecone, alpha hexachlorocyclohexane, beta hexachlorocyclohexane, lindane, pentachlorobenzene and endosulfan), industrial chemicals (Hexabromobiphenyl, hexabromodiphenyl ether and heptabromodiphenyl ether, pentachlorobenzene, perfluorooctane sulfonic acid, its salts and perfluorooctane sulfonyl fluoride, tetrabromodiphenyl ether and pentabromodiphenyl ether; and byproducts: Alpha hexachlorocyclohexane, beta hexachlorocyclohexane and pentachlorobenzene. Furthermore, in 2013, hexabromocyclododecane, in 2015, polychlorinated naphthalenes, pentachlorophenol and hexachlorobutadiene and in 2017 short chain chlorinated paraffins (SCCPs), decabromodiphenyl ether were listed. The current NIP addresses the POPs listed in 2009 and 2011. The POPs listed in 2013, 2015 and 2017 have not been assessed in this NIP update but a preliminary action plan has been included.

All these substances are designated as POPs and are toxic, persistent and can be transported over great distances through the air or water. POPs can cause adverse effects on the environment and health because they accumulate in organisms.

The Stockholm Convention imposes the obligation on the Parties to develop, within two years of the ratification of the Convention/adoption of the amendments, a NIP describing the national situation in respect of the substances covered by the Stockholm Convention and develop action plans. The first NIP of Vietnam was approved by the Prime Minister in 2006 by the Decision 184/2006/QD-TTg (here in after NIP 2006).

With funds made available by the Global Environment Facility (GEF) and with the assistance of the United Nations Development Programme (UNDP) was prepared an updated version of the NIP for Vietnam.

In comparison with the first NIP in 2006, this update NIP has mentioned new remarkable issues as: Concentrating on newly listed POPs which are popularly used in industries and other utilities; integrating its objectives and strategies with global and national issues such as climate change, sustainable development goals (SDGs), sustainable production and consumption, etc.; strongly link POPs with environmental health and included gender issue; involving diversity stakeholders, etc.

The NIP describes the background of the POPs issues in Vietnam and the current situation of the POP substances. Vietnam probably suffered more from the effects of POPs than any other country. Most of negative effects are related to the use of Agent Orange chemicals used as defoliants during the Vietnam War and their high contamination with dioxins. This affected quite large areas in the country and a large amount of contaminated people with associated health impacts including serious genetic effects in the following generations. In addition, still

population can be exposed at hundreds of POP pesticides contaminated areas. Remediation activities have started at many pesticides contaminated sites and for Agent Orange/dioxin sites.

Furthermore, the NIP details all the strategies and actions, which need to be undertaken in order to meet all the obligations of the Convention. Inventories for all POPs groups, initial and newly added POPs in 2009 and 2011, have been successfully compiled during the NIP preparation process. The inventories were robust enough for assessment of the dimension of the presence of different POPs categories in Vietnam, as well as for priority setting considerations for the action plans. Several inventories will, however, need to be broadly and more comprehensively conducted within the NIP implementation process.

As regards to POP pesticides, Vietnam as a country with a strong agricultural sector is a big market for pesticides. In recent years, the amount of pesticides in Vietnam is growing fast. Although POPs have been prohibited, POP pesticides are still in the Vietnamese market due to smuggling. Among the causes of illegal import, the following can be mentioned: Poor government control on chemical safety standards, low prices of illegal imported pesticides compared to legal ones, limited capacity of the customs authorities, police, and plant quarantine in arresting smugglers and confiscating illegal pesticides.

In respect to PCBs, PCBs were not produced in Vietnam; however, PCB-containing oils were imported into Vietnam in the period of 1960 - 1990 mainly in electrical equipment such as transformers, capacitors, industrial equipment such as hydraulic lifting, and high-pressure pumps among others. Currently, PCBs still exists in electrical equipment, industrial equipment, oil in storehouse, and some PCBs has penetrated into soil, water, lake and river sediments. The current status of PCBs inventory by implementing agencies shows that the total volume of oil contaminated with PCBs of 5-50 ppm concentrations is 739 tonnes, of 50-500 ppm concentrations is 589 tonnes, and over 500 ppm is 14 tonnes. In addition, there are a large number of Vietnam Electricity (EVN) transformers of which PCBs levels have not been evaluated, furthermore a huge number of capacitors and related oil, circuit breaker oil, and oil remaining in storage. Hydraulic fluids in the mining sector and other uses and PCBs in open applications have not been assessed yet. Also the contamination level of industrial oil in recycling has not been assessed.

Polybrominated diphenyl ethers (PBDEs) have not been produced in Vietnam, yet the country only produces, uses and disposes materials like electrical and electronic equipment and transport vehicles that are likely to contain PBDEs including listed POP-BDEs. The inventory of PBDEs in electrical and electronic equipment (EEE) and related waste (WEEE) throughout their life cycle from production to disposal lays a solid ground for effective management and helps proactively deal with issues related to environmental pollution and impacts on human health caused by PBDEs. The preliminary inventory and estimates with the limited available dataset from 2002 to 2006 show that the total volume of POP-BDEs involved in the material cycle was estimated to 161 tonnes, in which the quantity of POP-BDEs in each stage of use/storage, production, import, export and disposal was respectively 34.2; 64.8; 25.5; 16.2 and 20.7 tonnes. The amount of commercial c-octa BDE and total hexa and hepta BDE used in electrical and electronic equipment in the period from 2007 to 2014 in Vietnam is estimated at 3,792 kg and 2,048 kg, respectively. The amount of PBDEs, here mainly the amount of c-pentaBDE, in vehicles in Vietnam has been inventoried based on statistics data on the number of vehicles in use, produced and imported to Vietnam in 2010 and 2011. The total amount of POP-BDEs in the 1,285,739 vehicles in use (stock) were estimated to 6,540 kg with approximately 350 kg newly imported in 2011.

Hexabromobiphenyl (HBB) was not specifically addressed in the inventory since the historic production volume is considered small (approximately 6,000 tonnes) largely used in the 1970s in the U.S. Therefore, there is only very limited practical relevance. Since applications were

in the same use sectors (Plastic of electronics, PUR foams in transport) the possibly remaining HBB in products will be managed together with the POP-BDEs stocks and wastes.

In recent years, DDT has still been imported into Vietnam. DDT residue left in the warehouse and contaminated areas represent the source of POPs contamination that need further inventory in order to have appropriate control.

Perfluorooctane sulfonate (PFOS) and related substances are not produced in Vietnam, however, they are imported into the country and used in many areas such as industries, business and households. PFOS inventory was conducted in Vietnam in 2015 on the basis of estimating imported PFOS volume in articles that have high potential of containing PFOS based on international experience, namely textile and upholstery (0.11 tonnes/year to 3.45 tonnes/year in period of 1998-2013), paper and paperboard articles (0.2 tonnes/year to 4.8 tonnes/year in the period of 1998-2013), organic composite solvents and thinners and paint or varnish removers (62 kg/year in 2013), firefighting foam (10-15 tonnes in the period of 1998-2013). The work conducted in the initial inventory program is only limited to identifying the proportion of consumer goods, specialized articles and chemicals imported into Vietnam which have high potential of containing PFOS. Furthermore, PFOS, perfluorooctanoic acid (PFOA) and per- and polyfluorinated alkylated substances (PFAS) were detected in surface water, groundwater, soil, sediment, sludge, sewage and even fish. In-depth data on the weight of each group of articles and chemicals containing PFOS as well as data on concentrations of PFOS and related substances has not been adequately investigated. Some initial assessment of PFOS in the metal plating industry, firefighting foam and PFOS in the environment surrounding risk areas using PFOS (e.g. textile, paper, waste treatment, ...) have shown the risk of large amounts of PFOS has been used in the industry. Therefore, a national PFOS inventory and assessment and conducting PFOS management and reduction is essential in the coming period.

PCDD/PCDF release into the environment in Vietnam has been estimated based on national statistics on the capacity and releases of incineration and other major industrial Annex II and III sources based on the methodology and emission factors given by the UNEP Toolkit. The amount of dioxin/furan mainly released from waste incineration; metal industry, cement production; paper production, transport and open burning. The total amount of dioxin/furan emissions into the environment of Vietnam from industrial activities and incineration is estimated to be 568 g TEQ/year. The activity with the highest level of dioxin emission is waste incineration with the emission volume of 465.7 g TEQ/year, accounting for 82%; followed by metal industry at 47.8 g TEQ/year, accounting for 8.4%. The emission volume of open burning, cement manufacturing, paper production and transportation is 26.6; 17.9; 6.47 and 3.99 g TEQ/year, respectively accounted for 4.7%; 3.2%; 1.1% and 0.7%.

Inventory of new listed PeCBz were conducted for unintentional emission focusing on solid waste burning; biomass burning; and coal combustion. PeCBz emission (estimate for 2007 to 2012) in Vietnam estimated that the highest contribution result from waste combustion (67%). Total amount of PeCBz emission were estimated to 1,377 kg/year to 1,678 kg/year with medium value of 1,500 kg/year. PeCBz emission from coal burning is estimated to 50 kg/year.

Concerning the existing programs of monitoring POPs in the environment, Vietnam has a national environmental monitoring system. However, POPs are not included in this monitoring activity and network. Therefore, there are no specific regular programs on monitoring of POPs in the environment and in humans. The monitoring of POPs is an important approach for providing information about status of POPs and serve as a basis for the development and implementation of POP's management activities. Currently, the national environmental monitoring system is considered for re-planning and getting further investment.

Referring to information exchange and awareness raising for POPs, there were some fragmented initiatives conducted in Vietnam to raise awareness on POPs issues, but up to now, there was no overall POP-related awareness raising program implemented. Hence, in the following phase in Vietnam NIP for POPs, a systematic communication strategy shall be built and implemented to meet the requirement for strengthening management efficacy and risk prevention for POPs on the environment and public health.

Regarding the international cooperation for Stockholm Convention implementation, Vietnam has actively joined in international cooperation activities in associated with POPs management. In the period of 2005-2015, international cooperation activities in Vietnam in POPs management were strongly and widely conducted with links to most of POP-related sectors such as management of pesticide and PCB-transformed oil, controlling and dealing with dioxin pollution, building capacity for monitoring POPs pollution, handling and eliminating POPs wastes, etc. In bilateral cooperation, Vietnam has diversified cooperation activities with other countries such as Japan, Korea, the United Kingdom, Germany, the United States, Slovakia, Thailand, etc. in monitoring pollution and POPs wastes treatment.

In terms of technical infrastructure for POPs assessment, measurements and analysis, developing capacity for POPs monitoring and analysis in the future should concentrate on the following: Building a network consisting of specialized POPs monitoring laboratories and one national reference laboratory, developing labor forces and strengthening international cooperation.

In recent years, in order to enhance the capacity of POPs treatment, the Ministry of Natural Resources and Environment (MONRE) cooperated with the international and local experts, the organizations, the technology companies to review, assess different technologies to consider the possibility of transfer and application in Vietnam. Thus, there are a range of technologies rated to handle POPs in Vietnam. Several technologies have been assessed and licensed to be applied for destruction (such as co-processing PCBs in cement kiln) while some others are still being tested for their applicability. In the context of Vietnam, demand for treatment of POPs will focus on handle POP pesticides in residue forms and soil and other pollution. For PCBs, oil, materials, equipment and other wastes containing PCBs need treatment. For unintentional POPs, in particular the Agent Orange/dioxin hotspots need further treatment. For PBDE and PFOS, the stocks of products/articles need to be treated. In addition, contaminated areas with these industrial POPs might need remediation. To meet this requirement, the research, evaluation, transfer and application of technology to safely handle POPs in the future should be accelerated.

This NIP document summarizes the status of implementation on the activities foreseen during the first NIP prepared under the Stockholm Convention, with a focus on achievements of the following main tasks: Establishing policies and regulations on POPs management, strengthening capacity of POPs management, promoting researches and applying science and technology solutions in safe management, reduction, destruction and elimination of POPs, enhancing awareness, role and responsibility of levels, sectors, residential community, strengthening and diversifying investment funds and expanding and improving the efficiency of international cooperation.

The overall objective of the NIP is the safe life-cycle management, pollution control, reduction, treatment and finally elimination of POPs in Vietnam to meet the requirements of the Stockholm Convention on POPs, contribute to protecting human health and environment, toward sustainable development in Vietnam and international. Also, the NIP identified some cross-cutting objectives, namely appropriate institutional capacity, regulatory frame and stakeholder coordination for POPs and hazardous chemical management and substitution; enhanced capacity in science and technology for monitoring, understanding and management

of POPs and hazardous chemicals in the life cycle with appropriate knowledge and information management and related infrastructure; broad stakeholder awareness on POPs and other hazardous chemicals, related environmental health problems and management and phase out solutions; and synergistic implementation of conventions and SDGs where appropriate and integration in national chemical and waste management and the sustainable development strategy. Moreover, the NIP defined specific objectives: Controlling and safely manage POP pesticides; eliminating the use of equipment containing PCBs in concentrations equal to or greater than 50 mg/kg by 2025; controlling, limiting the use, substituting by sustainable alternatives and safe managing the industrial POPs; controlling the risk, treating, recovering and monitor environment in the area of dioxin contamination from toxic chemicals used during the Vietnam War; continuously reduce the emissions of UPOPs from productions, industries, and livelihoods; controlling risk of UPOPs to the environment and human health; identifying, environmentally sound manage and disposing POPs stockpiles; and identifying, securing and remediating POPs polluted areas.

The action plans and their activities included in this document are designed taking into account socio-economic and gender implications, the aim of their integration in the overall framework of chemicals and waste management, an integrated approach with other conventions where appropriate, with the implementation of related sustainable development goals and the principles and consideration of the sustainable production and consumption. Action plans have been developed for the management of individual POPs and for legislation/policy, stockpiles and wastes, contaminated sites with an own action plan for Agent Orange related polluted sites, for awareness raising, research capacity and monitoring, and management of environmental health. Priority projects have been identified.

Vietnam shall ensure the necessary resources, while mobilizing the contributions of the community and abroad for NIP implementation. It is also crucial importance to encourage investors, businesses, social organizations investing to implement pollution reduction and remediation projects through incentives such as policies on land, tax reduction, tax exemption, and favorable credits and nevertheless, the coordination and integration of National Plan with other related programs and projects among others. In this sense, the Government should create a legal basis and favorable conditions to encourage and attract the participation of all related economic sectors, domestic and foreign organizations, as well as investors for the implementation of the National Plan.

1. INTRODUCTION

1.1. STOCKHOLM CONVENTION ON PERSISTENT ORGANIC POLLUTANTS

The Stockholm Convention on POPs was signed by the representatives of governments in Stockholm on 22 May 2001. So far, there are 181 Parties to the Convention.

The Stockholm Convention is a Multilateral Environmental Agreement (MEA) and a global legally binding instrument. Its objective is to protect human health, biodiversity and the natural habitat against the threat of hazardous chemicals 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 - 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: POPs that need to be removed in manufacture and use (Annex A); POPs that are limited in production and use (Annex B); and unintentionally produced POPs (Annex C), see Table 1.

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 (PCBs); [1,1,1-trichloro-2,2-bis (4-chlorophenyl) ethane]; polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs).

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 (HCH), beta HCH, and chlordecone; a group of industrial chemicals, including hexabromobiphenyl (HBB), pentachlorobenzene (PeCBz), tetrabromodiphenyl ether, pentabromodiphenyl ether, hepta and octabromodiphenyl ether; the chemicals in Annex B, including industrial chemical perfluorooctane sulfonic acid (PFOS), PFOSF and its salts and related chemicals, and the chemical in Annex C: PeCBz.

In 2011, the COP 5 of the Stockholm Convention added technical endosulfan and its related isomers to Annex A of the Convention.

In 2013, the COP 6 of the Stockholm Convention added hexabromocyclododecane (HBCD) to Annex A.

In 2015, the COP 7 of the Stockholm Convention added pentachlorophenol (PCP), its salts and esters; polychlorinated naphthalenes (PCNs) and hexachlorobutadiene (HCBD) into Annex A and C of the Convention.

In 2017, the COP 8 of the Stockholm Convention added short chain chlorinated paraffins and decabromodiphenyl ether into Annex A and hexachlorobutadiene into Annex C of the Convention.

At present, there are 28 POPs listed in the Stockholm Convention. The current NIP addressed in addition to the initial 12 POPs also the 10 POPs listed in 2009 and in 2011.

The 06 POPs listed in 2013, 2015 and 2017 have not been assessed within this NIP update. However, an action plan for developing inventories and assessment of their situation in the country has been developed in the NIP.

Table 1. Chemicals listed in the Annexes of the Stockholm Convention on POPs

Annex A (Elimination)	Annex B (Restriction)	Annex C (Unintentional Production)
1. Aldrin 2. Chlordane 3. Dieldrin 4. Endrin 5. Heptachlor 6. Mirex 7. Toxaphene 8. Hexachlorobenzene (HCB) 9. Polychlorinated biphenyls (PCBs) 10. Chlordecone 11. Alpha hexachlorocyclohexane 12. Beta hexachlorocyclohexane 13. Lindane 14. Technical endosulfan and its isomers 15. *Pentachlorophenol (PCP) and its salts and esters** 16. *Polychlorinated naphthalenes (PCNs)** 17. Pentachlorobenzene (PeCBz) 18. Hexabromobiphenyl (HBB) 19. Hexabromodiphenyl ether and Heptabromodiphenyl ether (POP-BDE) 20. Tetrabromodiphenyl ether and Pentabromodiphenyl ether (POP-BDE) 21. *Hexabromocyclododecane (HBCD)** 22. *Hexachlorobutadiene (HCBD)** 23. *Decabromodiphenyl ether (DBDE)** 24. *Shortchain chlorinated paraffins (SCCPs) **	1. 1,1,1-trichloro-2,2-bis (4-chlorophenyl) ethane (DDT) 2. PFOS and related substances**Error! Bookmark not defined.**	1. HCB 2. PCBs 3. Polychlorinated dibenzo-p-dioxins (PCDD) 4. Polychlorinated dibenzofurans (PCDF) 5. PeCBz 6. *PCNs** 7. *HCBD **

*POPs listed in 2013, 2015 and 2017 not evaluated during this NIP update

1.2. UPDATING THE NATIONAL IMPLEMENTATION PLAN OF VIETNAM FOR THE STOCKHOLM CONVENTION

1.2.1. The first NIP of Vietnam

The Socialist Republic of Vietnam ratified Stockholm Convention on 22 July 2002. In order to implement Stockholm Convention, Vietnam developed the first NIP in 2006 with the objective is to safely manage, reduce and finally eliminate POPs in Vietnam, thus fulfilling the obligations to the Stockholm Convention and to ward sustainable development in Vietnam.

The first NIP consists of a synchronous system of actions and solutions, including those dealing with policies, institutions, management, technology, finance, awareness raising and international integration, aiming at fulfilling the obligations of Stockholm Convention gradually. In order for the NIP of the Stockholm Convention to be carried out effectively and synchronously, a roadmap is proposed, identifying clear priorities to be pursued in achieving the final goal of the NIP, namely to protect the environment and human health against POPs, consistent with the Convention's objective.

The NIP 2006 for Stockholm Convention includes the following contents:

I. Background

II. Status of POPs and POPs management in Vietnam

III. The National Implementation Plan for Stockholm Convention on POPs

IV. List of 15 national priority programs on POPs

The first NIP, prepared by the MONRE, was approved by the Prime Minister of Vietnam in the Decision No.184/2006/QD-TTg dated on 10th August 2006 and submitted to the Conference of the Parties of the Stockholm Convention in 2007.

1.2.2. Process of preparation of NIP update in Vietnam

To conduct the obligations from the Stockholm Convention and with the support from the GEF through the UNDP, from 2014-2015 the MONRE has in cooperation with stakeholders to develop the NIP update.

The NIP update process has followed the approaches provided by the Stockholm Convention Guidance such as Guidance for the review and updating of national implementation plans, Guidance on socio-economic assessment; Guidance for inventories of PFOS, PBDE among others.

The major activities in development of the NIP update have been conducted are:

- Establishment of groups for updating initial POPs situation and new POPs inventories;
- Assessment of national capacity for POPs management, treatment and disposal;
- Assessment of socio-economic impacts of using, production and elimination of new POPs in Vietnam;
- Determination of priorities and identification of national targets for the NIP update;
- Consultation with related stakeholders

1.2.3. Health and society problems and risks of POPs and hazardous chemicals

With the legacy of the health impact of former Agent Orange use and related dioxin contamination from the Vietnam War, Vietnamese has heavily and sadly experienced the impact of POPs on affected population including the impact on following generations. Besides, other POPs as POP pesticides, UPOPs, and industrial POPs have caused and are causing risks to human health, economy and society.

Also for the general population, there is a growing body of information and data on the links between pollution and health and this demonstrates more and more strongly the scale of the impacts of current chemical pollution and contaminants from air pollution and indoor exposure (including heating/cooking, chemicals used in buildings and consumer products) as well as exposure from contaminated sites. Death caused by pollution have today even a higher impact on diseases in developing and transition countries compared to major diseases like HIV, malaria or tuberculosis[5,6]. The numbers of people affected worldwide are now estimated to be of the order of 200 million with estimated 8 million deaths per year.

POPs, POPs-like chemicals[7] and other toxic chemicals (E.g. heavy metals, PAHs or endocrine

[5] Global Alliance on Health and Pollution (http://www.gahp.net/new/)

[6] Other studies see these diseases as the major reason for death (Institute for Health Metrix & Evaluation; http://www.healthdata.org/gbd/publications)

[7] Scheringer, M., Strempel, S., Hukari, S., Ng, C.A., Blepp, M., Hungerbühler, K. (2012) How many Persistent Organic Pollutants should we expect? Atmospheric Pollution Research, 3, 383–391.

disrupting chemicals[8,9]) play a crucial role. This highlights that a more critical assessment of the social burdens of pollution from chemical production and use and industrial production and releases as well as chemical exposure is needed.

One challenge of socio-economic assessment is that for many processes the assessment cannot be based on a single chemical but that the combined toxic release and effect of a process or an industry need to be included in the assessment to adequately address their health or environmental impact (E.g. recycling of electronic waste or release from an incinerator or secondary metal industry).

For Vietnam, the following health and socio-economic threats and concerns are highlighted as most relevant, with consideration of sustainable development goals:

A) Food and water safety (including exposure to POPs)

The basis for sustainable development is safe food (SDG 2) and safe drinking water (SDG 6) as well as clean and fertile soils (SDG 15). This environmental frame is the basis for the long-term development of a healthy society. Within this frame, a sustainable economy (SDG 9) can develop which should serve society development, poverty eradication (SDG 1) and decent work (SDG 8) but need to ensure the protection and possible improvement of the environmental situation. At the same time food is the major exposure pathway for most POPs while for the water soluble PFOS also exposure via drinking water is relevant[10,11].

B) Exposure of vulnerable groups and highly exposed groups

POPs have a particular impact on vulnerable groups. These include children which e.g. for new listed PBDEs have in average a higher exposure compared to adults[12]. POPs are also a particular threat for woman in reproductive age with the risk of negatively influence the reproductive health[13,14] and on the health of the next generation by transfer of POPs and other pollutants during pregnancy to the fetus and via breast milk to the baby, POPs with related developmental and other adverse effects. E.g. from the new listed POPs PBDE correlates to reduced IQ in children[15].

However, also the reproductive health of men is impacted by some POPs and other endocrine disrupting chemicals. In industrial countries since 50 years, the sperm quality is decreasing[16,17]. Chemicals play an important role in the decline of sperm quality including POPs (E.g. PCBs, DDT, PFOS[18]) but also other toxic chemicals such as certain phthalates and organophosphates[17].

One major challenge of the assessment of the impact of POPs and POPs-like[19] chemicals in

[8] UNEP & WHO (2013) State of the Science of Endocrine Disrupting Chemicals – 2012.

[9] Many POPs are at the same time endocrine disrupting chemicals.

[10] Brambilla G, D'Hollander W, Oliaei F, Stahl T, Weber R (2015) Pathways and factors for food safety and food security at PFOS contaminated sites within a problem based learning approach. Chemosphere 129, 192-202.

[11] Hu et al. (2016) Detection of poly- and perfluoroalkyl substances (PFASs) in U.S. drinking water linked to industrial Sites, Military Fire Training Areas, and Wastewater Treatment Plants. Environ. Sci. Technol. Lett. DOI: 10.1021/acs.estlett.6b00260.

[12] US EPA (2010) An Exposure Assessment of Polybrominated Diphenyl Ethers. EPA/600/R-08/086F, May 2010.

[13] CHE/Commonweal (2009) Hormone Disruptors and Women's Reproductive Health.

[14] Fei C, McLaughlin JK, Lipworth L, Olsen (2009) Maternal levels of perfluorinated chemicals and subfecundity. J Hum Reprod. 24, 1200-1205.

[15] Herbstman et al. (2010) Prenatal exposure to PBDE and neurodevelopment. Environ Health Perspect 118(5): 712-719. http://ehp03.niehs.nih.gov/article/fetchArticle.action?articleURI=info%3Adoi%2F10.1289%2Fehp.0901340

[16] Sharpe R (2009) Male Reproductive Health Disorders and the Potential Role of Exposure to Environmental Chemicals http://www.chemtrust.org.uk/wp-content/uploads/ProfRSHARPE-MaleReproductiveHealth-CHEMTrust09-1.pdf

[17] Jurewicz J, Hanke W, Radwan M, Bonde JP (2009) Environmental factors and semen quality.Int J Occup Med Environ Health.22, 305-329.

[18] Joensen , Bossi R, Leffers H, Jensen AA, Skakkebaek NE, Jørgensen N (2009) Do Perfluoroalkyl Compounds Impair Human Semen Quality? EHP 117:923–927. http://ehp03.niehs.nih.gov/article/info%3Adoi%2F10.1289%2Fehp.0800517

[19] Scheringer, M., Strempel, S., Hukari, S., Ng, C.A., Blepp, M., Hungerbühler, K. (2012) How many Persistent Organic

combination with the approx. 100,000 chemicals in use on health is the effect of chemical mixture. Various POPs have e.g. endocrine effects which additive or synergistic effects with hundreds of other endocrine chemicals.[20]

In addition, particular high occupational exposure risks exist. This includes farmer exposure to POPs and other hazardous pesticides. In a country with large agricultural activities as Vietnam pesticides can be still considered as the chemical group with the highest impact on human health and the environment. Other occupational exposures to POPs are e.g. fire fighters exposed to new listed POPs such as PFOS, PBDEs and unintentional POPs such as PCDD/PCDF and related PBDD/PBDF[21] or workers in the textile or plating industry exposed with PFOS.

C) Risk for industries for production and export

Several new listed industrial POPs can pose a risk to Vietnam production industries and exports. PFOS, PFOA and HBCD might be used in the textile industry. According to research of the Greenpeace, PFOS, PFOA**Error! Bookmark not defined.** and other persistent fluorinated chemicals and other hazardous chemicals were recently screened in outdoor textiles produced in Asia including Vietnam. They detected PFOA and some other hazardous chemicals in several of the textile samples including Vietnam[22]. In addition, electronics are screened for POP-BDEs and controlled for import within regulatory frames such as the EU RoHS directive.

Furthermore, there is a risk for the aquaculture and food export products like fish and shrimps if POPs are not adequately managed and contaminate surface waters or the fish feed leading to POPs residue in foods.

Due to international economic agreements, Vietnam is even stricter bound to take care of environmental and food standards including chemical contamination.

D) Challenge of end of life management and cost of destruction

The destruction of POPs stockpiles is very expensive. Export of POP-contaminated materials back to the original producers, normally industrial countries, for destruction is very expensive at about US$2,000 to US$5,000/t.[23] The management costs for the disposal of 03 million tonnes of PCB-containing equipment alone have thus been estimated at between US$ 06 billion and US $15 billion[24]. The most recent global PCBs inventory is estimated to 9.3 million tonnes of contaminated oil and equipment. Vietnam has started to manage and destroy their POPs stockpiles within the country. Although this result in cheaper transport and destruction, the management and cost are still a large burden for industry, authorities and the society.

E) Cost of contaminate soil and site remediation

The cost and the management challenge of contaminated sites (POPs, heavy metals, PAHs etc.) from more than a century industrialization are enormous and cannot adequately be managed even in industrial countries[25,26]. Vietnam witnesses the challenges and huge costs of

Pollutants should we expect? Atmospheric Pollution Research, 3, 383–391.

[20] UNEP & WHO (2013) State of the Science of Endocrine Disrupting Chemicals – 2012.

[21] Shaw SD, Berger ML, Harris JH, Yun SH, Wu Q, Liao C, Blum A, Stefani A, Kannan K. (2013) Persistent organic pollutants including polychlorinated and polybrominated dibenzo-p-dioxins and dibenzofurans in firefighters from Northern California. Chemosphere. 91, 1386-1394

[22] Greenpeace (2013) Chemie für jedes Wetter Greenpeace untersucht Outdoor-Kleidung auf perfluorierte Schadstoffe.

[23] The final cost for the destruction of highly chlorinated wastes is less than US$1,000/tonne, but the cost of packing and shipping is more than the destruction itself.

[24] Stockholm Convention (2010) PCB Elimination Club (PEN) magazine. Issue 1 12/2010. http://chm.pops.int/Implementation/PCBs/PCBsEliminationNetworkPEN/PENmagazine/tabid/738/Default.aspx

[25] European Environmental Agency (2014) Progress in management of contaminated sites (LSI 003) - Assessment May 2014.

[26] Faber D (2008) Capitalizing on Environmental Injustice. The Rowman & Litlefield Publishing Group, Inc.

investigation and the remediation of dioxin contaminated sites from Vietnam War supported by foreign aid. Furthermore, the experience of assessing and securing of more than 1,000 pesticide contaminated sites in Vietnam demonstrates the large burden of management of POPs and hazardous chemical contaminated sites. The experience highlight that after soils or ground water has been contaminated it is costly and difficult to restore them that they might serve again food production or residential purposes. Therefore, prevention has the highest priority. The experience of the last decade Stockholm Convention implementation has shown that developing countries are not in the position to appropriately manage POPs and have not the technologies to adequately destroy POPs stockpiles.

Considering all above mentioned health and socio-economic burdens and risks including the high cost for their life cycle and wastes managing and the high cost of their destruction highlight the need to strongly take precautionary approaches not to generate more POPs and POPs-like wastes and contaminated sites and food, water and soil pollution and related human contamination. Therefore, for this NIP and for the implementation plans, the precautionary approach will be considered.

Therefore, considering these socio-economic burdens, in the preparation of this NIP and for the implementation of the NIP following approaches are considered:

- The precautionary approach as emphasized by the Stockholm Convention and Rio Declaration on Environment and Development.
- Phase-out and substitution will be applied for POPs and POPs-like chemicals as fast as possible.
- The extended producer responsibility and the polluter pays principle will be applied to promote the internalization of environmental and social costs and the uses of economic instruments, taking into account that the polluter should bear the cost of pollution with due regard to the public interest considering Principle 16 of the Rio Declaration.

2. COUNTRY BASELINE INFORMATION AND POPs SITUATION

2.1. GENERAL INFORMATION OF VIETNAM

2.1.1. Natural conditions

Geographical location: Vietnam is located on the Indochina peninsula in Southeast Asia. It has a long land border of 4,550 km, bordering China to the North, Laos and Cambodia to the West, and Eastern Sea of Pacific Ocean to the East. On the map, Vietnam is an S-shaped strip of land, stretching from 23°23' to 8°27' North latitude. The country's total length is 1,650 km from the northernmost point to the southernmost point. Its width, from the Eastern coast to the Western border, is about 500 km at the widest part and about 50 km at the narrowest part.

The country's diverse topography consists of hills, mountains, deltas, coastline and continental shelf, reflecting the long history of geology and topography formation in a monsoon, humid climate and strong weather exposure. The topography is lower from the Northwest to the Southeast, which can be clearly observed in the flows of major rivers.

Three quarters of Vietnam's territory are made up of low mountains and hilly regions. Regions with elevation lower than 1,000 meters above sea level make up 85% of the territory. Mountainous regions over 2,000 meters above sea level account for only 1%. Hills and mountain ranges form a large bow, 1,400 km in length from the Northwest to the Southeast, heading towards the Eastern Sea. The highest mountain ranges are all located in the West and Northwest with the peak of Fansipan (3,143 meters), the highest in Indochina. Nearer to the Eastern Sea, the mountain ranges lower and usually end with a coastal strip of lowland.

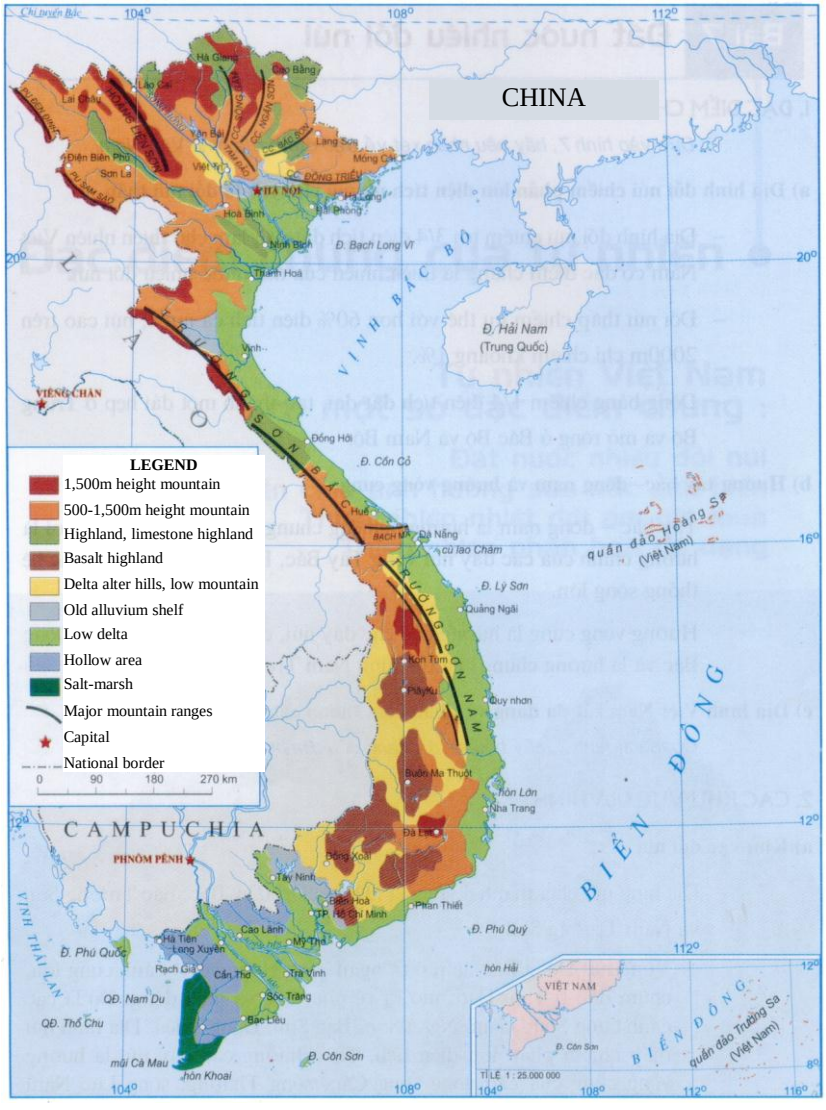

Figure 1. Topographic Map of Vietnam

Source: The Publishing House of Education and Training

Only one-fourth of the Vietnamese territory is covered by deltas, separated into regions by mountains and hills. There are two major deltas with fertile arable land in Vietnam, the

16,700 km^2 Red River Delta, locally known as the Northern Delta, and the 40,000 km^2 Mekong River Delta, or the Southern Delta. Between these two major deltas is a chain of small and narrow deltas along the Central coast from the Ma River basin in Thanh Hoa Province to Phan Thiet with the total area of 15,000 km^2.

Vietnam faces the Eastern Sea to the East and the Gulf of Thailand to the South and Southwest. The country has a long coastline of 3,260 km running from Mong Cai in the North to Ha Tien in the Southwest. Vietnam's territorial waters in the Eastern Sea extend to the East and Southeast, including the continental shelf, islands and archipelagoes. There is a group of around 3,000 islets belonging to Vietnam in the Tonkin Gulf, including Ha Long Bay, Bai Tu Long Bay, Cat Hai, Cat Ba and Bach Long Vi Island. Farther in the Eastern Sea are Hoang Sa Archipelago (Paracel Islands) and Truong Sa Archipelago (Spratly Islands). To the West and the Southwest, there are groups of islands including Con Son, Phu Quoc and Tho Chu.

Climate: Vietnam is located in the tropical zone. Its climate is characterized by high temperature and humidity all year round. The Northern part, under the impact of the Chinese mainland, has more or less mainland climate. In addition, the Eastern Sea greatly affects the country's tropical monsoon climate. As the monsoon climate does not spread evenly, there are different regions with different climates all over the Vietnamese territory. Vietnam's climate changes by seasons and by regions from the lowland to the highland, from North to South and from East to West. Given the strong influence of the Northeast monsoon, the average temperature in Vietnam is lower than that of many other Asian countries of the same latitude.

There are two major climate regions in Vietnam: (1) Northern Vietnam (from Hai Van Pass northwards) has a highly humid tropical monsoon climate with four distinguishable seasons (spring, summer, autumn and winter) and is influenced by the Northeast (from the Asian continent) and Southeast (from Thailand, Laos and Eastern Sea) monsoon. (2) Southern Vietnam (from Hai Van Pass southwards) has a rather moderate tropical climate given the weak influence of monsoon and is characterized by dry and rainy seasons and warm weather all year round.

Temperature: The average temperature in Vietnam varies between 21°C and 27°C and gradually increases from the North to the South. In the summer, the average temperature is 25°C (Hanoi 23°C, Hue 25°C, Ho Chi Minh City 26°C). In the winter, the temperature in the North reaches the lowest in December and January. In Northern mountainous regions like Sa Pa, Tam Dao and Hoang Lien Son, the temperature sometimes reaches 0°C with snow.

Vietnam has a considerable amount of solar radiation with the number of sunny hours varying between 1,400 and 3,000 per year. The annual average rainfall stands between 1,500 mm and 2,000 mm. Air humidity is around 80%. Given the influence of monsoon and complex topography, Vietnam is prone to natural disasters like typhoons, floods and droughts.

Rivers: Vietnam has a dense network of rivers and streams (2,360 rivers longer than 10 km), flowing in two main directions: Northwest-Southeast and bow shape. The Red River and the Mekong River, the two largest rivers in Vietnam, create two vast and fertile deltas. Each year, the rivers and streams are supplied with 310 billion cubic meters of water. The water supply for rivers and streams depends on the flood and drought seasons. 70%-80% of the annual water volume is provided in the flood season.

Land, Flora and Fauna: Vietnam's soil is diverse with high fertility, thus providing favorable conditions for the development of agriculture and forestry. Vietnam is also endowed with abundant and diverse flora of around 14,600 plant species. Vietnam's flora is mainly covered by tropical forests with plants and trees adapted to strong sunlight, high temperature and humidity.

The fauna in Vietnam is also abundant and diverse with various precious species listed in the World Red Book. 275 species of mammals, 800 species of birds, 180 species of reptiles, 80 species of amphibians, 2,400 species of fish and 5,000 species of insects have been identified so far. Dense forests, limestone mountain forests, and multi-canopied forests provide habitat to different species of monkey, languor, gibbon and wild cat. Vietnamese typical languor species include white-headed languor, delacours languor and black languor. Likewise, there are valuable bird species like pheasant and pheinardia ocellata. The high mountains in the North have many wild furred animals like selenarto, small bear, big black squirrel, fox, otter and civet. There are national parks of high bio-diversity such as Hoang Lien Son National Park (Fansipan Mountain area, Lao Cai Province), Cat Ba National Park (Quang Ninh Province), Cuc Phuong National Park (Ninh Binh Province), Pu Mat National Park and Phong Nha – Ke Bang National Park (Quang Binh Province), Bach Ma National Park (Thua Thien Hue Province), Con Dao National Park (Con Son Island in Ba Ria – Vung Tau Province), and Cat Tien National Park (Dong Nai Province), etc. These parks are ideal places for Vietnamese and foreign scientists to conduct research and also eco-tourism attractions. Additionally, UNESCO designates 9 World Biosphere Reserves in Vietnam, including Can Gio, Cat Tien, Cat Ba, Red River Delta, Kien Giang, Nghe An, Cu Lao Cham, Mui Ca Mau and Lang Biang.

Land resource: Vietnam has natural forests and many mineral deposits on the mainland such as phosphates, coal, manganese, bauxite, chromate, etc. Marine resources of Vietnam consist of oil, natural gases, and ores in offshore. With the steep river system which falls down from western highlands, Vietnam has huge potential of hydropower development[27].

2.1.2. Population

Vietnam has 54 ethnic groups, including 53 ethnic minorities, accounting for 14% of the total national population. Ethnic Vietnamese (also known as Kinh people) makes up of 86% concentrated in delta and coastal plains. Other ethnic groups except for Chinese, Cham and Khmer groups are living in the highland area. Among the ethnic minorities, Tay, Thai, Muong, Hoa, Khmer, Nung, etc are the biggest ones with a population of 1 million people per group. Brau, Ro Mam, O Du groups has the least population with hundreds of people per group. Many ethnic minorities have permanently settled in Vietnam territory for long time but some others migrated in Vietnam in recent hundred years such as the Chinese group in the South. Vietnam has a large population, listed 13th in the aspect of population but ranking 65th in the world in term of area.

In the investigation of the General Statistic Office in 2014, Vietnam's population is 90,728,900 people, including 44,758,100 men (accounting for 49.33%) and 45,970,800 women (making up 50.67%). The population density is highest in Red River Delta with 20.4 million people, the second highest is in the north of the Central and the South Central Coast with 19.3 million people, and the third is Mekong River Delta with 17.5 million people. The area with the smallest population is the Central Highland with 5.5 million people. According to the investigation, Vietnam has 28.8 million people living in urban areas (accounting for 32.2%) and 60.8 million people living in rural areas.

The densest city of Vietnam is Ho Chi Minh City (with 7.8 million people) and the runner-up is Hanoi (6.9 million people). Most cities in Vietnam have a high speed of urbanization, causing a rapid increase of population. The sex ratio of Vietnam now is 98 males/100 females, in which the highest ratio area is the Central Highland with 102 males/100 females and the lowest one is the Southern East with 95 males/100 females. The population of elders in Vietnam (over 60 years old) is 8 million people accounting for 9.45% of total national population.

[27] Portal of the Government of Vietnam. 2015

2.1.3. Economy

General information: Vietnam started to implement Innovation Policy in 1986 with three major pillars: (i) transforming from centrally-planned economy to market economy; (ii) developing a multi-sectoral economy in which private sectors play a significant role; (iii) actively and effectively integrating in the regional and world economy according to practical conditions of Vietnam.

After more than 20 years from the VI Party Congress in 1986, the innovation process of Vietnam has obtained great achievements. Vietnam's economy has maintained a high growth rate in many consecutive years. Being a WTO member helps Vietnam to deeply and widely integrate in the world economy, taking advantages of external resources to strengthen its industrialization and modernization. Vietnam sets a target to become an industrialized country by 2020.

The Law on Foreign Investment in 1987 is the first law creating the legal framework for the establishment of market economy in Vietnam. The promulgation of Law on Private Enterprises and Companies Law in 1991 has promoted the development of enterprises. Amended Constitution 1992 affirmed the existence and development of the multi-sector commodity economy with market orientation and the foreign investment sector. Following it is a series of significant laws of the market economy such as Land Law, Business Law, Tax Law, Bankruptcy Law, Customs Law, Procurement Law, Environmental Protection Law, Labor Law, etc. and hundreds of Ordinances, Decrees of the Government promulgated in order to concretize the implementation of laws for socio-economic development.

Besides the law development, a market institution of Vietnam has been gradually established. The government eliminated the central mechanism, subsidies, emphasized the commodity-monetary relationship, focused on the economic management measures, established series of financial organizations, and formulated fundamental markets such as currency market, labor market, commodity market, and land market, etc. Administrative reform has been strengthened to promote the competitiveness of the economy, create more favorable and adequate environment for the business activities, and mobilize all resources for economic growth. The administrative reform strategy in the period of 2001-2010 is the determination of the Government of Vietnam, highlighting the amendment of bureaucratic procedures, law, and economic management mechanism in order to create an active institutional framework to meet the development demand of the country in the new period.

In general, the strong economic reforms in the recent two decades have brought about significant preliminary achievements to the country. Vietnam was able to create a market economic environment of competitiveness and dynamics. A multi-sector commodity economy has been promoted, creating effectiveness in mobilizing the social resources to serve economic growth. The external economic relations has been more opened, which has attracted more foreign direct investment, expanded market for the export goods, and developed additional sectors to acquire more foreign currency such as tourism, labor export, and remittances, etc.

Over 20 years of innovation, the GDP of Vietnam has continuously increased. In the first stage of innovation process (1986-1990), GDP only gained 3.9%/year; in the following 5 years (1991-1995) GDP increased and reached the average increase of 8.2%. In the period of 1996-2000, GDP growth of Vietnam was 7.5% which was lower than the first half of the 1990s due to the impact of the financial crisis in Asia. Growth rate of GDP in Vietnam always maintains a high and stable rate.

Along with maintaining the GDP growth rate, domestic economic structure has significantly changed. The share of agriculture-forestry-fishery has dropped, while the share of industrial

and construction sectors has increased. There is also a positive change in the structure of each sector. For the industry, the share of processing industry has increased with better product quality. For the service, the share of high-quality services such as finance, banking, insurance, tourism, etc. has been going up.

Vietnam has used effectively the economic achievements to obtain the socio-economic objectives such as equally distributing the benefits of innovations to the community; linking economic growth with improvement of life quality; developing health and education; increasing the average life expectancy from 50 years in 1960 to 73 years in 2008, and 73.1 years in 2013; reducing poverty from 70% in the beginning of 80s to 14.75% in 2007 and 6% in 2014.

In foreign trade and international economic integration, with the open policy on international economic integration, the economic relations between Vietnam and other countries and international organizations has gradually been broaden. Vietnam is a key member of ASEAN, has actively implemented the AFTA agreement in ASEAN, and is an active member of APEC, ASEM and many other international economic organizations. The economic cooperation between Vietnam and big economies such as the US, EU, Japan, Russia, China, and India has gradually strengthened and expanded. Vietnam signed the bilateral trade agreement with the US, and the Framework agreement on comprehensive partnership and cooperation (PCA) with EU, and has negotiated investment agreement with the US and the agreement on comprehensive economic partner with Japan. In January 2007, Vietnam officially participated in the WTO, establishing economic relations with over 220 nations and territories. This is a benchmark for the comprehensive and adequate integration of Vietnam into the global economy. In October 2015, Vietnam negotiated the Trans-Pacific Partnership (TPP) with 11 other countries, which opens important opportunities for economic development.

After the reform, import-export turnover of Vietnam annually increased by over 10% which brought the total export value of Vietnam from 500 million USD/year in the years before reform to 48.4 billion USD in 2007, 62.7 billion USD in 2008, and 102 billion USD in 2011, 120 billion USD in 2012, and 139.3 billion USD in 2013. Export turnover in 2011 was 107.6 billion USD, 115.1 billion USD in 2012, and 132.6 billion USD in 2013. In 2014, the total export turnover reached 150.1 billion USD, increasing 13.6% compared with 2013. Domestic economic sector gained 48.5 billion USD, increasing 10.4%, the highest increase from 2012, which accounted for 32.31% of total export turnover and contributed 3.5 point of percentage to the common increase; the foreign investment reached 101.6 billion USD (including crude oil) increasing 15.2% which accounted for 67.69% of total export turnover and contributed 10.1 point of percentage to the common increase (gaining 94.4 billion USD (not including crude oil) and increasing 16.7%). The structure of export goods has experienced a positive transformation. The structure of export commodity in 2014 changed positively, with the transition from export of raw materials and mineral products to processed and manufactured products.

The share of heavy industrial commodity and minerals reached 66.5 billion USD, increasing 12.0% compared with the same period of 2013 and accounting for 44.31% of total export turnover in which: Telephone and related items are expected to reach 24.08 billion USD, increasing 13.4% and making up of 16.04%; electronic goods, computers, and related items are expected to gain 11.66 billion USD, increasing 7.77%; machines and related equipment reach 7.26 billion USD, increasing 21.6% and accounting for 4.84%; transportation means and related items reach 5.48 billion USD, increasing 10.4% and accounting for 3.65%. Light industrial commodities and handicrafts gain 57.9 billion USD, increasing 15.9% and accounting for 38.57%. The two commodity groups with the highest export turnover are telephone and related items (24.08 billion USD) and textile (20.77 billion USD). Only these two groups always gain a stable export turnover of over 1 billion USD/month. The structure

reflects the increased trend of processing and manufacturing commodities and decreased share of the raw export goods, which are mainly fishery, forestry and agriculture commodities and minerals. However, the raw export goods of Vietnam still account for major share which requires the greater effort for rapid increase of export industrial commodities.

Foreign direct investment: The Law on Foreign Direct Investment of Vietnam was promulgated in December 1987. This is the legal foundation for the foreign direct investment activities in Vietnam. The Law was amended and supplemented in 1990, 1992; and replaced by the Law on Foreign Direct Investment in 1996 (amended in 2000 and replaced by Investment Law in 2005). Currently, Investment Law 2014 is the latest legal document for investment sector. All amendments and supplement of the Law help to create an opened and more attractive investment environment for foreign investors in the key and prioritized sectors, especially in the high technological sector; high-tech supporting products research and development; production of new material and energy, clean energy, renewable energy; production of value-added goods, energy saving products; waste collection, disposal, recycling and reuse, etc.

In recent 25 years from 1988 to 2013, total FDI fund registered in Vietnam reached 218.8 billion USD, total implemented budget gained 106.3 billion USD in which the industrial sector accounted for about 60%. According to the statistics of Foreign Investment Department (Ministry of Planning and Investment), foreign investors registered 13.7 billion USD of investment in Vietnam in the first 10 months of 2014, equivalent to 71.2% compared with 2013. FDI increase is expected not only to bring high profits for the foreign investors but also to play a significant role in supplementing capital sources, transferring technology and modern business practices, exploiting the country's potentials, training and creating jobs for hundred thousands of workers, and contributing to socio-economic development of Vietnam.

2.1.4. Political system

Article 4 of the Constitution of the Socialist Republic of Vietnam in 2013 identified the role of the Communist Party of Vietnam: "Vietnam Communist Party - the pioneer of the working class and the people of Vietnam, the faithful representative for the benefit of working class and the whole nation, and considers Marxism - Leninism and Ho Chi Minh thought as the ideological foundation and the leading force of the State and the society.

The Vietnam's Communist Party closely associates with people and serves people and is under the monitoring of people and responsible for their own decisions to the people. The organizations of Communist and members of Communist Party of Vietnam operate within the framework of the Constitutions and the Law".

In the political system, the Socialist Republic of Vietnam is the state of rule of law; the current political system was formed since the establishment of Vietnam Government, including the political authority's structure as follow:

The Communist Party is the pioneer of the working class and the people of Vietnam; and is the faithful representative of working class and the people.

The people in the political system, as the historical creator, the people is the decisive force in the process of social change, has developed the current political system in Vietnam. All authorities belong to the people and they implement their power through the State; the State manages society by the law under the leadership of the Communist Party of Vietnam.

The Socialist Republic of Vietnam is the central organization and a pillar of political system, implements the will and the power of the people, represents for the people and responsible for the management of all social activities and the management of external and internal affairs.

The National Assembly is the highest representative body for the people, and the highest

state authority unit of Vietnam. The National Assembly has 3 major functions including policy-making; decision of significant issues of the country; and supreme monitoring to all the state activities.

The National President is the state head, represents for the nation in term of internal and external affairs and is assigned by the members of National Assembly. The Constitution clearly regulates that the National President has 06 tasks and authorities, in which the most important ones are announcing the Constitution, law, and ordinance; commanding the People's Armed Forces and being served as Chairman of the Council of Defense and Security; requesting the National Assembly to elect, and dismiss the Vice President, Prime Minister, Chief Justice of the Supreme Court, the Head of the Supreme Procuratorate.

The Government is the highest administrative unit of the state of the Socialist Republic of Vietnam; the term of the Government complies with the term of the National Assembly. The government manages the implementation of tasks on politics, economy, culture, society, defense, security and foreign affairs of the state; ensures the effect of the State from central to local level; ensures the respect and compliance with the Constitutions and law; promotes the people's ownership in the cause of national development and protection; ensures the stability and enhances the livelihoods and cultural life of the community. The Government consists the Prime Minister (the Constitution regulates that the Prime Minister must be the member of the National Assembly), the Deputy Prime Minister, the Ministers and other members.

The People's Court, includes the Supreme People's Court, the local People's Court, the Military Court and other courts established by law. They are the judicial organ of the Socialist Republic of Vietnam. In the special circumstance, the National Assembly can decide the establishment of the Special Court. During the trial, the jurors have similar rights and are independent with the judges and only obey law. The People's Court publicly hearings, excepting for the circumstance regulated by law. The People's Court judges collectively and decides depending on the majority.

The People's Procuratorate supervises the law compliance of the ministries, ministerial agencies, local authorities, socio-economic organizations, people's armed units, and citizens; implements prosecute rights and ensures that the regulations are strictly obeyed and unified. The Local People's Procuratorates, the military procuratorate examines the law compliance, implements prosecute rights within the responsibility regulated by law.

The socio-economic political organizations and community associations are the organizations representative for the benefits of the different communities which participate in the political system compliance with the principles, purposes, and the natures of each organization. In Vietnam, there are 05 socio-political organizations including Vietnam Fatherland Front, Labor Union, Vietnam Women's Union, Ho Chi Minh Communist Youth Union, and War Veterans' Association. There are many other social organizations and community associations. The organizations play a significant role in the struggle for national independence in the past. In the cause of national development and protection, the organizations have significantly contributed in implementing the policies of the Communist Party and the Government of Vietnam.

2.1.5. Society

Health: According to the investigation in 2013, the average life expectancy of Vietnam's people was high in which 70.5 for male and 75.8 for female. The mortality rate of children under 5 years old is 19/1.000. Increased rate of average population in the period of 2011-2013 was 1.05%/year, and is expected to reach 1% of expected goals by 2015. Fertility rate was 1.99 infants/women in 2011, 2.05 infants/women in 2012, and 2.02 infants/women in 2013. The number of the public clinics in 2013 was 13.120; the number of patient beds (excluding the health stations) in 2013

reached 283,000. On average, one thousand people had 25.5 beds; the number of doctors gained 75,000 people; on average, there were 8.4 doctors in a thousand people.

Education: According the investigation in 2009, the population rate over 15 years old with literacy is 93.5%. Among the population over 5 years old, 24.7% of population is in school, 70.2% of them finish the study and only 5.1% never go to school.

Poverty: Poverty rate rapidly decreased from 58.2% in 1993 to 9.6% in 2012; 7.6% in 2013; 6% in 2014.

Human development: According to the figures in 2003, human development index of Vietnam ranked 112 among 177 among other countries in the world; the sex development index ranked 87 among 144 countries; the poverty index ranked 41 among 95 countries. According to UNDP, Vietnam ranked 121 among 187 countries and territories in term of human development in 2013 and 2014. It means that Vietnam has average rank among other countries in the world.

2.1.6. Environment

Currently, Vietnam has been in modernization and industrialization process. The development activities of industry, transport and construction have generated large amount of waste and other releases into the environment. Although in 1995, Vietnam only had 12 industrial zones, by June 2010 there were about 253 industrial zones established by decisions of the Prime Minister in which 171 industrial zones have been operated. By 2014, Vietnam had 295 established industrial zones with total natural land areas of 84 thousand ha in which 56 thousand ha of industrial land area could be hired, accounting for 66% of total natural land area. Among them, 212 industrial zones have been operated with total natural land area of 60 thousand ha and 83 industrial zones have been in the process of compensation for land clearance and construction with total natural land area of 24 thousand ha (Ministry of Planning and Investment, 2014).

To serve for the socio-economic development, the use of chemicals is very important, not only in production and service but also in daily life. According to the statistics of the scientists, about 5 to 7 million chemical substances have been identified; over 80,000 substances have been used in production and other activities; over 1,000 new chemicals have been annually recognized and produced.

Recently in Vietnam, it has been able to see the huge risks to human health and the environment from emissions of hazardous chemicals or the improper use and disposal of pesticide chemicals which have caused serious environmental pollution. It is expected that total quantity of annual use in Vietnam reach 9 million tonnes, in which 3 million tonnes are fertilizers and 4 million tonnes are petroleum products. In the recent years, the use of chemicals and chemical safety becomes an emerging issue of the world and Vietnam, in which chemical emissions are of key relevance. The chemicals include toxic substances contained in furniture, paper, shoes, products serving human life such as clothing, foods, furniture, computers, telephones, vehicles, which have been and still are discarded into the environment (mainly landfills and dumps). The chemicals are released into the environment at the production processes, during the use phase of products and at the end of life at disposal and recycling. Releases are into air and through wastewater or as solid waste. Adverse effects are air pollution, acid rain, pollution of surface and ground water, accumulation in sediments and soils, and harms to the humans as well as affecting fauna and flora including wild life.

In the industrial sector, the mining, especially gold mining has been operated in uncontrolled manners, without a consistent planning, which lead to the risk of toxic chemical penetration into the environment, especially high risk of penetration into the drinking water and irrigation

water. Furthermore, many cement plants have been developed in order to meet the demand of construction in the urbanization process of the country. Cement kilns in Vietnam are mostly using coal as fuel. Besides, thermal power plants using coal, metal recycling villages and waste burial areas are the main sources of toxic chemical including POPs release. Therefore, it is emphasized that there is a high risk of toxic chemical release from mineral exploitation, production of building materials, coal burning and waste disposal. According to the survey of MONRE in 2009, the release sources of mercury from exhausts and solid wastes of the above facilities have been identified and it requires a detailed and in-depth assessment on their potential negative impacts on the human health. This is especially important when Vietnam signed the Minamata Convention on mercury.

Another source of toxic chemical in Vietnam which is of high concern now is the electronic waste including fridges, air-conditioners, microwaves, fluorescent lamps, washing machines, computers, mobile phones, television, and audio equipment, etc. WEEE contains residual, persistent, and toxic chemicals including heavy metals such as nickel, chromium, mercury and POPs and other organic pollutants such as polychlorinated biphenyls and listed bromine fire retardant chemicals. WEEE is now considered as the fastest growing waste stream, expected to increase to globally 50 million tonnes per year with associated releases in particular from non-BAT recycling. However, many people in Vietnam have not yet recognized the danger of the related toxic chemicals and releases.

The rapid development of all industrial sectors in the whole country is causing an increase in release of toxic pollutants and chemicals, as main sources of pollution in soil, water, and air.

- Air:

Recent assessments indicated that the air quality in Vietnam has been strongly affected by the socio-economic development activities (industrial production, transportation, service, business, etc.) have posed negative impacts on the community health, caused environmental pollution and influenced the sustainable development target of the country. Meanwhile, environmental protection and pollution control in Vietnam is weak and insufficient due to the lack of legal framework and economic tools and a consistent database system for air pollution management and control. The system of statistics, registration, and inventory on fixed and mobile release sources caused environmental pollution is inadequate, leading to late updates of changes and process of air emission in particular and air quality in general. When environmental incidents or air pollution occur, the management agencies have difficulty in timely assessing and analyzing or clearly identifying the reasons and solutions. The inspection and control of air pollution has not been implemented regularly, the mechanism of environmental pollution control has not been consolidated and its efficiency has not been ensured.

- Water:

Water pollution is another emerging problem in Vietnam's process of socio-economic development. According to the monitoring data, concentrations of organic substances in the rivers and canals in the urban areas are at the high level exceeding the permissible standards several times. The parameters of ammonium, COD, BOD_5, and Coliform exceed the thresholds from dozens to hundreds of times.

- Soil:

In the past soil environment was not well addressed in regulations. It was often included in the land use management. Recently, recognizing the soil pollution situation, Vietnam Government has issued some policies and regulations for improvement. In 2010, the Prime Minister adopted the Plan on Handling and Preventing Environmental Pollution caused by persistent plant protection chemicals in the whole country by Decision No. 1946/QD-TTg

dated October 21st 2010. In 2012, the National Target Program on reducing pollution and improving environment in the period of 2012-2015 was approved by the Prime Minister in Decision No. 1206/QD-TTg dated 02 September 2012. From these legal documents, many projects and activities focusing on treatment and remediation of polluted areas have been conducted.

In law level, recently, soil environment has been put in Section 3 on Protection of land environment of the Law on Environment Protection 2014. The section regulates the requirement in impacts assessment to the soil environment in implementing projects, activities. It also requires investigating, inventories of soil pollution to remediate. With principle provisions, this section has provided legal basis for development of policies, strategies and other regulations to protect soil environment as well as rehabilitation of polluted areas in Vietnam.

Along with the pollution of water and air, soil pollution is an alarming problem, especially due to the use of agricultural chemicals and fertilizers. Soil pollution not only negatively impacts on agricultural production and produce quality but also indirectly influences human health and animals. The main cause of soil pollution is from agricultural chemicals and chemical fertilizers which have been gradually accumulated in the soil through seasons. The second source is from waste of human and industrial activities (solid, liquid, and gas). On the other hand, soil is a part of the environment, together with air, water and biology ring; therefore, it has accumulated pollutants including POPs. Additionally, metal mining often causes high metal concentrations in the surrounding soil compared with background soil which leads to soil pollution. Recognizing the importance of soil and demand of soil preservation in Vietnam, state management agencies, research centers, institutions and universities have carried out initial researches and assessed the current status, trend and causes of soil pollution in Vietnam.

2.2. LEGISLATION AND POLICY FRAMEWORK

2.2.1. Environmental Protection Policies and Laws

Viewpoints of environmental protection and sustainable development are presented consistently in the directions and development policies and laws of Vietnam.

Vietnam adopted and promulgated many policies and strategies on sustainable development such as Resolution No. 41-NQ/TW dated November 15, 2004, Directive No. 36-CT/TW dated June 25, 1998, Orientation on sustainable development (21 Agenda) dated August 17, 2004, National Environmental Protection Strategy towards 2020 and vision to 2030; Comprehensive Strategy on poverty reduction, Plan on fully handling units causing serious environmental pollution, Action Program of the Government, ministries, sectors and localities to implement Resolution No. 41-NQ/TW, National Plan on Environmental Pollution Control (2005), National Strategy on water resource towards 2020, Strategy on solid waste management in urban areas and industrial zones towards 2020, Plan to implement Stockholm Convention, Green Growth Strategy 2015-2020, Sustainable Development Strategy 2011-2020; Cleaner Production Strategy in Industry towards 2020, Targeted Program for response to climate change and green growth in the period of 2016 – 2020, Plan on handling and preventing environmental pollution caused by persist plant protection chemicals in the whole country, the strategies on sector development such as industry, agriculture and rural development, construction, health, transportation, fisheries, etc.

Regarding to legislation framework, Vietnam finalized many legitimate documents directly or indirectly related to environmental protection. At highest level, there are Environmental

Protection Law 1993, Environmental Protection law 2005 and the latest law is Environmental Protection Law in 2014. Based on this foundation, the legislation system on environmental protection has been formed and continuously developed. The documents guiding the implementation of Law have been developed and detailed into the synchronized legal framework on environmental protection. Additionally, Vietnam promulgated Land Law (1993, 2003, 2013), Mineral Law (1996, 2005, 2010), Law on Water Resource (1998, 2012), Fisheries Law (2005, 2014), Law on Forest Protection and Development (2007), Business Law (2005, 2014), Chemical Law (2007), the Penal Code (1985, 2009, 2015), Decree No. 68/2005/ND-CP on Chemical Safety, etc. Besides the adjustment of relations related to the resource exploitation and usage, the rights and obligations to serve for the development purpose, there are regulations on environmental protection and sustainable development.

Concerning the chemical safety management (including POPs), Vietnam promulgated 06 Laws, 04 ordinances, and dozens of related legal documents. The activities of import, export, trading, and circulation of chemicals and chemical products have been implemented according to the regulations of Vietnam. Vietnam has continuously finalized the legal system on environmental protection. The sanctions and economic measures complying with market economy have been strengthened for pollution control and prevention.

Vietnam has re-constructed the institutional and administrative system to promote environmental protection. MONRE was established in 2002, responsible for state management of environment including safe management, pollution control of chemicals and hazardous waste on the whole country. Almost all provinces and cities have established Divisions of Natural Resources and Environment at district level.

In Vietnam, investment for the environment has been still inadequate. Vietnam has direction for strengthening and diversifying investment for environment including investment source from state budget, private finance source, and international financial support. The research and development activities on environmental protection have been promoted yet still limited due to the lack of investment and a consistent system. Currently, Vietnam has reinforced the socialization of environmental protection.

Vietnam established an Environmental Protection Fund in June 2002. The Fund is the state financial organization under MONRE and under the state management on finance of MOF. The functions of the Fund are to mobilize domestic and foreign financial resources complying with the regulations of Vietnam in order to create investment fund for the environmental protection activities as well as to financially support programs, projects, and activities on prevention and handling of pollution, environmental degradation and incidents causing large-scale impacts at national and/or inter-regional level.

In recent years, Vietnam has been active and involving in the international cooperation on environmental protection at regional and international levels. Currently, Vietnam has participated in many international conventions on environment (18 related international conventions and agreements) including Climate Change Convention, Stockholm Convention on POPs, Minamata Convention on mercury, Kyoto Protocol, Clean Development Mechanism, the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal, Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on their Destruction, Convention of the International Labor Organization on the safety in the use of chemicals at work among others.

2.2.2. Legal documents on environmental protection

In recent years, the National Assembly and Government of Vietnam has developed and promulgated many legal documents on environmental protection directly or indirectly related to POPs management as follow:

- Law on Environmental Protection No. 55/2014/QH13 dated June 23, 2014.
- Decree No. 19/2015/ND-CP dated February 14, 2015 of the Government of Vietnam on regulating in detail some provisions of Law on Environmental Protection.
- Decree No. 18/2015/ND-CP dated February 14, 2015 of the Government of Vietnam on regulating environmental protection planning, strategic environmental assessment, environmental impact assessment, and the environmental protection plan.
- Decision No. 1216/QD-TTg dated September 05, 2012 of the Prime Minister approving Strategy on National Environmental Protection toward 2020, vision to 2030.
- Decision No. 34/2005/QD-TTg dated February 22, 2015 of the Prime Minister on promulgating Action Plan of the government to implement the Resolution No. 41-NQ/TW dated November 15, 2014 of the Political Bureau on environmental protection in the process of promoting national industrialization and modernization.
- Decision No. 153/2004/QD-TTg dated August 17, 2004 of the Prime Minister on promulgating direction of Sustainable Development Strategy in Vietnam (Agenda 21 of Vietnam).
- Decision No. 81/2006/QD-TTg dated April 14, 2006 of the Prime Minister adopting National Strategy on Water Resource toward 2020.
- Decision No. 184/2006/QD-TTg dated August 10, 2006 of the Prime Minister adopting National Plan to implement the Stockholm Convention on Persistent Organic Pollutants.
- Directive No. 26/CT-TTg dated November 26, 2007 of the Prime Minister on controlling and assessing the implementation of plan and targets on natural resources, environment and sustainable development.
- Decision No. 403/QD-TTg dated March 20, 2014 of the Prime Minister adopting National Action Plan on Green Growth in the period of 2014 – 2020.
- Decision No. 577/QD-TTg dated April 11, 2013 of the Prime Minister adopting general plan on environmental protection of the craft village towards 2020 and vision to 2030.
- Decision No. 1419/QD-TTg dated September 07, 2009 of the Prime Minister adopting "Cleaner Production Strategy in Industry towards 2020".
- Decision No. 1440/QD-TTg dated October 06, 2008 of the Prime Minister adopting the Planning of building solid waste treatment area 3 in the key economic zone of the North, the Central and the South towards 2020.
- Decision No. 1946 /QD-TTg dated October 21, 2010 of the Prime Minister adopting Plan on Handling and Preventing Environmental Pollution caused by persistent plant protection chemicals in the whole country.
- Decision No. 2149/QD-TTg dated December 17, 2009 of the Prime Minister adopting National Strategy on Integrated Management of Solid Waste toward 2025 and vision to 2050.
- Decision No. 76/QD-TTg dated January 11, 2016 by the Prime Minister approving the National Action Program on sustainable production and consumption by 2020, with a vision to 2030.

2.2.3. Legal documents on Chemical Management

A range of legislation and related legal documents considering chemical management have been developed and issued.

- Chemical Law 2007: Chemical Law approved by the XII National Assembly, 2nd Session, No. 06/2007/QH12 dated November 21, 2007. The Law regulates chemical activities, safety in the chemical activities, rights and obligations of the organizations, individuals participating in the chemical activities, state management on chemical activities.
- Decree No. 68/2005/ND-CP dated May 20, 2005 of the Government of Vietnam on chemical safety (replaced by the Decree No. 113/2017/ND-CP);
- Decree No. 95/2012/ND-CP dated November 12, 2012 of the Government of Vietnam regulating tasks, mandates, authorities, and organization of Ministry of Industry and Trade;
- Decree No. 113/2017/ND-CP implementing Chemical Law dated October 09, 2017 of the Government to regulate in detail and guide the implementation of several provisions of the Chemical Law;
- Decree No. 104/2009/ND-CP dated November 09, 2009 to regulate list of hazardous products and hazardous product transport by road vehicles;
- Decree No. 163/2013/ND-CP dated November 12, 2013 to regulate the sanctions of administrative violations in chemical field, fertilizer and industrial explosive materials;
- Decision No. 26/2016/QD-TTg dated July 01, 2016 of the Prime Minister issued Regime of response toxic chemicals incident;
- Directive No. 03/CT-TTg dated March 05, 2013 of the Prime Minister on strengthening the prevention and response to the toxic chemical incidents;
- Decision No. 851/QD-BCT on establishing Chemical Department with regulation of tasks, mandates, authorities, and organization of the Department;
- Circular No. 28/2010/TT-BCT of the Minister of Industry and Trade to regulate in detail several provisions of Chemical Law and Decree No. 108/2008/ND-CP dated October 07, 2008 of the Government to regulate in detail and guide the implementation of several provisions of the Chemical Law;
- Vietnam Standard TCVN 5507:2002 Hazardous Chemical – Safety regulation in production, trade, use, storage and transport;
- Circular No. 04/2012/TT-BCT dated February 13, 2012 of the Minister of Industry and Trade to regulate the classification and labeling of chemicals;
- Circular No. 20/2013/TT-BCT dated August 05, 2013 of the Minister of Industry and Trade to regulate the plan and measures of preventing and responding chemical incidents in the industrial sector;
- Circular No. 07/2013/TT-BCT dated April 22, 2013 to regulate the registration of hazardous chemical use for producing goods and products in industrial sector;
- Circular No. 30/2011/TT-BCT dated August 10, 2011 of the Minister of Industry and Trade to contemporarily regulate on allowed quantity limit of some toxic chemicals in the electrical and electronic products;
- Circular No. 16/VBHN-BCT dated April 25, 2014 of the Minister of Industry and Trade to contemporarily regulate on allowed quantity limit of some toxic chemicals in the electrical and electronic products.

2.3. ASSESSMENT OF THE STATUS OF POPS IN VIETNAM

2.3.1. Status of past, current and future import, export, production and use of POP pesticides (Annex A, Part I chemicals)

a) Status of pesticide import

Pesticides management was first officially mentioned in the regulation in 1986 by the Decision No. 454/QD of the State Committee for Science and Technique on promulgating one national standard on plant protection - Terms and definitions. Then, in the Joint Circular No. 04-TT/LB dated on November 21st, 1990 of the Ministry of Heavy Industry and Ministry of Agriculture and Food Industry on management, production, use and trade of plant protection chemicals, the list of allowable plant protection chemicals has been mentioned. In 1991, the first list of allowable plant protection chemicals was issued by the Circular No. 208/BVTV-KHKT/QD. Since then, the lists of allowable and forbidden plant protection chemicals have been revised and issued regularly. Until now, Vietnam has banned the use of 14/15 types of POP pesticides (except for chlordecone, see Table 2).

Table 2. Current regulations on prohibition of POP pesticides in Vietnam

No	POP pesticides	Time of prohibition
1	Aldrin	1992
2	Chlordane	1992
3	Dieldrin	1992
4	Endrin	1992
5	Heptachlor	1992
6	Mirex	2011
7	Toxaphene	1992
8	1,1,1-trichloro-2,2-bis (4-chlorophenyl) ethane (DDT)	1992
9	Hexachlorobenzene (HCB)	2007
10	Chlordecone	
11	Alpha hexachlorocyclohexane	1992
12	Beta hexachlorocyclohexane	1992
13	Lindane	2011 (in health care) and 2015 (in agriculture)
14	Technical endosulfan and its related isomers	2015
15	Pentachlorophenol (PCP), its salts and esters	2015

As a country with strong agricultural sector, Vietnam is a big market for pesticides. In recent years, the amount of pesticides in Vietnam is growing fast. According to existing regulations (Circular No. 03/2016/TT-BNN on the list of plant protection drugs), allowable active substances used in Vietnam is 1,764. According to information of the Plant Protection Department - Ministry of Agriculture and Rural Development, in the last 3 years, annual plant protection chemicals imported was about 100,000 tonnes. The import is still growing: E.g. the total import of insecticides and pesticide in the first 11 months of 2013 was 695.53 million US$, 10.99% higher than the same period in 2012.

Besides, there is a large amount of illegally imported pesticides which are not controlled and might partly contain POPs. Because the production of synthetic chemicals for crop protection has not met the demand, Vietnam still has to import many raw materials. Structure of pesticides imported and used in Vietnam has shifted towards markedly increasing the proportion of herbicide and reduce the incidence and pesticides. In current use of pesticides in Vietnam, there is about 45-47% herbicide; 20 -22% fungicides; 22 -23% pesticides; remaining drugs, growth regulators and other drugs as rodenticide, snail insecticides. Although have

been prohibited, POP pesticides are still floating on Vietnam market due to smuggling.

The state of pesticides smuggling

Like many other countries in the world, the state of pesticides smuggling is complicated in Vietnam. In Lang Son Province whose border is 253 km, the state of smuggling in general and the pesticides one is very complex. Many pesticides which don't have clear sources, labels, and manual were illegally transported through the border and were sold in the Tan Thanh, Loc Binh, Ban Nga markets. A part of the amount of pesticides will be bought by the merchants. They will be labeled and distributed in many provinces in the North. These pesticides are often the old generation which is highly toxic and banned. Many pesticides which have been banned since 1992 is still illegally imported and used in Vietnam. However, the amount of pesticides that is seized is less than the amount which is smuggling in the fact.

Moreover, cause of the high benefit, the sellers take advantage of the farmers' discretion to sale the products which labels are dis honest, incorrect to make the users misunderstand and cause the bad effect to the human health and pets. The trend of people who like to use the cheap pesticides with strong effect and do not care about the environment and human health is a remarkable situation. This is one of the reason that some of banned and out of list pesticides are still on the market and cause the pollution for human health and the environment.

In the 2013, Lang Son Province has seized and destroyed 9,514 kg of out of list pesticides and 2,046 packaging. The amount of Lao Cai Province is 4,223 kg of pesticides and 130 kg of packaging (MARD, 2014).

At present, in addition to POP pesticides have been banned, some added in 2009, 2011, 2013 and 2015 may still presence in the market. One of the typical cases is that in the early of 2015, interdisciplinary inspection team of the Department of Agriculture and Rural Development has inspected, found and seized the shipment of banned pesticides in Tien Phong, Me Linh District. In the site on the behind of the store, they found 41 bottles of endosulfan (100g/ bottle) which is banned of producing, sale, using in Vietnam[28].

The information collected from Department of Custom and Department of Environment Protection in provinces (not sufficient) by the Pollution Control Department, Vietnam Environment Administration when working with local authorities reveal that about 5-7 tonnes of illegal pesticides were monthly seized by the Custom Department in the Northern provinces having borders with China, while there was a larger amount not being confiscated. The process of seizure also showed that there were no descriptions of chemical composition on labels of many pesticides. Therefore, to determine whether or not they contain POPs, the pesticides had to be sampled continuously and it was very costly. In this regard, the continued illegal import of pesticides, many of which contain POPs (such as DDT, lindane), will increase threats to the environment and human health. Due to lack of resources on safe storage and treatment, normally, these pesticides are located in storage areas of Custom Department and Department of Plant Protection for several years before treatment. This may cause the leakage and emission to the environment.

The causes for illegal import of a large amount of pesticides including counterfeit pesticides include:

- Although the production of POP pesticides is illegal, production facilities have been seeking cheap supplies. On the other hand, the control of the government for the chemical safety standards is still poor. As a result, the qualities of much of the raw

[28] The project Building Capacity to Eliminate POPs Pesticides Stockpiles in Vietnam. 2015. Report on current situation of pollution caused by POPs pesticides stockpiles in Vietnam

materials are not known and they may contain POPs.

- Illegal imported pesticides are significantly cheaper than legal ones, thus creating a motive for poor farmers to buy smuggled and partly counterfeit pesticides.
- Due to high toxicity, the pesticides display good results in the prevention of pests and diseases, therefore being trusted by users.
- Due to financial difficulties and limited access to appropriate technologies and collaboration between departments and agencies, the authorities face many difficulties in disposal of POP pesticides stockpiles.
- The capacity of customs authorities, police, and plant quarantine inspection are still limited in arresting smugglers and confiscating illegal pesticides. Typically, the examination of pesticides is difficult, especially in case the pesticides lose labels; therefore, it requires chemical testing, which is time-consuming and costly to identify chemical composition. In many cases, even when a label is available, one cannot guarantee the information on the label is correct. The other difficulty is the lack of storage. There is no extra space once the warehouse has been full.

b) The trade and use of pesticides

The distribution, trading and use of pesticides in Vietnam in recent years have been much improved; however, some weaknesses still exist, stemmed right from the perception of people. In the management of pesticides business, there remain many unregistered businesses or seasonal retailers (drug stores, drug selling points which do not meet requirements of construction or specialization, selling with other commodities such as food); or drug sellers are ignorant of pesticides. All of these have been causing difficulties for management. According to the Plant Protection Department, Vietnam has about 22,000 shops selling pesticides on the market. Although pesticides are a commodity of restricted and conditional trading, up to 20% of businesses are trading pesticides without certificates, which are mainly small shops or shops in remote areas. Moreover, due to un-fixed selling points and small retailers, the investigation of specialized agencies faces many difficulties, while the role of local governments in the management of pesticides has not been clearly expressed. The qualification of drug sellers is low compared with requirements.

Besides, the use of pesticides by local people is also of high concern. Surveys in many local places show that pesticides are scatter distributed and in small volumes to communities; thus, it is difficult to control the quality, types of pesticides as well as packaging processes. Most people buy and prepare pesticides in non-safety manner, having potential of skin and respiratory exposure. In addition, used bottles and packages containing pesticides are littered unconsciously, poisoning cattle, poultry and humans and adversely affecting the environment.

2.3.2. Assessment of PCBs (Annex A Part II chemical)

2.3.2.1. Lubricant and other performance oil production and use in Vietnam

Waste transformer oils and other oils partly contaminated with PCBs sometime enter industrial oil recycling and can contaminate lubricant and other industrial oils or grease[29]. Therefore, it is important to have an overview on the lubricant oil sector and possible contamination pathways and their control. Furthermore, PCBs oil has partly been substituted with short chain chlorinated paraffin currently assessed in the POP Reviewing Committee. Therefore, a short overview is given here with the need to further assess potential

[29] Wijegunasekara B, Ranpatige D, Hewawasam V, Werahera SM, Azmy SAM, Weber R (2015) PCB inventory and management challenge & progress in Sri Lanka. Organohalogen Comounds 77, 519-522.

contamination (see action plan for PCBs).

Currently, the lubricant market in Vietnam has been supplied by more than 30 manufacturers, typically Castrol, Shell, Total, Chevron, Motul, PV Oilube, Petrolimex, Mipec, etc. For blending oils, businesses focus on market segments of large volumes; whereas blending oils with small volumes and requiring technical complexity are directly imported from the parent companies or foreign partners. Import of specialized oil is often combined with other business activities; therefore, there has been no statistical list. This type of oil accounts for 20% of oil consumption. Consumption of lubricants (including greases) in 2013 in Vietnam was estimated at 320,000 tonnes (PV Oil, 2013).

- Base oil including SN 150, SN 300, SN 450 base oil and BS 150 base oil.

- Additives: Imported in the forms of synthetic or separate additives to be added to the base oil in order to improve the properties of the lubricant.

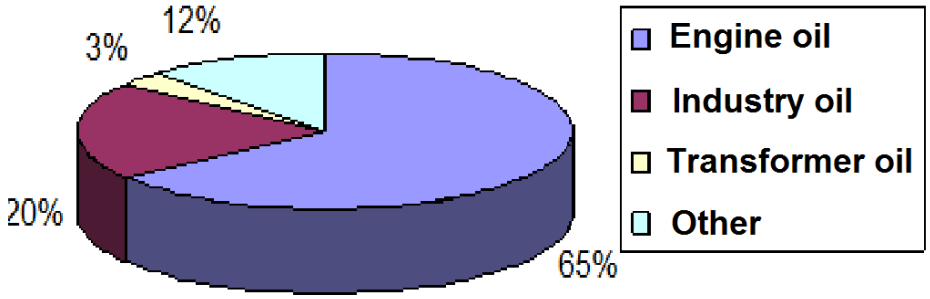

Figure 2. Proportions of lubricants

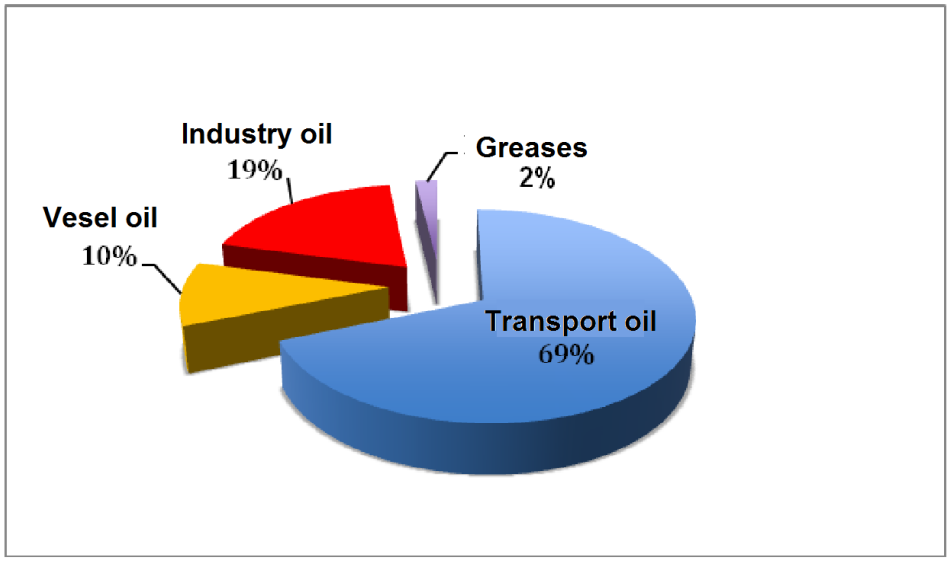

Figure 3. Amount of oil by type

Source: PV Oil 2013

Production of lubricants by category

Engine oil is formulated and supplied on the market in largest volume, while industrial oil and transformer oil account for only a modest proportion. Oil is used for the purpose of making new and replacing equipment during maintenance. The classification of oil below underlines the oils added with chlorine compounds, including: Gear drives, hydraulic oil, heat transfer

oil, cutting fluids, oil for power sector, cooling liquid.

Regarding the disposal of oil, waste oil after being replaced will be collected by recycling or waste treatment facilities for the purpose of processing and then reused in equipment or to be used as fuel in industrial production processes, or to create by- products like asphalt, candles, etc. and to be reused in industry, household and service. However, there have been no statistics related to the use of these discarded oils yet and the potential impact of waste oils containing PCBs has not been assessed.

2.3.2.2. Inventory of PCBs in Vietnam

PCBs was not produced in Vietnam; however, PCB-containing oils were imported into Vietnam in the period of 1960 - 1990 mainly in electrical equipment such as transformers, capacitors, industrial equipment such as hydraulic lifting, high pressure pumps, etc. Currently, PCBs still exists in electrical equipment, industrial equipment, oil in storehouse, and some PCBs have penetrated into soil, water, lake and river sediments.

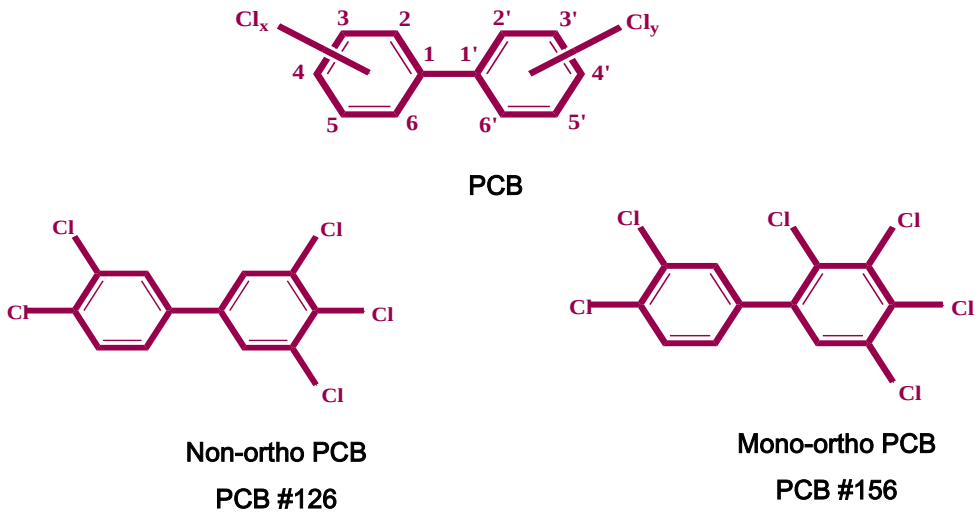

Figure 4. General chemical structure of PCBs and two typical PCB congeners

From 2005 to 2009, Vietnam had three units in charge of PCBs inventory, including Vietnam Electricity, Vietnam Environment Agency/MONRE and the Ministry of Industry and Trade (MOIT). Most recently, through the Project PCBs Management in Vietnam deployed from 2010 to 2015, PCBs inventory has been conducted on the national scale, targeting at electrical equipment both within and beyond the power sector, including transformers and capacitors, industrial equipment and stockpiled oil.

2.3.2.2.1. The PCBs inventory results in EVN

According Vietnam Electricity, until April 1998, EVN has used over 17,688 tonnes insulation oil, including non-PCB oil, oil suspected of containing PCBs and PCBs contaminated oil, which were supplied from 17 different countries around the world[30].

Transformer

Up to June 2015, 47,766 oil samples had been quick tested and 9,006 of them had been analyzed by using GC/MS. The results showed that: 28,824 quick analyzed samples (61% of

[30] The presentation "*Vietnam Electricity (EVN) with PCBs management issues"* of Board of Science Technology and Environment, Vietnam Electricity presented at the Workshop on *Dissemination of information to journalists about the persistent compounds and PCBs compounds* held in Hoa Binh city from 13-14 January 2011.

total analyzed samples) have PCBs concentration in the range of ≥ 5 - 50 ppm and 1,944 quick analyzed samples (equivalent to 4%) contain over 50 ppm of PCBs. GC/MS analyzed samples showed that: Only 562 samples of the above 28,824 quick tested samples have PCBs concentration in the range of ≥ 5 - 50 ppm; 431 samples of the above 1,944 quick tested samples have PCBs concentration ≥ 50 ppm.

Discarded capacitors

There are 30,298 discarded capacitors were inventoried by EVN. Among these, 26,537 capacitors (equivalent to 87.6%) do not have information about types of oil or liquid used and these were classified as PCBs suspected capacitors. In the remaining 3,761 capacitors (equivalent to 12.4%), most of them (3,690 capacitors) were classified as non-PCB.

TU/TI and breakers

Statistical data of TU/TI and breakers inventoried are not available yet.

2.3.2.2.2. The PCBs inventory results in Non-EVN

Transformers, electric equipment

In 93,846 equipment inventoried in 63 provinces/cities of Vietnam there are 35,948 equipment (38.3%) suspected PCBs contamination[31]. By 2015, 4,500 equipment had been sampled and 50% of them had been analyzed, analysis results showed that: 147 samples have PCBs ≥ 5-50 ppm, 7 samples have PCBs ≥ 50 ppm.

Capacitors

The report of CS3/ISEA of Vietnam PCBs Management Project (2014) also showed that number of PCBs suspected capacitors are 5,612, of which, 204 capacitors were manufactured before 1995; 2,413 capacitors were manufactured in the period of 1996-2000 and 2,995 capacitors do not have related information. So far, the amount of oil contained in these capacitors has still not been determined yet.

In addition, currently, companies, enterprises, businesses of major corporations are also operating and storing 702 PCBs suspected equipment (including transformers, generators, compressors, breakers, capacitors, devices used hydraulic oil, lubricating oil, etc.) that were manufactured before 1995 and 70 equipment were manufactured in the period of 1996 – 2000.

Estimated amount of PCBs suspected oil

The current status of PCBs inventory by implementing agencies shows that the total volume of oil contaminated with PCBs of 5-50 ppm concentrations is 739 tonnes, of 50-500 ppm concentrations is 589 tonnes, and over 500 ppm is 14 tonnes.

In addition, there are a huge number of capacitor oil, circuit breaker oil, industrial oil, oil remaining in storage and a large number of EVN transformers of which PCBs levels have not been evaluated yet. In addition, hydraulic fluids in the mining sector and other uses and PCBs in open applications have not been assessed yet.

Therefore, the inventory needs to be extended to capacitors and other equipment, the remaining transformers and potentially contaminated waste oils and continuously updated, applying the method of equipment records and labelling combined with sample analysis to obtain sufficient and accurate data for a full PCBs inventory.

[31] PCBs Management Project. 2013. The final Report CS3/ISEA: National inventories of PCBs – Non EVN

2.3.3. Assessment of POP-BDEs (Annex A Part IV and Part V chemicals) and HBB (Annex A Part I chemical)

The brominated flame retardants (BFRs) Hexabromobiphenyl and certain congeners/homologues of c-PentaBDE and c-OctaBDE two commercial polybrominated diphenyl ether mixtures including the listed tetraBDE, pentaBDE, hexaBDE and heptaBDE (POP-BDEs) were added to Annex A of the Stockholm Convention on POPs in 2009.

PBDE has not been produced in Vietnam, yet the country only produces, uses and disposes materials like electrical and electronic equipment and transport vehicles that are likely to contain PBDEs including listed POP-BDEs.

2.3.3.1. Inventory of POP-BDEs in electrical and electronic equipment

The inventory of POP-BDEs in electrical and electronic equipment and related waste throughout their life cycle from production to disposal lays a solid ground for effective management and helps proactively deal with issues related to environmental pollution and impacts on human health caused by POP-BDEs. Data are collected on 6 EEE categories, which include TV, mobile phone, telephone, fridge, air-conditioner and washing machines. The preliminary inventory and estimates with the limited available dataset from 2002 to 2006 showed the flow of POP-BDEs as described in Figure 5.

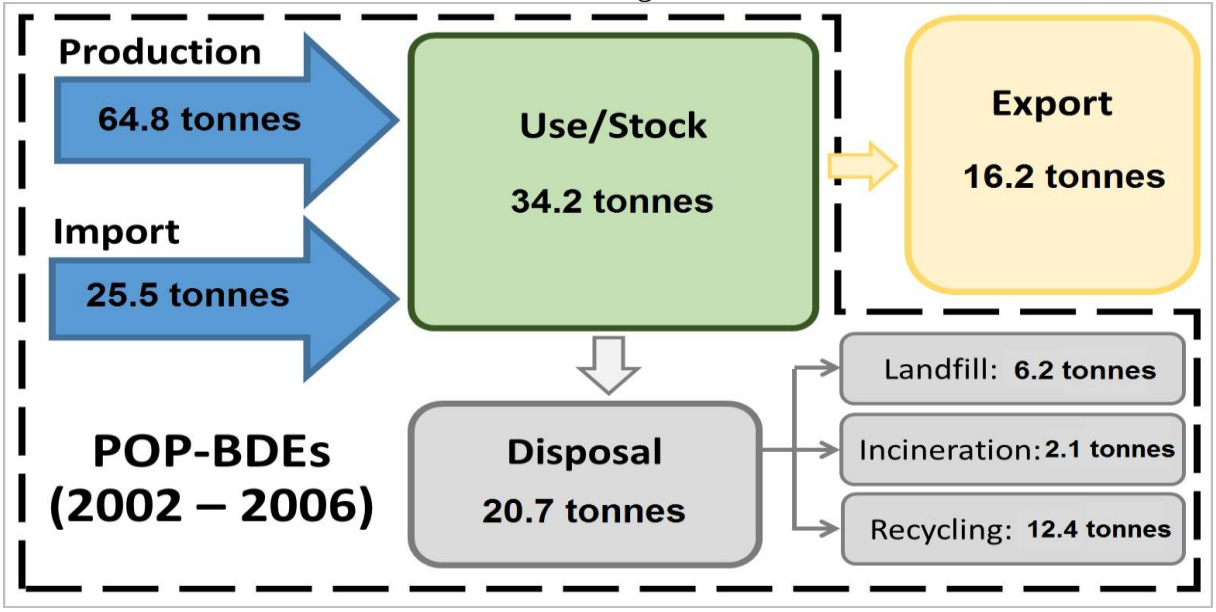

Figure 5. Mass flow of POP-BDEs contained in electronic equipment in Vietnam[32]

The estimates of commercial c-octaPBDE and related POP-BDEs (total hexa and hepta BDE) used in EEE for the period of 2007-2014 are shown in the Table 3 below.

In total several 100,000 tonnes of WEEE plastic are present in Vietnam which will need environmentally sound management including the management of brominated POPs, other flame retardants and additives present in these materials.

Overall this first inventory combined with initial environmental and human monitoring (see below) show that the increasing use of electronic and electrical equipment coupled with manual recycling of electrical waste have caused POP-BDEs contamination in Vietnam. In addition, the risk of POP-BDEs release is present at landfills and storage and gathering sites of discarded electrical and electronic equipment.

[32] NIP Update Project. 2015. Report of new POPs inventories

Table 3. Estimate of POP-BDEs quantity present in electrical and electronic equipment in the period from 2007 to 2014*[33]

Year	Polymer volume; tonnes*	Estimate of commercial c-octaBDE; kg*	Estimate of total hexa- and heptaBDE; kg
2007	337,762	477,513	257,857
2008	374,552	510,369	275,599
2009	424,977	458,434	247,554
2010	443,985	428,268	231,264
2011	475,926	473,598	255,743
2012	474,152	399,227	215,582
2013	511,518	476,431	257,272
2014	879,618	568,065	306,754

*total accumulated plastic and total accumulated PBDE (2014 include the previous year)

2.3.3.2. Inventory of PBDE in the transport sector

The amount of PBDE, here mainly the amount of c-pentaBDE, in vehicles in Vietnam has been inventoried based on statistics data on the number of vehicles in use, produced and imported to Vietnam in 2010 and 2011. The total amount of POP-BDEs in the 1,285,739 vehicles in use (stock) were estimated to 6,540 kg with approximately 350 kg imported in the inventoried year (2011).

Table 4. Recalculation of c-PentaBDE present in the transport sector to the listed POP-BDE homologues (TetraBDE, PentaBDE, HexaBDE and HeptaBDE) for the relevant life cycle stages*[34]*

	Distribution homologues c-PentaBDE	POP-BDEs in vehicles currently in use in inventory year 2011 (in kg)	POP-BDEs imported[35] in vehicles in the inventory year 2011 (in kg)*	POP-BDEs in end-of-life vehicles in the inventory year 2011 (in kg)	POP-BDEs disposed off in the past from the transport sector (in kg)
Total c-PentaBDE		6542	352		
TetraBDE	32%	2051	113	-	-
PentaBDE	56%	3590	131	-	-
HexaBDE	9%	577	32	-	-
HeptaBDE	0.5%	32	1.8	-	-

** from 2010 to 2011; - Data not available.*

In total also several 100,000 tonnes of plastic and foams are present in the transport sector which need to managed the next decades including partly POPs (POP-BDEs and HBCD) and other toxic additives (other flame retardants, SCCPs, phthalates).

2.3.3.3. Inventory of POP-BDEs in other minor uses

In this first inventory other potential uses of POP-BDEs (in furniture, textiles, insulation in construction) were not assessed. Due to the lack of flammability standard for specific uses in Vietnam, it can be assumed that the POP-BDEs use in furniture, mattress, textile, and carpet industry are not existing or at least not significant. Further assessment would need a

[33] NIP Update Project. 2015
[34] NIP Update Project. 2015
[35] Please note that the imported vehicles are also included in the inventory of "currently in use/sale" and that these two categories are not summed up.

monitoring approach.

2.3.3.4. Inventory of HBB

HBB was not specifically addressed in the inventory since the production volume is considered small (approximately 6,000 tonnes) largely used in the 1970s in the U.S. Therefore, there is only very limited practical relevance. Since applications were in the same use sectors (Plastic of electronics, PUR foams in transport) the possibly remaining HBB in products will be managed together with the POP-BDEs stocks and wastes.

2.3.3.4. Use of POP-BDEs, HBB and HBCD alternatives

Currently it is not known what flame retardants are used in Vietnam (e.g. in textile industry, polymer production or construction). In addition, it is not known what alternative flame retardants are imported in products such as polymers or textiles. It is suspected that partly DecaBDE is used/present in these articles and processes which is suggested for next activities. In addition, HBCD listed in 2013 to the Convention might still be used. There is an urgent need to assess what alternatives are used in Vietnam and what alternatives would be the preferred alternatives considering toxicity and environmental impacts.

2.3.4. Assessment with respect to DDT (Annex B Part II chemical)

Vietnam has never produced DDT. Before 1985, Vietnam used pesticide imported from the former Soviet Union and the socialist countries (previously) with quantities of 6,500 to 9,000 tonnes/year. According to statistics of General Statistics Office, from 1957 to 1990, the total amount of DDT imported was about 240,422 tonnes only. However, during the stage of agricultural development after renovation, the amount of DDT imported was highly increased, it was 423,358 tonnes imported only from the Federal Republic of Russia during the period from 1992 and 1994.

Figure 6. DDT stockpile in Hung Nhan cave, Quang Binh province

The statistics of the General Department of Statistics showed that in 2012 and 2013 Vietnam still imported goods with code 290392 (HCB and DDT) from China with the import value was $ 238,000 (2012) and $ 56,000 (2013).

In the health care sector and military in the past, Vietnam had the high ratio of malaria carriers. DDT had been used since 1949 and widely used in the year of 1962, 1963 and 1981 (about 1,000 tonnes/year). During the 1990s, malaria epidemics occurred in the broad area, so the amount of DDT imported into Vietnam increased significantly, especially in the years of 1992 and 1993. The storage, transportation, distribution and use of DDT for malaria prevention along Ho Chi Minh trail were strongly conducted in the period of 1956-1979 with estimated at 15,000 tonnes DDT[36].

Pesticide is DDT which were stored mainly in the pesticide storage before 1990 and allocated mostly in the North Central Province (84%) and Highland Provinces (14%). Since 1992, DDT

[36] Project on Building capacity to eliminate POPs pesticides stockpiles in Viet Nam. 2015. Existing pollution situation caused by POP pesticides stockpiles in Vietnam

was banned for use in agriculture in Vietnam. However, DDT was still used for health protection purposes until the end of 1994. In 1994, the Institute of Malaria, Parasitology and Entomology stopped supplying DDT for the provinces, but in some locals still preserved and used DDT. By the year 1995, Vietnam officially stopped using DDT in controlling malaria vectors. Due to many shortcomings in management, the quantity of DDT was still being used in combating malaria and other insects.

In Vietnam, DDT (mixed with lindane) stockpiles still exists (around 100 tonnes) and contaminated areas (see below POPs stockpile section). Furthermore, DDT imported according to Vietnam General Statistic Office's data should be clarified to have appropriate control.

2.3.5. Assessment of PFOS (Annex B Part III chemical)

2.3.5.1. Status of PFOS management in Vietnam

PFOS is not produced in Vietnam; however, it is imported into the country and used in many areas such as industries, business and households.

In reality, there have been no legal documents directly regulating the management of PFOS in Vietnam. However, Vietnam has developed and enacted a number of legal documents related to indirect management of new POP compounds (including PFOS) as follows:

- Law on Environmental Protection: Specifies that substances with high toxicity, persistence, high ability of transport and accumulation in the environment, negative impacts to the environment and human health must be registered, investigated, inventory controlled, assessed, risk managed and disposed.
- Law on Chemicals 2007: POP chemicals are on the list of import restrictions and conditional business.
- For electrical and electronics appliances, Vietnam has no specific provisions for PFOS, even though it has regulations on permissible concentration of heavy metals (Pb, Cd, Hg, Cr^{6+}), polybrominated biphenyls and PBDEs.
- For firefighting materials, the Police Department of Fire Fighting, Prevention and Rescue currently merely recommends the use of chemicals under the Montreal Protocol (restricting ODS substances). Despite no regulations on the use of PFOS in firefighting foams, this sector has recommended the reduction and gradual replacement of the bromide derivative compounds.
- For textile and civil plastic, there have been no regulations for this issue. When importing materials from abroad, importers use standards or regulations of the exporting countries for plastic or fabric materials.

2.3.5.2. PFOS inventory in Vietnam

PFOS and PFOSF are fully fluorinated compounds and generally known under the name of PFOS, were added into Annex B of the Stockholm Convention in 2009. They are commonly used as salts or incorporated into larger polymer. PFOSF is used as an intermediate to produce different PFOS related substances (precursors). PFOS have been used in a wide range of industrial and consumer applications and products since 1950s with major use in the1970 to 2002.

The perfluorinated carbon chain has both hydrophobic and lipophobic properties. They can repel fat, dirt and water. These unique properties make them valuable for various industrial and consumer applications as surface active substances. Industries have been identified in using PFOS are: Electronic, semiconductor, metal plating, rubber and plastic, photo imaging, petroleum and mining. Major consumer products which may contain PFOS are synthetic carpet, treated paper, textile, furniture, leather and coating products. The main producing company 3M in 2000 announces the phase out of PFOS and the production amount dropped

from approximately 4,500 tonnes to about 100 to 200 tonnes mainly produced in China with minor production in Germany. However, still PFOS and related substances are found in high concentration in different environmental samples of surface water, sediment and biota, breast milk and food. PFOS is practically non-degradable under environmental relevant conditions and therefore is highly persistent. Several of them are considered toxic and bio-accumulative in the environment. According to Article 15 of the Stockholm Convention, every four years, parties produce/use PFOS have to report on PFOS elimination progress. Thus, it is necessary to inventory PFOS. Vietnam conducted a preliminary PFOS inventory to have initial information on PFOS.

PFOS preliminary inventory

The assessment and preliminary inventory of PFOS in Vietnam was conducted in 2015 based on main activities: Assessment of import, use and release of PFOS based on data of consumption products, chemicals and specialized products may contain PFOS to estimate volume of products contain PFOS and PFOS amount following the Guideline for PFOS inventory of the Stockholm Convention; assessment of use and storage products/wastes may contain PFOS; assessment of PFOS release and PFOS contaminated areas. The results are showed in the following Table[37]:

Table 5. Results of assessment and inventory of PFOS

No	Articles	Estimated PFOS amount; tonnes/year	Note
1	Textile and upholstery	0.11- 3.45	Period of 1998-2013
2	Paper and paperboard	0.2-4.8	Period of 1998-2013
3	Chemicals (i.e. organic composite solvents and thinners, not elsewhere specified or included; prepared paint or varnish removers)	0.062	
4	Firefighting foam	10-15	Period of 1998-2013

These estimates have uncertainties since it was based on importation data that have shown to lead to an overestimation of PFOS levels[38]. On the other hand, there is no quantification of the several potential industrial users.

Major PFOS uses in Vietnam are likely firefighting foams and chromium plating. In addition, oil drilling, aviation hydraulic fluids, insecticides, surface treated materials, could be current uses and they are needed for further assessment.

In Vietnam, there are nearly 150 establishments working in metal plating, in which about 30% is chrome plating[39]. Besides, there are metal plating facilities at household scale which have not been registered. These establishments are potential sources of PFOS emission especially the survey conducted in 2015 has found the existence of PFOS in wastewater and sludge of plating companies.

Furthermore, PFOS, PFOA and other PFAS have been found in surface water, groundwater, soil, sediment, sludge, wastewater and even fish. In-depth data on the weight of each group of articles and chemicals containing PFOS as well as data on concentrations of PFOS has not been adequately investigated. The existence of PFOS in the environment has been examined based on only a modest number of samples. This shows the high risk of use and emission of

[37] NIP Update Project. 2015.

[38] Korucu MK, Gedik K, Weber R, Karademir A, Kurt-Karakus PB (2015) Inventory development of perfluorooctane sulfonic acid (PFOS) in Turkey: Challenges to control chemicals in articles and products. Environ Sci Pollut Res Int. 22, 14537-14545

[39] Vietnam Yellow Page. 2015

PFOS from industries and use of articles containing PFOS. Therefore, a national PFOS inventory program and activities and projects for management and reduction of PFOS should be conducted in the future.

Use of PFOS alternatives

For almost all applications of PFOS alternatives are available. For Vietnam the area of potential PFOS use are textile, fire-fighting foams, chromium plating, aviation hydraulic oil and oil drilling operation. For these application alternatives are available.

Alternatives to PFOS containing foams are globally available and can also be used in Vietnam. For chromium plating alternatives might be available but still also industrial countries have listed exemptions.

In oil drilling, the chemicals used as additives in oil wells drilling were obtained from companies working in the field of oil exploration and production. For the specific improvement of oil extraction, the use of PFOS is not specific and therefore there should be a range of alternatives.

2.3.6. Assessment of unintentional produced POPs (Annex C chemicals)

Unintentional POPs listed in Annex C of the Stockholm Convention include PCDD/PCDF, HCB, PCBs, PeCBz and PCNs.

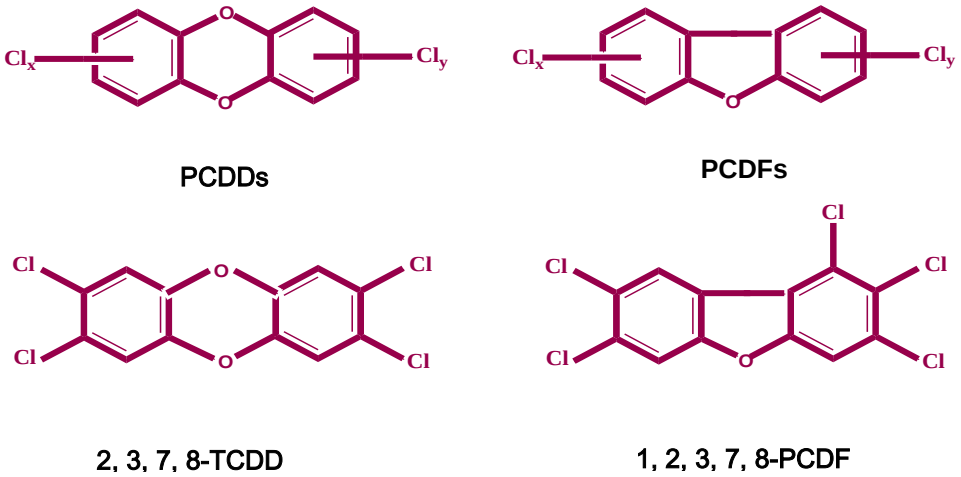

Figure 7. Chemical structure of dioxin, furan and two typical toxic 2,3,7,8-substituted PCDD and PCDF congeners

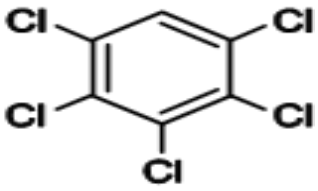

Figure 8. Chemical structure of PeCBz

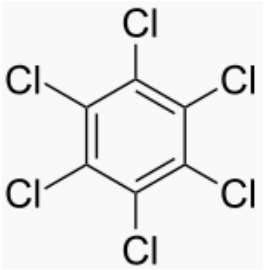

Figure 9. Chemical structure of HCB

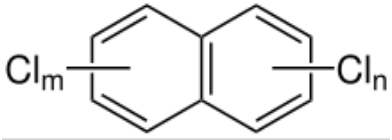

Figure 10. Chemical structure of PCNs

The Stockholm Convention requires Parties to take measures to continuously reduce and eventually eliminate the emissions of UPOPs. Specifically, the Convention requires Parties to adopt at least the following measures, in order to reduce the total emissions from human-caused sources of each chemical listed in Annex C, with the objective of continual reduction and ultimately eliminate, if possible:

- Develop an action plan or regional or sub-regional action plans. The action plan must include: Reviewing the current emissions and projections for the future; evaluating the effectiveness of laws and policies related to the control of such emissions; and implementing education, training and awareness raising about UPOPs emission control action and strategy.
- Encourage the application of best available techniques and best environmental practices (BAT/BEP) to reduce emissions of the substances in Annex C. When applying BAT/BEP, Parties should consider the general guidance on measures to prevent and reduce emissions in Annex C and guidelines on BAT/BEP, to be adopted by decision of the Conference of the Parties.
- Encourage the development and, if appropriate, request the use of substitute or renovated substances, products and manufacturing processes in order to prevent the formation and release of chemicals listed in Annex.
- Apply the emission thresholds or operational standards to fulfill its commitments towards the application of best available techniques specified under this section.

For assessment of UPOPs releases, Vietnam conducted the inventory using the 2013 version of the "Toolkit for Identification and Quantification of Releases of Dioxins, Furans and Other Unintentional POPs under Article 5 of the Stockholm Convention on Persistent Organic Pollutants" of UNEP. The type of release sources has been surveyed and inventory results are presented as follows:

2.3.6.1. Inventory of PCDD/PCDF

2.3.6.1.1. Inventory of PCDD/PCDF from waste burning

PCDD/PCDF emissions from open burning activities in Vietnam are identified based on national statistics of incineration operations, methodologies and emission factor values through means like air, soil, water, products and waste (depending on operation types) referenced from Toolkit 2013. The open burning in Vietnam is divided into 02 major categories, including biomass burning and waste incineration.

Figure 11. Simple brick furnace

In Vietnam, open burning of agricultural wastes, landfills, forest fire, illegal burning and other open combustion in rural and craft villages are quite popular. Recently, open burning of agricultural wastes (straw) has become common. It causes severe environmental issues. According to data of national inventory for dioxin/furan by UNEP, these activities have average release at 22.6 TEQ/year during last six years (2006-2012)[40]

Figure 12. Waste open burning

The amount of dioxins/furans release into the environment in Vietnam over the years from 2007 to 2012 by open burning including with major release from Waste combustion at landfills and dumping sites released the highest

[40] Open Burning Project, 2015

level, accounting for about 61-63% of total emissions from open burning (Figure 13)[41].

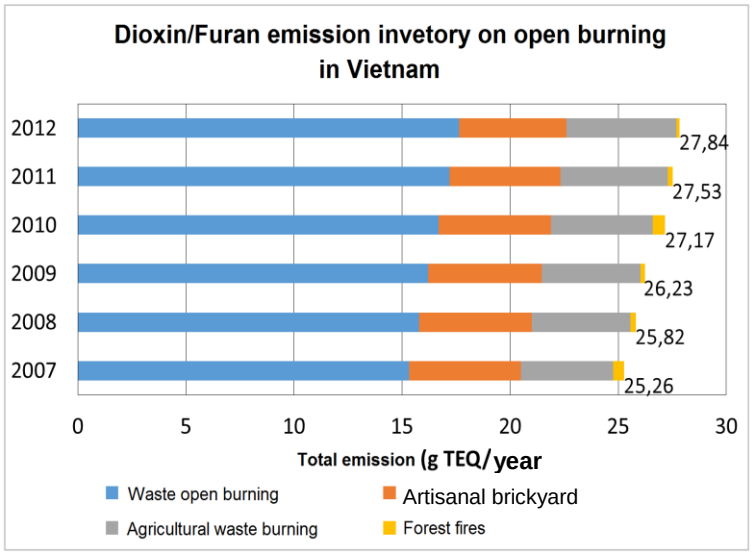

Figure 13. PCDD/PCDF emitted from open burning in Vietnam in 2007-2012

In Vietnam currently, one of the sources of emissions of dioxins/furans to the environment is from solid waste incinerators. Districts and communes tend to invest in solid waste incinerators with small capacity for handling domestic waste. By 2015, according to provincial reports, the country has about 50 solid waste incinerators, mostly small incinerators with treatment capacity below 500 kg/hour The technical quality of the waste incinerator is not sufficient. Of this about 2/3 incinerators are manufactured and assembled in Vietnam.

Figure 14. Domestic waste

The investment in incinerators with small capacity is temporary a solution contributing to address the problem of solid waste generated especially in rural areas. However, some of these incinerators does not have exhaust treatment systems and no emission sampling points; no appropriate design, emission records and related documentation. Many small-scale incinerator construction investments in the province led to the waste scattered and difficult to control emission of secondary pollution. Even with a number of large-capacity incinerators, there have the current problems of non-optimal sorting, feeding, and no energy recovered; ineffectively pollution control. The leachate collection and treatment system and the handling of the smell are also not appropriate.

Through the survey, the fact that many incinerators not high treatment efficiency, emissions arising not been strictly controlled, risk of dioxins/furans emission.

Research by Vietnam Environment Administration (VEA) implemented in 2014-2015 period discovered dioxin/furan emissions of hazardous waste incinerator at concentrations of 0.5 - 20 ng TEQ/Nm^3.

2.3.6.1.2. Inventory of PCDD/PCDF emission from steel manufacturing

In 2010, although the design capacity of the steelmaking facilities in Vietnam was 8.8 million tonnes, the total output of steel and steel billets actually made was around 4.63 million tonnes/year. In recent years, Vietnam's steel industry has seen a high growth rate, over 18%/year. According to the forecasts of steel demand in the economy and the targeted output of the steel sector for the period 2007 - 2020, the output of steel and steel billets of Vietnam in 2020 will double increase compared to 2010, i.e. about 9 million tonnes/year. For the

[41] NIP Update Project. 2015

technical objective, Vietnam will have 40% of the steel produced by EAF furnaces equipped with dust filtration systems and 60% by BOF medium and high frequency furnace installed with emission treatment system by 2020.

Table 6. PCDD/PCDF release into the air and residues from steel production in Vietnam in 2010 and projections for 2020

No.	Technology	Capacity *(tonnes/year)*	Weight of emission*(g TEQ/year)*	
			Air	*Residues*
Year 2010		**4,633,000**	**8.813**	**38.985**
1	Dirty and poorly controlled steel scrap	150,000	1.500	2.250
2	Clean or dirty steel scrap, or iron, having filter cloth behind furnace	2,423,000	7.269	36.345
3	Clean or dirty steel scrap, or iron, EAF furnace equipped with APC system; or BOF furnace	260,000	0.026	0.390
4	Blast furnace with APC system	1,800,000	0.018	ND*-
Year 2020 (estimated)		**9,000,000**	**11.894**	**56.175**
1	Dirty and poorly controlled steel scrap	100,000	1.000	1.500
2	Clean or dirty steel scrap, or iron, having filter cloth behind furnace	3,600,000	10.800	54.000
3	Clean or dirty steel scrap, or iron, EAF furnace equipped with APC system; or BOF furnace	450,000	0.045	0.675
4	Blast furnace with APC system	4,850,000	0.049	N.D*

**not determined*

Inventory of PCDD/PCDF release from steelmaking process based on actual measurements

Researches by Vietnam Environment Administration and the University of Natural Sciences, Vietnam National University conducted in 2012 on 17 dioxin/furan indicators in 06 emission samples and 04 fly ash samples at 02 steelmaking facilities show that: The total content of PCDD/PCDF in emissions of the steel furnace was 0.048 ng TEQ/Nm^3 (for EAF furnace) and 0.166 ng TEQ/Nm^3 (for BOF furnace). The total dioxin/furan concentration in fly ash of surveyed steelmaking factories was 342 pg TEQ/g (for EAF furnaces) and 325 pg TEQ/g (for BOF furnaces).

PCDD/PCDF emissions from 02 steel plants in Vietnam in 2012 were of 1.45 µg TEQ/tonne (for EAF furnaces) and 0.353 µg TEQ/tonne (for BOF furnaces). These values were within the default range specified by the Toolkit (from 0.01 to 10 µg TEQ/ton of product, depending on the technology) and slightly higher than the reference level specified in the Toolkit, which indicates the risk of underestimation of dioxin emissions into the environment from steelmaking operations from the toolkit. This requires further studies to supplement the available database on emissions of dioxin/furan of the steel industry in Vietnam.

In addition to the above activities, dioxin/furan emissions were also evaluated for the production of cement, paper and thermal electricity.

2.3.6.1.3. Summary evaluation on the status of PCDD/PCDF release in Vietnam

PCDD/PCDF release into the environment in Vietnam has been estimated based on national statistics on the capacity and output of industrial activities and incineration and based on the methodology and emission factors given by the UNEP Toolkit. The amount of PCDD/PCDF released into the air, water, soil, products and waste of major Annex II and some Annex III

sources with high potential of PCDD/PCDF release include: (1) waste incineration; (2) secondary metal production; (3) uncontrolled burning; (4) cement production; (5) paper production and (6) transportation is illustrated in Table 7[42].

In this inventory a range of sources have not been considered including chemical industry and chemical import. For these sources, more assessment including monitoring is needed in future.

The total amount of dioxin/furan emissions into the environment of Vietnam from industrial activities and incineration is estimated to be 568 g TEQ/year. The activity that has the highest level of dioxin emission is from waste incinerators with the emission volume of 465.7 g TEQ/year, accounting for 82%; followed by metallurgy at 47.8 g TEQ/year, accounting for 8.4%. The emission volume of open burning, cement manufacturing, paper production and transportation is 26.6; 17.9; 6.47 and 3.99 g TEQ/year, respectively accounted for 4.7%; 3.2%; 1.1% and 0.7%. Although this is only estimated data using the default emission coefficient specified by the Toolkit, it contains useful information about the level of dioxin emissions from industrial activities in Vietnam. Moreover, the actual measurements from a number of surveys and studies conducted by scientists, both domestically and overseas, have detected the presence of dioxin/furan in industrial waste sources and other environmental objects in Vietnam. Initial data on inventory of dioxin/furan has been published; however, the database on the inventory of these toxic substances in the country is still very limited and needs to be regularly updated in the future. Table 7 above just shows the incomplete UPOP emissions from 6 branches in Vietnam. Besides, recycling and production of non-ferrous metals have not been evaluated. With operational characteristics of this sector in Vietnam with many small metal recycling facilities, metal recycling craft villages, emissions UPOP in this area should be focused for assessing and implementing UPOP measures to reduce emissions.

Table 7. The amount of PCDD/PCDF release into the environment in Vietnam

No.	Activity	Weight of emission *(g TEQ/year)*					
		Air	*Water*	*Soil*	*Product*	*Waste*	***Total***
1	Waste incineration	287.8	0	0	0	177.9	***465.7***
2	Metal industry	8.81	0	0	0	38.98	***47.8***
3	Uncontrolled burning	24.3	0	0.87	0.37	1.11	***26.6***
4	Cement production	17.9	0	0	0	0	***17.9***
5	Paper production	0.006	0	0	0.657	5.33	***6.47***
6	Transportation	3.99	0	0	0	0	***3.99***
Total		**568**					

2.3.6.2. Inventory of PeCBz

PeCBz may be formed unintentionally from incineration and other thermal processes, organochlorine production and other industrial activities involving chlorine. The inventory of unintentional PeCBz focused on burning activities: (1) solid waste burning; (2) biomass burning; and (3) coal burning.

2.3.6.2.1. PeCBz emission from waste combustion

Waste combustion is a potentially significant source of PeCBz emissions. Estimation of major wastes (Domestic waste, normal and hazardous industrial waste, medical waste) in Vietnam indicates that total waste generated in 2014 was 30 million tonnes in which about 400,000 tonnes were incinerated. By using PeCBz emission factor of $7.6.10^{-8}$ kg/kg referred to international experience[43], emission of PeCB from waste incineration in Vietnam is estimated at 30.4 kg/year.

[42] NIP Update Project, 2015

[43] Bailey R.E. (2007). Pentachlorobenzene - Sources, environmental fate and risk characterization. www.eurochlor.org.

2.3.6.2.2. PeCBz emission from biomass combustion

Biomass in Vietnam is mainly agricultural residues such as straw, rice hulls, leaves and stems of corn, cassava, and peanuts. Most agricultural by-products have been burned on fields, a small amount has been used as fuels for cooking and other activities. The main agricultural crops in Vietnam are rice, corn, sugar cane and peanut, in which rice accounts for about 71%, corn accounts for about 17%, sugarcane accounts for about 10%. The statistical data on the amount of burned agricultural byproducts and PeCBz release from 2007 to 2012 are given in Table 8[44]. PeCBz emissions from biomass combustion from 2007 to 2012 are compiled in Table 8 with using PeCB emission factor of $1.18.10^{-8}$ kg/kg[45]. From this table, the average amount of PeCBz emissions from biomass combustion in Vietnam is 500 kg/year; this amount is much smaller than the amount of 43,900 kg of PeCBz in Canada in 2007[46].

Table 8. Amount of burned agricultural residues and PeCBz emission from agricultural residues combustion from 2007 to 2012 in Vietnam

Year	Agricultural by products *(tonnes)*	Burned amount *(tonnes)*	Amount of PeCBz emission*(kg)*
2007	7,760,774	3,880,387	458
2008	8,299,895	4,149,948	490
2009	8,293,293	4,146,647	489
2010	8,545,550	4,272,775	504
2011	9,026,829	4,513,415	533
2012	9,258,124	4,629,062	546

2.3.6.2.3. PeCBz emission from coal incineration

An unintentional emissions source of PeCBz is coal combustion. However, concentration of Chlorine in coal is very small; the formation of PeCBz from this source is much smaller than waste combustion and biomass combustion. PeCBz emissions amount can be calculated from the data on coal consumption in Vietnam collected from Vietnam National Coal and Mineral Industries Group and using emission factor of $1.45.10^{-9}$ kg/kg extrapolated from HCB emission factors from coal combustion (Bailey R.E. (2007), as follows:

Table 9. PeCBz emissions from coal combustion

No	Year	Amount of coal consumption *(kg)*	Amount of PeCBz emission *(kg)*
1	2012	39.38×10^9	57.1
2	2013	28×10^9	40.6
3	2014	29.6×10^9	42.9
4	2015	35×10^9	50.75

2.3.7. Summary of future production, use, and releases of POPs – requirements for exemptions

For the Parties of the Convention to have roadmap for implementing safe management, reduction and elimination of POPs appropriately with the actual conditions, the Convention allows its Parties to explain and register the need to continue the use of POP substances for listed exemptions.

According to Article 4 - Register of specific exemptions of the Convention that prescribed: All Parties of the Convention have been allowed to register specific exemptions for chemicals listed in Annex A or Annex B. Accordingly, Parties are allowed to use notification in writing

[44] NIP Update Project. 2015.

[45] Bailey R.E. (2007). Pentachlorobenzene - Sources, environmental fate and risk characterization. www.eurochlor.org.

[46] NIP Update project. 2015

to Secretariat to register one or more specific exemptions for chemicals listed in Annex A or Annex B. All registrations of specific exemptions shall expire five years after the date of entry into force of this Convention with respect to a particular chemical, unless an earlier date is indicated in the Register by a Party, or an extension is granted up to five years if the Conference of the Parties decided to extend on the basis of priority consideration for special circumstances of Parties that are developing countries or a transitional economy.

Stockholm Convention noted that at the time of May 17, 2009, no Party shall register the specific exemption listed in Annex A concerning the chemicals of aldrin, chlordane, dieldrin, heptachlor, hexachlorobenzene, and mirex. Therefore, in accordance with clause 9, Article 4 of the Convention, these chemicals will not be registered specific exemptions except hexachlorobenzene used as an intermediate in a closed system.

The Convention also stipulates that all the specific exemption in Annex A could be implemented by the Parties registered the exemption under the provisions of Article 4, unless the use of PCBs in the commodity as prescribed in Part II of this Annex; hexabromodiphenyl ether and heptabromodiphenyl ether as prescribed in Part IV; and pentabromodiphenyl ether, and tetrabromodiphenyl as prescribed in Part V of this Annex.

Under the provisions of the Convention, there are not any specific exemption for the use of old POPs listed in the Convention since 2004 (it over more than 5 years since the date on which the Convention enters into force for these chemicals).

Therefore, as prescribed of the Stockholm Convention, Vietnam shall not register specific exemptions for production and use of 13 chemicals as following: Aldrin, alpha hexachlorocyclohexane, beta hexachlorocyclohexane, chlordane, chlordecone, dieldrin, endrin, heptachlor, hexabromobiphenyl, mirex, pentachlorobenzene, toxaphene, hexachlorobutadiene.

For DDT, lindane, endosulfan and its isomers, and PCP, Vietnam has banned the use of these chemicals, therefore not registered exemptions for these POPs.

For POP-BDEs, the area with potential use of POP-BDEs in Vietnam is the production of electrical and electronic appliances where plastic containing POP-BDEs might be recycled. It is also an industry that is being developed in Vietnam. Data from the General Statistics Office showed that in recent years, the production index for electrical and electronic products is higher than 100%, especially this index in 2014 was 135.2%. This reflects the shifting trend of big electronics companies in the world from neighboring countries to Vietnam. Up to now, Vietnam has registered specific exemption for tetrabromodiphenyl ether and pentabromodiphenyl ether for recycling purposes within 05 years. In the coming time, Vietnam should specifically assess the needs to use of some POPs to perform register of specific exemptions for hexabromodiphenyl ether, heptabromodiphenyl ether and decabromodiphenyl ether under the provisions of the Convention.

For PFOS: According to the statistics on the import and use of products possibly containing PFOS, which consists of main groups: Consumer products mainly are textiles and upholstery fabrics, synthetic carpets, leather, paper and paperboard; Specialized products mainly include insecticides and materials for fire extinguishers; Industrial chemicals such as uses in chromium plating, waterproof materials, shoes polishes, chemicals and preparations containing per- or polyfluorinated alkylated substances (PFAS), reverted chemicals used in textile industry, chemicals used in the paper industry, organic solvent mixtures, paint or varnish removers, surfactants, imaging chemicals and the chemicals in the perhalogen form with fluorine and chlorine only. The products in the consumer sector are tending to increase in Vietnam.

Up to now, Vietnam has not registered exemption for use of PFOS. However, it should be

noted that at COP 7 in 2015, the Conference of Parties has decided to stop register of specific exemptions for the production and use of PFOS for carpets, leather and clothing, textiles and upholstery, paper and packaging, coatings and coating additives, rubber and plastic. Therefore, Vietnam will not be registered specific exemption for the use of these chemicals in the fields above. Therefore, in the future, Vietnam will carry out the detail assessment and consider registering for specific exemption of PFOS in accordance with provisions of the Stockholm Convention.

For polychlorinated naphthalenes, currently there is no information on the status in Vietnam. Thus, the need to use polychlorinated naphthalenes should be assessed (for the production of intermediate chemical in the manufacture of polyfluorinated naphthalenes including octafluoronaphthalene).

For pentachlorophenol (specific exemption for the production and use of PCP for utility poles and cross arms), Vietnam has just banned this chemical since 2015. Therefore, it might be still used in agriculture and some other purposes due to unawareness of the users. Vietnam needs to assess the need of registration for the allowed specific exemption of PCP for wooden utility poles and cross arms.

For hexabromocyclododecane (exemption for polystyrene foam sheets and polystyrene used for extrusions in buildings), Vietnam should also assess the use areas to have appropriate management measures and to decide on registered exemptions.

For hexachlorobenzene, Vietnam should implement activities to detail assess the status and needs to use to consider and register exemptions when this substance used as an intermediate in a closed system.

For SCCPs, Vietnam should implement activities to detail assess the status and needs to use to consider and register exemptions according to provisions of the Stockholm Convention.

Therefore, according to the provisions of the Stockholm Convention and the current regulations of Vietnam, the following POPs will be further assessed for possible registration of exemptions: PFOS, HCB, PCP, hexabromodiphenyl ether, heptabromodiphenyl ether, decabromodiphenyl ether, HBCD, PCNs and SCCPs.

2.3.8. Assessment and information of POPs stockpiles and contaminated sites

Vietnam is probably one of the countries suffered most effects of POPs. Most of negative effects are related to the use of chemicals/AO used as defoliants during the Vietnam War and their high contamination with dioxins. This affected large areas in the country and a large amount of contaminated people with associated health effects including genetic effects and disabilities in following generations.

Still the population can be exposed at AO/dioxin and other POPs contaminated areas. This also includes POP pesticides stockpile at Hung Nhan cave in Quang Binh province and hundreds of contaminated sites in Nghe An, Quang Binh provinces. Remediation activities have started at many sites for pesticides[47] and for dioxin/AO contaminated sites.[48]

2.3.8.1. Pesticide stockpiles and contaminated sites

2.3.8.1.1 Pesticide stockpiles

There are few stockpiles left and mainly from historical use of DDT in military, agriculture

[47] Five-year implementation report on the pesticides contaminated sites in Vietnam - footnote

[48] R. J. Cooke GEF/UNDP Project on Environmental Remediation of Dioxin Contaminated Hotspots in Viet Nam. Independent Expert Evaluation of Three Pilot/Laboratory Scale Technology Demonstrations on Dioxin Contaminated Soil Destruction from the Bien Hoa Airbase in Viet Nam. March 2015.

and medication purposes. Based on primary assessment of two main stoskpiles found in Hung Nhan site, Tuyen Hoa, Quang Binh province and Nghia Trung, Nghia Dan, Nghe An province, there are about 100 tonnes POP pesticides in total (mostly DDT and lindane). According to the Historical Development of Industry and Trade sector in Vietnam report, Vietnam produced lindane in 1960s with the annual capacity an about 200 tonnes with the lindane concentration about 13%. An assessment is needed to clarify if waste HCH isomers stockpiles exist at this chemical production site of Viettri Chemical Factory similar to other production site[49]. Another source reviled that in the period of 1984-1987, concentration of HCH in wastewater in Viet Tri Chemical Factory was higher 120 times above the allowable level[50] indicating that stockpiles at site exists and further assessment is needed.

2.3.8.1.2. The status of pesticide contaminated sites

There are many areas in Vietnam where the stock of POP pesticides has posed or pose risks on the environment and human health. According to the survey and inventory conducted by the MONRE and the report of the Provincial People's Committees (PPC), up to 2015, there are 1,562 sites where pesticides stockpiles were deposited in the whole country at 46 provinces and cities.

After implementation of the POP Pesticides Project in 2010-2015, the definition and categorization of stockpiles and contaminated sites have been finalized. Guidance has been developed for assessment and management of pesticide contaminated sites. The general features of the areas are:

- Almost of the sites are noted that they were the storages of the agricultural and medical chemical in the period of 1980 -1990. The past holders of the storages are cooperatives, agricultural and forestry farms and bottling, packaging facilities, chemical distribution agency, and/or chemical storage for epidemic prevention of the health. The popular state is that the area is divided for the household, used for the other objective and/or circulation. To the area remaining the storages, they are in deterioration because of the lack of management and maintenance.

- All the sites are noted that they stored many types of pesticides including POPs (mainly DDT, lindane).

- After the chlor – chemical is banned in 1992, the remaining were landfill sparsely or transported to other sites, or stored without management/maintenance. Therefore, cause of the storage deterioration by time, they spread out and pollute the surrounding land and water.

- They are noted to use pesticides containing metal such as mercury. The survey results and reports of the pesticides pollution to the VEA (as described above) also show that there is many areas using and residing the chemical (such as: Falizan). However, the detail data of the chemical (amount of use, incident in the process of operation, the amount of residence,) is still restricting.

2.3.8.1.3. Environmental pollution caused by POP-pesticides

Results of the survey and evaluation of the current state of environmental pollution caused by plant protection chemicals in recent years have revealed many existences as well as high risks of POP-pesticides to human health and the environment.

Many former pesticides POPs storages, in which some storages contained pesticides with mercury compounds that are highly toxic and persistent (e.g. 1.5 tonnes falizan is buried in

[49] Vijgen J, Abhilash PC, Li Y-F, Lal R, Forter M, Torres J, Singh N, Yunus M, Tian C, Schäffer A, Weber R (2011) HCH as new Stockholm Convention POPs – a global perspective on the management of Lindane and its waste isomers. Env Sci Pollut Res. 18, 152-162.

[50] The complete document of the National Assembly (Volume 2) in the period of 1984 – 1987

the ground behind the Thot Not Plant protection station, Can Tho). Especially, in Nghe An, pesticides disposal sites scattered during the war period are still causing serious pollution. At many sites, the concentration of POP-pesticides in soil was up to thousands of ppm, DDT residual in the soil excesses the limit thousand times. In many places, the rate of people living around the pesticides contaminated sites suffered from serious diseases such as cancer rate is abnormally high. In some places, pesticides were penetrated into the soil and then leaked into the groundwater. When people dig wells, the water even has the smell of insecticide (as in Ha Tinh, Bac Ninh and other places). There are places, for example of this impact at Yen Son District, Tuyen Quang province, where at least 14 people have died or have other diseases possibly related to a large source of DDT residual. In Da Nang city, there are two old and idle pesticide stockpiles where the surrounding soil is polluted. These 2 storages are located in Lien Chieu and Son Tra District. In Quang Nam Province, 02 storages contained pesticides in the list of not allowed to use: 01 storage in Que Son and another in Nui Thanh district, Thanh Xuan Commune.

The sites of stockpiles are worth more concerns than the residue on the ground due to bigger size yet less control. They are known now after extensive inventory activities. However, because of different reasons, in some areas, local people are still living near the contaminated sites and therefore they have been affected by POPs.

Pesticides stockpiles are causing significant impact on public health and the environment in these contaminated sites. The pesticides stockpiles were mostly built in the 1980s and backwards, without taking into account storages' proper structure and foundation for prevention of potential contamination. Moreover, the storages have not been maintained and repaired since then; therefore, they have been seriously deteriorated: Broken floor and cracked walls, dilapidated roofs, no windows left, temporary doors. There are almost no drainage systems, the pesticides are washed away when it is heavy rain, which caused ground water, surface water and soil polluted in broad area, posing direct impacts on people health and life.

2.3.8.2. PCBs stockpiles and contaminated sites and related pollution

Since 2006, there have been several researches, surveys and assessments related to PCBs pollution in Vietnam. Studies included the project "Investigate PCBs volume, evaluate pollution levels, and confine the pollution caused by disposal of PCBs and PCB-containing waste on the national scale" in 2009 and the project "Statistics and evaluate PCBs at national level" in 2006 leaded by VEA; program "Investigate and evaluate the management and pollution level of PCBs leakage" in 2008 of the Centre of Environmental Consultancy and Technology, VEA; the program "Investigation and inventory, screening and assessment of the current status of electrical equipment at 04 Power companies in Southern Vietnam" in 2008 and a number of scientific studies conducted by local and international experts.

In 2009, the Vietnam Environmental Administration implemented the project "Investigate PCBs volume, evaluate pollution levels, and confine the pollution caused by disposal of PCBs and PCB-containing waste on the national scale." The project conducted surveys at 105 enterprises with 112 storage sites in the whole country and takes samples in 106 areas with a total area of about 64,460 m^2. In which, the largest area was the Red River Delta region with 28 points/215 samples, total area of 13,080 m^2; followed by the Northeast region with 23 points/113 samples, total area of 5,680m^2; Mekong Delta region with 22 points/235 samples, total area of 9,230m^2; Southeast region with 14 points/159 samples, total area of 7,700m^2; North Central region with 09 points/131 samples, total area of 2,570 m^2; South Central region with 08 points/103 samples, total area of 8,600 m^2 and the smallest was the Northwest area with 04 points/63 samples, total area of 12,200m^2; Highlands region 04 points/75 samples, total area of 5,400 m^2. The project set criteria to evaluate PCBs pollution levels according to the sampling location as follows:

- Group 1: PCBs concentration below 5 ppm
- Group 2: PCBs concentration ranging from 5 ppm to 10 ppm
- Group 3: PCBs concentration ranging from 10 ppm to 50 ppm
- Group 4: PCBs concentration ranging from 50 ppm - 500 ppm
- Group 5: PCBs concentrations higher than 500 ppm

The analysis results show:

- No areas were contaminated with PCBs concentrations higher than 500 ppm.
- Detect 04/108 areas having PCBs concentrations ranging from 50 ppm to 500 ppm. The Southeast region had 02 contaminated areas (storage area of 32 tonnes transformer oil with PCB; MBA Storage of Center of Electric Testing under Ho Chi Minh City Power Company; Red River Delta region had 01 contaminated site (Van Mon village, Yen Phong, Bac Ninh) and South Central Coast had 01 contaminated site (estuary of Han River, Da Nang).
- Detect 13/108 areas having PCBs concentrations ranging from 10 ppm to 50 ppm. The largest number of areas was the Red River Delta region with 04 contaminated areas, the next was the North Central region with 03 contaminated areas (including 01 electrical equipment landfill belonging to Nghe An power transmission company), the last was Mekong River Delta and Southeastern regions with 02 contaminated areas for each region.
- Detect 16/108 areas having PCBs concentrations ranging from 5 ppm to 10 ppm. The largest number was in the Red River Delta region with 05 areas; followed by the Mekong Delta with 04 areas and the Central Coast area with 02 areas, the rest area (East North, North West, North Central and Southeast) had 01 area for each region.
- Detect 53/108 areas having PCBs concentrations less than 5 ppm. The largest region was Mekong River Delta with 16 areas, followed by the Red River Delta with 12 areas, Northeast region with 10 areas, Southeast region with 08 areas, the Central Coast with 05 areas, North Central with 04 areas and the last was North West region with 02 areas.

2.3.8.3. POP-BDEs contaminated sites and stockpiles

POP-BDEs stockpiles

POP-BDEs stockpiles are present in Vietnam mainly in plastic from EEE and WEEE. The volume of c-OctaBDE in Vietnam is estimated to 63.4 tonnes containing 34.2 tonnes of POP-BDEs. This POPs stockpiled is contained in approximately 1,750 tonnes of CRT plastic casings.

In addition, a much larger volume of WEEE plastic is contaminated with DecaBDE which is recommended by POPs Review Committee for listing to the Convention in 2017.

The second stockpile of POP-BDEs is in polymers in vehicles. In total, 6.54 tonnes of POP-BDEs are contained in polymers of vehicles in use. In addition, HBCD listed in 2013 and decaBDE recommended for listing are also contained in vehicles probably in a considerably higher concentration according to screening results in Japan. This needed to be considered in the future via inventory activities.

POP-BDEs contaminated sites

POP-BDEs are in particular released in open burning of WEEE plastic in non-BAT recycling or other open burning scenarios, Furthermore, a major share of PBDE-containing materials ends up in landfills. POP-BDEs can partly be leached from these materials in landfill leachate or released via landfill fires.

Some samples from first of such sites with potential POP-BDEs contamination have been sampled and analyzed. The total POP-BDEs in sediments from an area of electronic waste recycling in Hung Yen contained POP-BDEs in the range of 1.31 - 1715 ng/g. Sediments near a plastic recycling village in Hanoi were in the range of 22.53 - 863.61 ng/g and samples close to a landfill in Hanoi had POP-BDEs levels between 3.76 - 83.58 ng/g.

This first monitoring of POP-BDEs at some potential contaminated sites has shown that POP-BDEs were present partly at high levels and need further assessment. Currently no standards for soils have been developed which would define a soil or sediment as contaminated.

2.3.8.4. PFOS contaminated sites and stockpiles

Major PFOS contaminated sites from experience in other countries are from the use of firefighting foam in practice areas (e.g. at airports, refineries, military installation) and where PFOS has been used in industry (e.g. chromium plating or carpet and textile production) and related landfills. Furthermore, also municipal landfills contain today probably the largest reservoir/stocks of PFOS. Due to the water solubility PFOS is continuously released and contaminate ground water and surface water from these contaminated sites/stockpiles.

A primary evaluation of PFOS at a first landfill have been conducted in the framework of Project "Update The National Plan on the implementation of Stockholm Convention on POPs". The PFOS levels in surface water sample taken at the pond and ditch near the Tay Mo landfill in Hanoi ranged between 0.46-44.22 ng/l. The PFOA concentration at the site was between 1.43-169.27 ng/l. The sediment sample taken at the area near the landfill had PFOS concentration of 0.94 ng/g and a PFOA concentration of 0.39 ng/g.

This can be seen as a first start for an assessment of PFOS contaminated sites. Of urgent need is e.g. the assessment of areas where firefighting foam has been used including the practice areas at airports, military and large oil storages. Furthermore, areas where PFOS has been used in industries and related disposal sites e.g. from chromium plating and sites where sludge from chromium plating have been disposed.

2.3.8.5. Agent Orange/dioxin contaminated sites from Vietnam War and other sites pollution

2.3.8.5.1. Agent Orange/dioxin contaminated sites from Vietnam War

During the Vietnam War, the US military sprayed huge amount of herbicide over Vietnam territory, on an area of about 2,631,297 ha (of which 86% was sprayed two times, 11% were sprayed more than10 times). According to Young (2009), the total amount of herbicides brought into Vietnam was 79,488,240 liters. By 1972, 25,200 barrels of Agent Orange (equivalent to 5,241,600 liters) were brought back to U.S under Pacer Ivy Operation, the total amount of herbicides used was 74,175,920 liters. The total amount of herbicides was 76,954,806 liters, equivalent to 95,112,688 kg (~ 95 million kg), in which dioxin-containing herbicides occupied 67%, mainly Agent Orange with the amount of 49.27 million liters, equivalent to 63,000 tonnes[51].

There were 25,585 villages located in the sprayed area. Under the topographical conditions of Vietnam, the area affected by dioxin was even larger because the sprayed area was often located at the upstream of the Truong Son mountain range. Due to rainy weather, rain water spread Agent Orange and related dioxin and caused pollution to whole South of Vietnam. The herbicide and dioxin spay has caused in addition to the detrimental health effects on the population also serious consequences for the environment, degraded the ecosystems, reduced

[51] MONRE (Office 33). 2013. Comprehensive report agent orange/dioxin contamination at three hotspots: Bien Hoa, Da Nang and Phu Cat airbases

the number of rare and precious animals and plants, as well as the biodiversity.

However, at "hot spots" area such as the former storage, loading and washing areas at Bien Hoa, Da Nang and Phu Cat Airbases, the dioxin contamination was very high. In Bien Hoa airbase, the TEQ concentration of PCDD/Fs in soil and sediment varied from 7.6 – 962,000 and 17 – 4,860 pg/g dry wt, respectively. It should be noted that the guideline for necessary remediation of the contaminated soil is 1,000 pg/g TEQ and those for sediment is 150 pg/g TEQ. Besides, PCDD/Fs levels in fish ranged between 1.8 – 288 pg TEQ/g wet wt[52].

In Da Nang airbase, PCDD/Fs concentration in soil was from 20 - 365,000 pg TEQ/g which is 300 times than standard QCVN 45:2012/BTNMT (1.200 pg TEQ/g). The concentration in sediment collected in several ponds near the *hot spot* areas ranged from 63 – 6,800 TEQ pg/g and the maximum TCDD level recorded in fish fat was 3,000 pg TEQ/g (wet weight basis), which is 100 times the acceptable fish consumption level established by Health Canada. Moreover, some individuals who carried out aquaculture (harvesting fish and lotus) in the contaminated Sen Lake near the hot spot areas were found to have the high dioxin concentrations in their blood ranging from 20 – 1,230 pg TEQ/g lipid basis[53].

In the past years, many efforts to remediate/mitigate dioxin in the three hotspots exceeding limits have been implemented.

Contaminated soil in Phu Cat Airbase was 7,500 m^3 which was contained by a secured landfill with an area of 4 hectares at a depth of 1.2 to 1.4 m to eliminate the exposure of dioxin. A monitoring system in this area is developed with the support by Czech Republic Government. The landfill was handed over to MOD[54].

In Da Nang Airbase, the mixing and loading areas, the former storage area, Sen Lake, and Pacer Ivy site, with a total volume of 73,000 m^3 are contaminated with dioxin, and required remediation. Soil and sediments were excavated and put into two closed piles for in-pile thermal desorption[55].

According to USAID projections, the environmental remediation of Danang airport currently underway by a process known as in-pile thermal desorption (IPTD) will be completed in March 2017 at an estimated cost of $88 million. This is $50 million higher than the original projected cost of the project[56]. However, after finishing the first phase, nearly 150,000 m^3 of soil, sediment should be handled, including approximately 100,000 m^3 must be thoroughly treated by technology IPTD and burial will isolate about 50,000 m^3 of soil, sediment dioxin levels 150 to 1,000 pg TEQ/g. There has been 45,000 m^3 processed, end of 2016 the Ministry of Defense (MOD) and USAID will continue Construction of Phase 2, additional processing 45,000 m^3 of soil, mud dioxin in Da Nang International Airport.

Bien Hoa airbase was the airport used for the most Agent Orange spraying missions during the war, and is where the most herbicide was stored and used by the U.S. military with high contamination levels (up to 1,000,000 pg TEQ/g). At Bien Hoa airbase, the Vietnamese government has already conducted some mitigation measures to contain the dioxin

[52] Thuong NV, Hung NX, Mo NT, Thang NM, Huy PQ, Binh HV, Nam VD, Thuy NV, Son LK, Minh NH (2015). Transport and bioaccumulation of Polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofuranes at the Bien Hoa Agent Orange Hotspot, Vietnam. Environmental Science and Pollution Research, 22:14431–14441

[53] Minh NH, Boivin Th, Canh PN, Son LK. Comprehensive assessment of dioxin contamination in Da Nang Airbase and its vicinities: Environmental levels, human exposure and options for mitigating impacts. Interdisciplinary Studies on Environmental Chemistry — Environmental Research in Asia, pp. 21–29. TERRAPUB, 2009.

[54] Office of National Steering Committee 33 (2013) AGENT ORANGE/DIOXIN CONTAMINATION AT THREE HOTSPOTS: BIEN HOA, DA NANG AND PHU CAT AIRBASES. Updated November, 2013

[55] Office of National Steering Committee 33 (2013) AGENT ORANGE/DIOXIN CONTAMINATION AT THREE HOTSPOTS: BIEN HOA, DA NANG AND PHU CAT AIRBASES. Updated November, 2013

[56] Michael F. Martin (2015) U.S. Agent Orange/Dioxin Assistance to Vietnam. CRS Report prepared for members and committees of Congress. Congress Research Service 7-5700. November 13, 2015

contamination. A passive landfill (in which the contaminated soil is left untreated) containing 43,000 m^3 of contaminated soil excavated from the herbicide storage area was completed in 2009. However, the airbase has several other distinct dioxin "hot spots" that have not been addressed[57]. The study also determined that contaminated soil had spread from the "hot spots" into nearby lakes, ponds, creeks, and drainage ditches, increasing the amount of soil and sediment that will require treatment.

UNDP has been working with Office 33 and MONRE for five years to map out the dioxin contamination at Bien Hoa airbase, and develop a master plan for dioxin remediation. According to their joint investigation, approximately 250,000 cubic meters of soil will require decontamination with an estimated cost of at least $250 million. In September 2013, USAID contracted CDM International Inc. to conduct an environmental assessment of the Bien Hoa airbase to examine a number of dioxin remediation alternatives. The assessment is scheduled to be completed in 2016. USAID is working closely with MONRE and MOD on the assessment project[58].

2.3.8.5.2. Other potentially dioxin contaminated sites

During the inventory development, the presence of other dioxin/UPOPs contaminated sites have not been assessed. However, since the largest amount of dioxin present today are from historic releases and have accumulated due to their persistence in soils and sediments, the assessment of further dioxin/UPOPs contaminated sites is suggested as a task in the action plan.

Preliminary considerations on dioxin/UPOPs contaminated sites - other than from Agent Orange use - based on experiences from other countries suggest that following areas could be potentially contaminated:

- Areas with impact from long-term industrial releases from metal industries or incinerators or from disposal of solid residues such as fly ashes or other residues from flue gas cleaning.
- Potentially PCBs contaminated sites can also be considered PCDD/F contaminated as PCDF is present in PCBs and can be formed from PCBs.
- (Historic) application sites of dioxin/UPOPs containing pesticides and chemicals: This include chlorinated phenol derived pesticides such as 2,4-Dichlorophenoxy acetic acid (2,4-D), 2,4,5-T, Pentachlorophenol (PCP). Pesticides also contain HCB or PeCBz such as PCNB/quintocene and other.
- Timber manufacture and treatment sites where PCP has been used.
- Textile factories where chloranil, PCP or other dioxin containing chemical have been used (production site, sediment of waste water release and sites of waste disposal).
- Leather factories where PCP has been used (production site, sediment of wastewater release and sites of waste disposal).
- Sites where waste is and have been burned in the open for extended time.
- Sites of major fire accidents.
- Sites where copper cables and other electronic waste are or have been burned in the open.
- Dredging of sediments; contaminated flood plain.
- Dumps of wastes/residues from Source Groups 1-9: (e.g. sites where ashes from incinerators are disposed; Sites where ashes from metal industry were/are disposed).

[57] Hatfield Consultants (2011) Environmental and Human Health Assessment of Dioxin Contamination at Bien Hoa Airbase, Viet Nam: Final Report. August 2011

[58] Michael F. Martin (2015) U.S. Agent Orange/Dioxin Assistance to Vietnam. CRS Report prepared for members and committees of Congress. Congress Research Service 7-5700. November 13, 2015

2.3.9. Existing programs of monitoring POPs in environment and emissions

2.3.9.1 Monitoring programs and studies

The monitoring of POPs is an important approach for providing information about status of POP and serves as a basis for the development and implementation of POPs management activities. Vietnam has a national environmental monitoring system. However, POPs are not included in this monitoring activity and network. Therefore, there are no specific regular programs on monitoring of POPs in the environment and in humans. Currently, the national environmental monitoring system is considered for re-planning and getting further investment. The government of Vietnam promulgated the Decree No. 127/2014/ND-CP on conditions for environmental monitoring activities (VIMCERTS system). This decree was aimed for heightening the quality of monitoring environmental parameters. There were some laboratories granted with certificates for analyzing some POPs in the environment.

Currently, Vietnam is participating a regional POPs monitoring project. Within this project, more capacity will be built and options on national monitoring programs will be discussed.

In Vietnam, some programs on POPs analysis and monitoring have been implemented in cooperation with international research agencies such as:

- Analyses of DDT, HCH, PCBs, and HCB residues in bird migration in the North Vietnam (1997) implemented by the Center for Environmental Technology and Sustainable Development (Vietnam National University, Hanoi) in collaboration with the Ehime University, Japan. Monitoring of DDT, HCH, PCBs and HCB residues in the coastal mussels and fishes in Vietnam (1997-1999) under the 'Asia – Pacific Mussel Watch' was undertaken by the Research Center for Marine Environment and the Ehime University (Japan).
- Monitoring of chlorinated insecticide in water and sediments in West Lake, Ba Be lake, Red river, Ba Lat estuary, Ha Long bay, rivers in the Central Region and Hue lagoon has been implemented by Center for Environmental Technology and Sustainable Development – Vietnam National University, Hanoi (VNU-Hanoi) under the framework of the 'Monitoring of the East Asia hydrosphere' program (lead by United Nation University, Japan) (since 1998).
- Studies of DDT and PCBs residues in surface sediments and water in irrigation channels in Hanoi and some other coastal locations in the North (1994-1999) under the collaboration program among Vietnam Atomic Energy Institute, Quality Assurance and Testing Center 1 (QUATEST 1), Institute of Nuclear Energy (Portugal), and Marine Environment Laboratory (Monaco). This activity was organized and coordinated by the International Atomic Energy Agency (IAEA).
- POPs monitoring in the East Asia was implemented by Ministry of Environment (Japan) in collaboration with other East Asia countries including Vietnam. This project has been deployed since 2007 with focus on analysis of POPs in air.
- Research project at ministry level "Status of POP pollution in the environment in Hanoi' (Ministry of Science and Technology – 2002) implemented by the Analysis Division of QUATEST 1, focusing on analysis of insecticide residue in soil.
- Some activities and programs in analyzing insecticide residue in soil and plants implemented by Plant Protection Research Institute, Ministry of Agriculture and Rural Development.
- The research project at national level KHCN.07.15 on identification of super ecological poisonous substances in industries and households, and recommendations for treatments for environmental pollution' implemented by Vietnam – Russia Tropical Center.

- A project on assessment of Agent Orange/dioxin residue in military airports where dioxin used to be archived before dispersion during Vietnam War was implemented by Vietnam – Russia Tropical Center.
- The task on analysis under the Program 33 implemented by Vietnam – Russia Tropical Center in collaboration with other agencies such as Vietnam Environment Agency, Institute for Biological Technology, Center of Environmental Technologies of the High Command of Chemistry, and Southern Institute of Water Resources, etc.
- Some international cooperation research programs with other countries such as Canada, United States, Netherlands, etc. in analyzing dioxin and impacts of dioxin and other chemically toxic substances deployed by American Government during Vietnam War.
- Monitoring the content of chlorinated pesticides and PCBs in sediment and irrigation channels in Hanoi' implemented by Center for Environmental Technology and Sustainable Development (VNU-Hanoi), Center for Environmental Monitoring (Vietnam Environment Administration), and Swiss Federal Institute of Aquatic Science and Technology, 8600 Du¨ Bendorf.
- 'Investigation of PCBs content and distribution in soil layers in Hanoi' implemented by Hanoi Water Resources University, Center for Environmental Technology and Sustainable Development, and Northwestern University of Applied Sciences (Switzerland).
- Researches about POPs pollution (including PCBs, DDT, PBDE, etc.) implemented by Center for Environmental Technology and Sustainable Development (VNU-Hanoi).
- Programs for environmental monitoring of dioxin contamination in hot spots implemented by Dong Nai's Provincial Department of Natural Resources and Environment and Institute of Natural Resources and Environment (Vietnam National University – Ho Chi Minh City – VNU-HCM).

Results of pollution assessments have shown that POPs are present in environmental samples in different environmental components in Vietnam. DDT was estimated to be higher, while PCBs is as high as other countries in the area, yet much lower than those in developed industrial countries. Specifically, in dioxin-polluted areas, the dioxin content was estimated as very high.

2.3.9.2. Major findings of POP pesticides monitoring

Among POP substances, DDT is the most common group with highest concentration in comparing with other OCPs in environmental samples (including soil, sediment, surface water, air and biology). In DDT group, beside p,p' DDT (mother product), there were other transformed products such as DDD, DDE, and especially DDE- the most stable transformed product in water. We shall pay attention on the proportion of p,p' DDT versus total DDT to make relative comparison of time for stop using DDT in different areas or to determine recent illegal use sources or pollution spreading from neighboring countries.

The research "Study and assess the levels of persistent organic toxic in water and sediments in some coastal estuaries in Quang Nam and Da Nang" conducted by Hanoi University of Natural Resources and Environment from 2013 to 2015, within the scope of research, authors evaluated the HCB and DDT concentrations in water and sediment samples in some rivers. The analysis results of water samples showed that most of the water samples were contaminated with HCB and DDT. In particular, total DDT concentration in Han river water samples ranged from 0.01 to 0.078 µg/L, lower than permitted limit of the National technical regulation on surface water quality QCVN 08-MT: 2015/BTNMT. HCB concentration is from 0 to 0.045 µg/L. Total DDT concentration in Cua Dai river water samples ranged from 0.05 to 0.421 µg/L.

Analysis results of sediment samples also showed that most of the sediment samples are contaminated with HCB and DDT. In particular, total DDT concentration in sediment samples at Han river estuary ranged from 0.976 to 23.556 µg/kg, some sediment samples had high levels of DDT than permitted limits (according to QCVN 43: 2012/BTNMT, 4.8 µg/kg). Total DDT concentration in sediment samples from Cua Dai was ranging from 1.14 to 8.12 µg/kg.

In 2011, pesticide contamination in some agricultural areas in Northern Vietnam, concentrations of pesticides with halogen compound in water samples was at undetectable level in Minh Dai village, Phu Tho province. The concentration of DDT in the soil of Minh Dai village was in approximately 1.8 to 132 ng/g in dry weight (average of 29 ng/g), the concentration of DDT in the soil samples of Hoang Liet village, Hanoi ranged from 1 – 51 ng/g in dry weight (average of 17 ng/g)[59]. In addition, DDT also was detected in samples of vegetables and tea.

After DDT, HCH is the second most common and high concentrated group among OCPs, where HCH isomer (also called Lindane or 666) was the pesticide that used in large quantity in Vietnam in the past. Thus, HCH shall be included in the list of POPs to be monitored in Vietnam.

There was no analysis for mirex and toxaphene in environmental samples in Vietnam. For mirex, it might be that this compound was not or rarely imported into Vietnam. Toxaphene has been proved to be imported and used, but only few laboratories in the world can detect that (required special equipment: Negative ionized gas chromatography in combining with mass spectrometry). Thus, no information about residue of these two complexes was available. Hence, mirex and toxaphene can be eliminated from list of POPs to be monitored in Vietnam.

Other OCPs such as heptachlor, aldrin, endrin, dieldrin, chlordane and HCB were detected in environmental samples with less frequency and at level of concentration close to detection limit of the analytical method.

2.3.9.3. Major findings from PCBs monitoring

A study on PCBs pollution in irrigation channels in Hanoi showed a wide spread of PCBs pollution. PCBs concentrations varied from 22 to 153 ng per gram (in Nhue river), 3 to 7 ng per gram (in To Lich river), 42 to 122 ng per gram (in Lu river), 36 to 139 ng per gram (in Set river), 237 to 328 ng per gram (in Kim Nguu river), and 20 to 384 ng per gram (in Yen So lake). PCBs content in sediment in irrigation channels in Hanoi showed an increasing trend of PCBs pollution which is equivalent to heavily polluted areas in some countries in the world[60]. Changes in the range from 1.3 to 384 ng per gram (104 ng per gram on average), PCBs concentration in sediment showed a clear increase from 0.79 to 40 ng per gram (13 ng per gram in average) in 1997 and 15 to 120 ng per gram (45 ng per gram) in 1999. A study on PCBs content in the Sai Gon – Dong Nai estuary, Ho Chi Minh City in 2007, however, showed a decrease in level of PCBs pollution from 3 to 6 times in comparing with results from studies in early 1990s[61].

Results of the survey and assessment of the management of PCBs and pollution caused by PCBs leakage in 2008 conducted by the Centre for Environmental Consultancy and Technology in 09 provinces (the survey focused on the equipment storage of the power company) show that: At almost of the points, PCBs was spilled into the environment, yet

[59] Pham Manh Hoai et al. 2011. Pesticide pollution in agricultural areas of Northern Vietnam: Case study in Hoang Liet and Minh Dai communes

[60] Hoai et al. 2010. Recent levels of organochlorine pesticides and polychlorinated biphenyls in sediments of the sewer system in Hanoi, Vietnam. Environmental Pollution 158, 913–920

[61] Nguyen Hung Minh et al. 2007. Persistent Organic Pollutants in Sediments from Sai Gon–Dong Nai River Basin, Vietnam: Levels and Temporal Trends

moderate concentrations, ranging from 0.003 µg/g to 2.564 µg/g, except for one area around the storage of 32 tonnes of waste oil from 04 transformers of Thu Duc Water Plant under the management of Saigon Water Supply Company that had PCBs concentrations in soil at relatively high levels, ranging from 19.8 µg/g to 22.1 µg/g in soil samples and ranging from 0.021 µg/L to 0.012 µg/L in water samples.

Several researches have found PCBs in environmental components such as:

A study on PCBs contamination in northeast coastal areas and the Red River Delta in 2012 showed that, for coastal areas: Total PCBs concentrations in water ranged from 644.76 ng/L to 939.46 ng/l during the rainy season and this was 1.46 times higher in the dry season; PCBs in sediments ranged from 8.0 to 11.6 ng/g; PCBs in clams was about 23.7 ng/g - 55.9 ng/g. For the Red River Delta region: PCBs concentration in water was ranging from 134 to 1,305 ng/l in the dry season, and in rainy season PCBs was 9.75 times higher than in the dry season; PCBs in sediments ranged from 3.4 to 26.6 ng/g in dry season[62].

The sediment samples taken from Nhue, To Lich, Lu, Set, Kim Nguu rivers and Yen So lake in 2009 had PCBs concentrations relatively high (1.3 to 384 ng/g), the concentration of PCBs in sediments increased significantly compare with the concentration in 1997 (ranging from 0.70 to 40 ng/g)[63].

Weitao Wang and his colleagues working together in a study of PCBs concentrations in the air in Vietnam in 2015 have found that the average concentration of total PCBs in the air in summer is 311.8 pg/m^3 and in winter is 509.3 pg/m^3. The highest PCBs concentrations have been detected in the suburbs or areas near large urban areas[64].

Silvia Giuliani and his colleagues studied the PCBs concentration in sediments in the lagoon area at central coast have found that PCBs concentrations were ranging from 1.32 to 44.7 µg/kg [65].

PCBs were found in air samples and sediment, especially in sediment in urban areas such as in Thi Nghe channel, Ho Chi Minh City, or soil in transformer stations in Hanoi. Another study from the PCBs Management Project in 2015 has monitored PCBs in food samples.

[62] Nghi et al. 2012. Monitoring POP in coastal Vietnam and some results of Polychlorinated biphenyls (PCBs) pollution status in the northeast coastal region and Red river delta, Vietnam

[63] Hoai et al. 2010. Recent levels of organochlorine pesticides and polychlorinated biphenyls in sediments of the sewer system in Hanoi, Vietnam. Environmental Pollution 158, 913–920.

[64] Wang et al. 2016. Seasonal characteristics and current sources of OCPs and PCB and enantiomeric signatures of chiral OCPs in the atmosphere of Vietnam. Sci Total Environ.; 542,:777-786.

[65] Giuliani et al. 2011. PCB in Central Vietnam coastal lagoons: Levels and trends in dynamic environments. Marine Pollution Bulletin 62, 1013–1024.

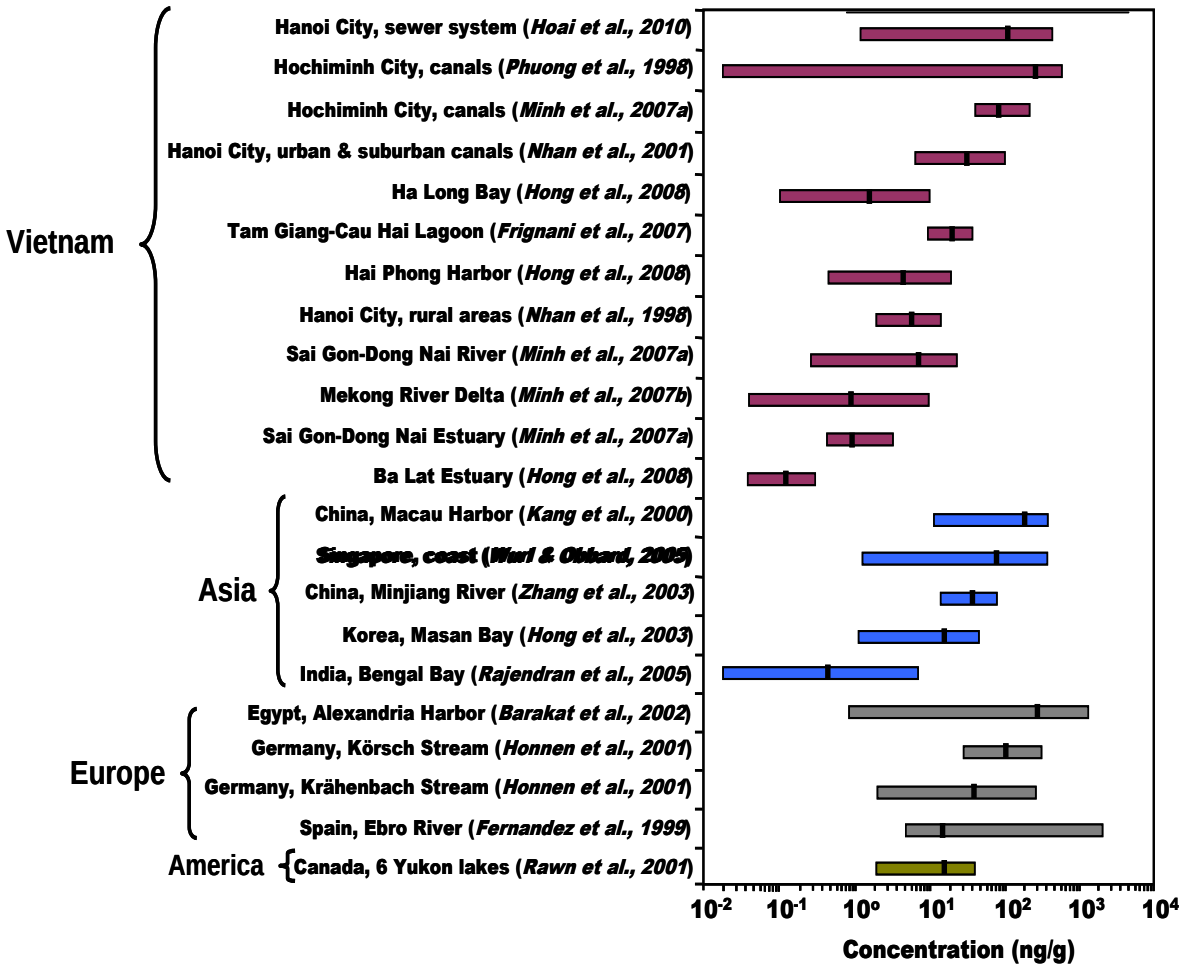

Figure 15. PCBs content in sediment in Vietnam in relative to other pollution areas in the world[66]

2.3.9.4. Major findings of PBDE monitoring

In Vietnam the last 5 years monitoring studies for PBDEs have been conducted in some research centers and universities in collaboration with foreign research groups such as the US and Japan. The results mainly focus on a number of subjects having high accumulation and characteristics of PBDEs as household dust samples, soil samples, sediments, fish samples. Mainly urban areas and some areas of electronic waste recycling and landfills have been assessed.

[66] Hoai et al. 2010. Recent levels of organochlorine pesticides and polychlorinated biphenyls in sediments of the sewer system in Hanoi, Vietnam. Environmental Pollution 158, 913–920

The level of PBDE concentration in air in Vietnam lies in the middle range in comparison with other countries. The concentrations of PBDEs in indoor air in different countries in the world range from lower than 1 pg/m^3 to 4,000 pg/m^3. In Hanoi, suburban areas have pollution levels similar to the global background level. Urban areas and rural reference areas with e-waste recycling activities have high PBDE levels in air. In particular families with e-waste recycling activities have high concentration of PBDEs in air indicates that e-waste recycling activities is a major exposure source in Vietnam with related contamination risk (see below).

A group of scientists at Hanoi University of Science, Hanoi National University and the National Institute of Labour Protection analyzed PBDE in dust in two e-waste recycling villages in Trieu Khuc, Hanoi and Bui Dau, Hung Yen. The levels of PBDE accumulation in dust in Vietnam were compared with other countries in the world as illustrated in Figure 16[67].

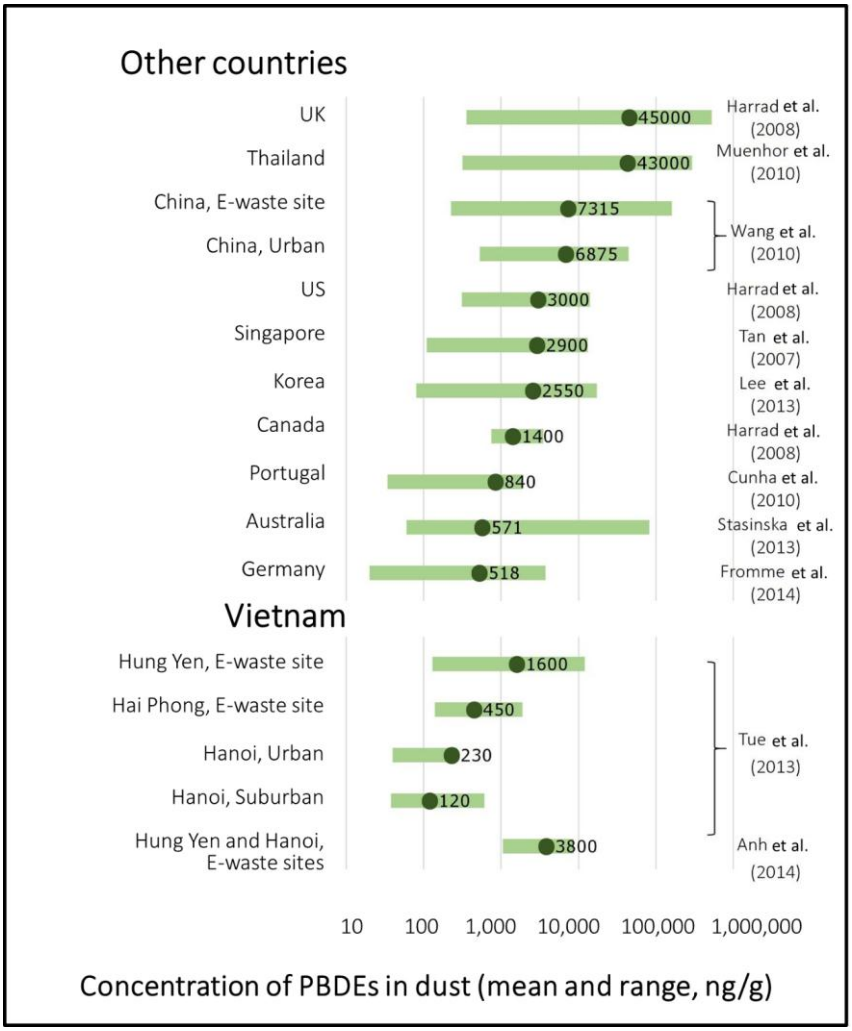

Figure 16. Comparison of PBDEs accumulation in dust in Vietnam some countries

In Vietnam, research on PBDEs in soil is scares. However, the available data provides information to preliminarily evaluate the background concentration level and trace potential pollution source. The concentration level and distribution of PBDEs in soil at Thi Nai pond in the center of Vietnam, located in a region with a number of economic, tourist and industrial production activities, has been studied. 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)[68].

Soil samples from open waste landfill sites in several Asian countries including Vietnam, India, Cambodia, and Malaysia have been collected by a Japanese research group from 1999-2007 to evaluate the pollution level of brominated flame retardants, including PBDEs. Among the investigated countries, Vietnam had the highest PBDE levels 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 landfill areas in other countries of the region. However, if compared with other PBDEs hot spots in southern China, the largest PBDE emission source until now is

[67] NIP Update Project, 2015

[68] Romano S. 2013. PBDEs and PCBs in sediments of the Thi Nai Lagoon (Central Vietnam) and soils from its mainland.

still e-waste recycling activities or e-waste burning[69].

The data on PBDEs 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 PBDEs polluted places are e-waste recycling sites. Excluding the high pollution at recycling sites, other areas in Vietnam have a PBDEs 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 (Figure 17)[70].

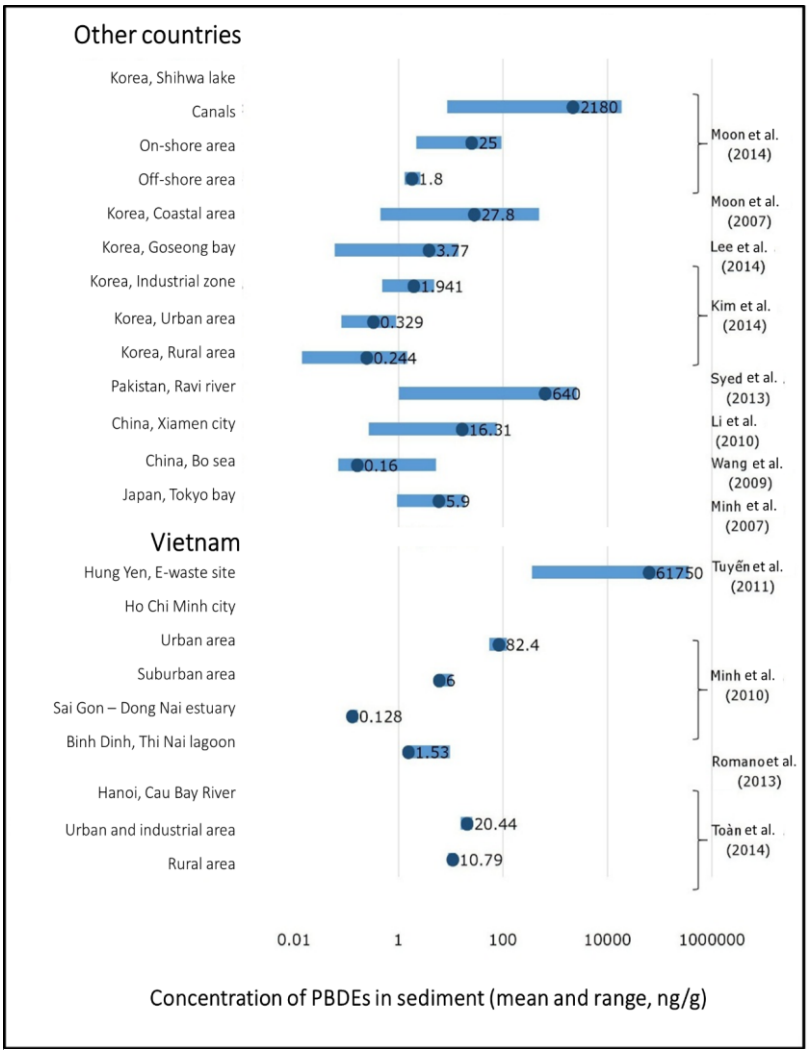

Figure 17. Pollution of PBDEs in soil of Vietnam and some countries

2.3.9.5 Major findings of PFOS monitoring

Capacity to measure PFOS and some other PFAS has been developed in several laboratories in Vietnam. Some environmental monitoring studies have been conducted in recent years. Results of actual surveys of surface water, groundwater, soil, sediment, wastewater and sludge from sewage treatment plants at the sites potentially contaminated with PFOS show that:

[69] Eguchi A. 2013. Soil contamination by brominated flame-retardants in open waste dumping sites in Asian developing countries.
[70] NIP Update Project. 2015

Table 10. PFOS concentration in surface water[71]

Surface water near areas	Quantity of samples	PFOS (ng/L)			PFOA[3] (ng/L)			PFAS[2] (ng/L)		
		Mean	Max	Min	Mean	Max	Min	Mean	Max	Min
Textile	9	< 0.14	0.69	< 0.14	3.32±1.31	5.59	0.55	7.37±1.37	9.55	5.6
Plastic recycling from waste	8	3.89±2.72	9.03	0.52	7.15±7.15	23.15	1.96	45.81±53.17	163.8	11.02
Paper recycling	9	2.31±1.65	5.16	0.23	14.54±14.08	42.89	3.15	47.25±35.68	163.8	11.78
Near industrial zone, automobile manufacture	4	0.96	1.59	< 0.14	10.20±5.88	16.34	3.28	46.75±56.69	131.46	13.7

The concentrations of PFOS, PFOA[3] and other PFAS[2] in surface water sampled near plastic and paper recycling areas, industrial zones and automobile manufacturing facilities were much higher than in surface water sampled near textile and dyeing villages. Surface water sources near plastic waste recycling facilities were contaminated with PFOS, PFOA and other PFAS[2] at the concentrations of 3.89±2.72 ng/L, 7.15±7.15 ng/L and 45.81±53.17 respectively. For the surface water sources near paper recycling facilities, these values were respectively 2.31±1.65 ng PFOS/L; 14.54±14.08 ng PFOA/L and 47.25±35.68 ng PFAS/L.

The results show that many samples were above a PFOS level of 0.65 ng/l which the Dutch National Institute for Public Health and the Environment (RIVM) has determined as maximum permissible concentration for surface waters[72] based on the high tolerable daily intake of the European Food Safety association[73]. The highest levels were detected in the environment tend to involve direct emissions from industries using the PFC. Water environment in the vicinity of industries that use PFAS[2] were recorded at a concentration of about 01-1,000 ppt[74].

For groundwater, PFOS concentrations in two groundwater samples were at the level < 0.14 ng/L, meanwhile PFOA and PFAS concentrations ranged at 0.55-5.59 ng PFOA/L and 6.44-8.51 ng PFAS/L respectively. This concentration is much lower than the levels of PFOS in groundwater (0,4µg / L) as recommended by the US Environmental Protection Agency[75].

Wastewater samples after treatment taken from three metal plating companies have PFOS in the range of 0.73-17.69 ng/L, PFOA is 0.5-1.03 ng/L, PFAS is 10.82-29.67 ng/L. Three sludge samples in the three companies have PFOS in 0-35.41 ng/g, PFOA is 0-0.11 ng/g, PFAS is 0.46-37.11 ng/g.

Sludge samples from domestic and industrial wastewater treatment plants, ash samples of

[71] NIP Update Project. 2015

[72] C.T.A. Moermond, E.M.J. Verbruggen, C.E. Smit (2010) Environmental risk limits for PFOS - A proposal for water quality standards in accordance with the Water Framework Directive. RIVM Report 601714013/2010

[73] The current Tolerable Daily Intake of PFOS suggested by the European Food Safety Association (EFSA) is too high and will need reassessment (P. Grandjean & R. Clapp (2015) Perfluorinated Alkyl Substances: Emerging Insights Into Health Risks NEW SOLUTIONS: A Journal of Environmental and Occupational Health Policy 25(2) 147–163; Brambilla et al.- (2015) Chemosphere 129, 192-202.

[74] Federal Facilities Research Center. 2015. Perfluorinated Chemicals (PFCs): Perfluorooctanoic Acid (PFOA) & Perfluorooctane Sulfonate (PFOS) Information Paper.

[75] Federal Facilities Research Center. 2015. Perfluorinated Chemicals (PFCs): Perfluorooctanoic Acid (PFOA) & Perfluorooctane Sulfonate (PFOS) Information Paper.

industrial waste incinerators and healthcare waste incinerators were all detected containing PFOS, PFOA[3] and other PFAS[2] with concentrations ranging from < 0.1 – 35.4 (ng PFOS/g, in dry weight), < 0.1 – 0.11 (ng PFOA/g, in dry weight) and 0.46-37.1 (ng PFAS/g, in dry weight), respectively;

21 out of 22 analyzed sediment samples (95.5%) found PFOS with concentrations ranging in 0.1 – 1.06 ng/g, in dry weight 22 out of 22 samples detected PFOA with concentrations ranging from < 0.1 – 0.39 ng PFOA/g in dry weight and for total measured PFAS 7.36-9.48 ng/g in dry weight.

Two soil samples at two areas in Hanoi where firefighting foam testing occurred have been collected and analyzed in 2015. The results showed that PFOS concentration is from 0.73 – 15.54 ng/g and PFOA is from 0.13 – 6.52 ng/g[76].

PFOS, PFOA[3] and other PFAS[2] were found in some fish samples from textile and dyeing villages in Bac Ninh province with concentrations ranging from < 0.5 – 1.20 (ng PFOS/g in wet weight), < 0.5 (ng PFOA/g in wet weight) and 2.35-5.69 (ng PFAS/g in wet weight). This value is smaller than the Canadian study conducted from 1979 to 2010 with PFOS concentrations in fish in the range of 16-109 ng PFOA/g wet weight[77].

2.3.9.6. Major findings of dioxin/UPOPs monitoring

The dioxin contaminated areas from Vietnam War have been intensively studied and information is shortly compiled in section 2.3.8.5 above. Furthermore, unintentional releases from different sources have caused PCDD/F pollution in the environment.

2.3.9.6.1. Monitoring of PCDD/PCDF contamination at open waste dumpsites

The analysis of soil samples from open waste dump sites in Hanoi and Ho Chi Minh City helped detecting PCDD/Fs with the concentration of 2,300 to 6,200 pg/g (equivalent to 80 to 800 pg TEQ/g), which is much lower than that in polluted areas due to war.

2.3.9.6.2. Monitoring of PCDD/PCDF air emissions in industrial sectors

PCDD/PCDF emissions of industrial Annex II and III sources (waste incineration, cement production, secondary metal, thermal power, paper production, brick production) were monitored in projects executed by the MONRE, MOD with support from UNDP, UNIDO and GEF. Analysis was provided by Dioxin Laboratory belonging to the Center for Environmental Monitoring under VEA; and the Dioxin Analysis

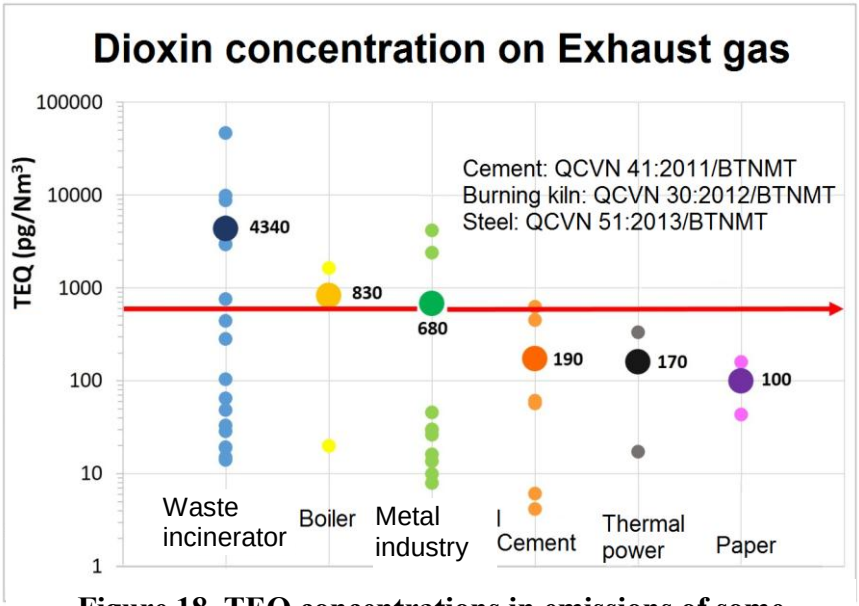

Figure 18. TEQ concentrations in emissions of some industrial sectors

[76] NIP Update Project. 2015

[77] http://open.canada.ca/data/en/dataset/bf7f03a9-1adb-424f-9778-3b1a868a9c1b

Division, the Sub-Institute of Environmental Chemistry, Vietnam – Russia Tropical Center, MOD are compiled in Figure 18[78].

2.3.9.6.3. PCDD/F levels in industrial solid waste

Certain industrial solid waste from various industries may contain PCDD/F contamination. Solid waste samples taken for analysis are usually in the forms of raw material, fly ash, ash at the furnace bottom, in which fly ash samples known as highly contaminated waste including heavy metal unintentional POPs, PAHs among others. Ashes are generated e.g. in incinerators, power plants, cement kilns, metal industries. The next suggested step is to either bury it in the landfill or use as materials for construction after being added with some additives. It is necessary to take into account the risk of release of toxic substances from the ash into the environment over time and the accumulated volume of waste. Initial monitoring solid residues have been sampled and analyzed in Vietnam and the TEQ concentrations (mean values and concentration ranges) in the industrial solid waste samples from the metal industry, waste treatment, boiler, cement production, brick production and thermal power in Vietnam is compiled in Figure 19[79].

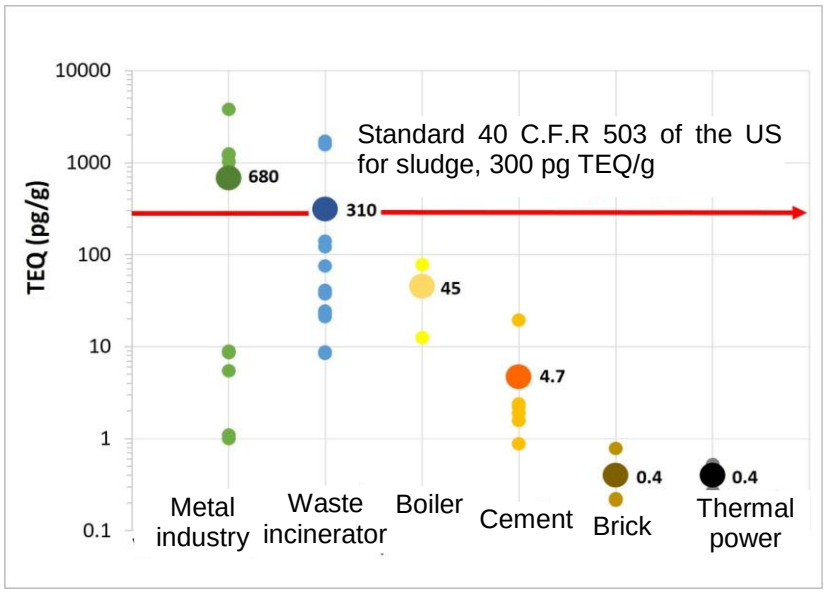

Figure 19. TEQ concentration in solid waste incineration in some industries

The TEQ concentration in fly ash samples of some metal production plants are significantly higher than those in other industrial activities such as waste incineration and cement production. The second highest level of dioxin pollution in fly ash is released from waste incineration, followed by operation of boilers, cement production. The lowest level is brick production and thermal power.

Vietnam has no regulations on dioxin limits in residues and products. In this preliminary monitoring the solid waste from waste incinerator and cement production are below the soil standards of 1,000 ng TEQ/kg. However, it is known that fly ashes from incinerators can have higher contamination levels. Some fly ash samples of the EAF furnace had also high TEQ levels. This highlights the need of a rigorous management of dioxin contaminated industrial solid waste.

TEQ concentrations in fly ash depend very much on the technology of the incinerator and the operation. In the survey results presented above, the TEQ concentrations from the metallurgical plant using EAF furnace technology are many times higher than those from the metal industry using blast furnace technology. This is an essential reference for facilities using EAF furnace, so that they need to actively improve both production technology and waste disposal technology. For newly established facilities a careful selection of appropriate

[78] NIP Update Project. 2015
[79] NIP Update project. 2015.

technologies, aiming at minimizing the formation of PCDD/F is needed.

2.3.10. Identification of impacted population POPs to the environment and human

The human health effects from dioxin caused by Agent Orange spray during the Vietnam War has shown what severe health effect POPs can have and highlighted the importance to protect humans from POPs exposure.

Some preliminary assessments of exposure and possible impacts of other POPs to human have been conducted.

2.3.10.1. PCBs

Non- and mono-ortho-PCBs have dioxin-like toxicity. PCBs have recently been classified as category 1 carcinogens. Furthermore, PCBs are endocrine disrupting chemicals.

In 2015, research in the scope of the PCBs Management Project conducted by the national POPs laboratory found PCBs in some food samples. Some of the measured foods were above the European food limits. More monitoring is needed to understand the sources for PCBs in food and related exposure.

2.3.10.2. PBDEs

PBDEs has been shown to have adverse effects on the endocrine function of the human body involving a wide range of health problems such as memory impairment, and cause reproductive defects, cancer. Many studies in the world have shown that PBDEs impact on the vulnerable groups, such as maternal and infant through blood and breast milk; households are exposed to PBDEs in food, dust and indoor air; worker exposure, exposure in the electronics recycling industry, manufacturing or removing products containing PBDEs.

In Vietnam, studies on PBDEs has been conducted since 5 years mainly in some institutes, research centers and universities in collaboration with foreign research groups such as the US and Japan. The results mainly focus on a small number of vulnerable humans and PBDEs in household dust samples, soil samples, sediments, fish samples. The study area has not extended throughout the country. They are mainly in urban areas and some areas of electronic waste recycling, landfill.

In Vietnam, the PBDEs accumulation in the humans has not been widely studied, partly because of the lack of advanced analytical techniques and difficulties in sample collection.

One study analyzed 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[80]. According to this study, the PBDEs 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 PBDEs exposure for humans. PBDEs concentrations in breast milk of 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 PBDEs concentrations in breast milk in Vietnam were compared with other countries in the region and in the world. USA and Canada have the highest level of PBDEs exposure in breast milk, about 50 ng/g lipid wt., followed by Asian countries like China (Quanzou and Shanghai)

[80] Tue NM, Sudaryanto, A, Minh, TB, Isobe, T., Takahashi, S., Viet, P.H., Tanabe, S. 2010. Accumulation of polychlorinated biphenyls and brominated flame retardants in breast milk from women living in Vietnamese e-waste recycling sites. *Science of the Total Environment*, 408, 2155-2162

with a concentration of 10 ng/g fat. Other Asian countries like the Philippines and Indonesia and European countries have a relatively low PBDEs concentration of 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 demonstrates the risk to the health of workers and their children.

2.3.10.3. PFOS

Young women who are in contact with PFOS are vulnerable for their reproductive health. PFOS is related to reproductive health decrease not only in women but also in men. A study in Denmark showed that PFOS (and PFOA) content led to the decrease in quality of sperm in men. When a pregnant woman is exposed to PFOS, it might be transmitted to the baby and continued transmitting to the baby by breastfeeding (through milk) after parturition. It led to negative impacts on the development of the newborn baby.

PFOS can be contained in food contact paper such as wrapping paper or baking paper. So consumers and the population can be directly exposed via consumer products. Industrial uses in plating industry and semi-conductor industry, firefighting foam can lead to exposure of workers. Furthermore, relevant PFOS exposure can result from contaminated sites.

Levels in humans have not been monitored in Vietnam.

2.3.11. Socio-economic impacts of POPs

A preliminary socio-economic study has been developed within the NIP update. Socio-economic impacts in eliminating new POPs including PBDE and PFOS are as follow:

PBDEs

In Vietnam, PBDEs content in the environment and human body is at moderate and low level in comparing with other countries. However, there are areas with abnormal high level of PBDEs pollution in particular e-waste recycling. Main sources of PBDEs exposure and dispersion are plastic parts in old and discarded electronic equipment. Targets of severe impacts of PBDEs are pregnant women (or young mothers) and newborn babies. Of particular concern is the transmission from mother to baby by breastfeeding. Exposure can result in households and workers who are in contact with materials containing these substances in their living environment or in working environment with high PBDEs content in products and goods. Studies in Sweden showed that PBDEs elimination remarkably helped reducing mentioned risks[81].

To minimize and eliminate PBDEs, relevant solutions are associated with norms for waste controlling, separation, measuring, monitoring and processing shall be employed. Expense for making technical norm is anticipated as 3 million dongs (VND) per norm. Anticipated expense is estimated as quite low in comparing with the society costs. If reports for PBDEs are made twice per year with 500 nationwide samples (each time), annual monitoring for a POPs (PBDEs in this case) shall be 850,000,000 million VND. Expenses for burning hazardous and poisonous waste in Vietnam are estimated in some studies and articles. There were large variations in estimation due to different calculation for processing expense, collecting expense, cost price and market price (willing-to-pay price). Total processing expense is assumed to be 552.72 billion VND per year.

PFOS

PFOS is widely used in different products and classified as three main groups (i) Surface processing: PFOS-related chemicals are used for surface processing for preventing stick of soil,

[81] Meironyté D. 1999. Analysis of polybrominated diphenyl ethers in Swedish human milk. A time-related trend study, 1972-1997

oil or water on individual and household goods, and mainly used for protecting clothes, leathers and carpets; (ii) paper protection: PFOS-related chemicals are used in making resilient paper, avoiding penetration of fat, oil, water or other sector (cardboard, etc.) and (iii) Specialized chemicals: PFOS-related chemicals are used in industrial, trade and consumer products. It consists of commercial PFOS's compound such as firefighting foam, metal-plating, electronic, photographic, and optical inscribing materials, shampoo, carpet detergent, etc.

Negative impacts from PFOS use and production are (i) reproductive health and (ii) environmental pollution. Young women and men are in contact with PFOS and its related substances are risk for their reproductive health. Pregnant woman exposed to PFOS is risk by transmitting to her baby and continue transmitting to her newborn baby by breastfeeding after parturition leading to negative impacts on the development of the newborn baby. PFOS and its related substances are accumulated to pollute underground and surface water, and spoil salt-water, fresh water and terrestrial ecosystem by mean of food chains.

Solutions for minimizing and eliminating PFOS are equivalent to PBDE with relevant expenses for making norms and monitoring. Furthermore, the substitution and control of current PFOS use is associated with cost. For waste processing, reference data for relevant expenses for eliminating and replacing PFOS in firefighting foam in countries are largely varied. It is hard to provide a solid expense for Vietnam with very limited background information. It is anticipated with low estimation from foreign countries (as EU) as 134,000 USD per year.

Benefits

Social benefits for minimizing and eliminating new POPs are including benefits in health, economics and environment. Benefit in health shall be accurately estimated using Disability-Adjusted Life Year (DALY) and value of a statistical life (VSL), by transferring DALY value and assumption for 1,000 people per year, annual benefit in health is anticipated as (US) $40.468 million. Economic benefit is achieved from avoiding risks of decrease in exporting aquatic products due to intoxication, with annual benefit of (US) $14 millions, without taking benefit from avoiding decrease in exporting agricultural products, decrease in consumption of new POP-bearing goods into account. Benefit for the environment was not quantified in this preliminary study.

By comparing expenses for making, implementing policies and environmental processing with aims for new POPs controlling, benefits shall always be larger without fully estimating all benefits. Moreover, in case countries are all reducing and eliminating new POPs, amount of existing POPs shall be reduced, and expenses for processing are reduced proportionally, which led to higher net social benefit. Thus, from a socio-economic point of view, it is crucial to eliminate and minimize new POPs and control their release for the protection of public health, guarantee of environmental quality, maintaining economic interest, and increasing social benefits.

2.3.12. Information exchange and awareness raising for POPs in Vietnam

In implementation of the NIP 2006 up to now, there have activities regarding information exchange and awareness raising for POPs in different forms such as: Workshops, conferences, and training sessions for POPs (including PCBs, POP pesticides, dioxin, etc.); articles and news about POPs in media; mainstreaming POPs in legal documents on controlling of chemical pollution, prevention and dealing with environmental incidents; exchange activities and missions in central and local state management agencies as well as in businesses, etc. (see below for individual activities).

No separated program for information exchange and awareness raising for POPs was created,

however, activities for POPs were only done by special training sessions on awareness raising for PCBs, POP pesticides, etc. Thus, the number of participants and the depth of information are still low. In general, the level of awareness was insufficient to change behaviors related to safety control and prevention of risks caused by POPs.

In reality, awareness of social groups including environmental managers in state agencies or businesses about POPs is limited. Initial survey on POPs understanding among 05 groups including environmental managers in ministries/sectors; environmental managers at local level (provinces, districts); environmental managers in businesses; teachers, students and pupils; and community shows that within the three biggest drawbacks in Stockholm Convention implementation in Vietnam awareness in included together with *finance* and *technology*. Thus, communication, education, awareness raising and social alert for POPs shall be crucial requirements with equivalent importance to safe treatment of these substances.

The NIP 2006 defined the mandatory tasks for communication, education, and awareness raising for POPs and shall have helped diversifying POP-relative awareness raising activities. These activities shall be accumulated and managed in a project with sub-projects, diversified targets and different forms of media. In principle, this project shall have influences on both direct and indirect POP-related targets, which will be used as bases for other project's activities in associated with sound management and treatment of POPs. In reality, not only finance and engineering are needed to completely solve and safely eliminated POPs. Nevertheless, especially awareness on POPs shall play an important role in limiting negative impacts of mentioned substances on the living environment and people health.

As environmental protection agencies such as MONRE do not have sufficient resources to focus on environmental communication, the roles of media in this field should be increased. However, in fact, recent social surveys have shown that environment was still considered as a minor topic on most of public as well as group communication channels. On the other hand, current activities in environmental communication only employed vertical model (top-down control) without considering other horizontal models of communications (direct dialogue between communicator and audience). This helps explaining limited efficacy in environmental communication works, and the low impacts of environmental communication programs and plans in strengthening social responsibility among citizens in environmental protection and sustainable development. Thus, project' efficacy is strongly depended on both vertical and horizontal environmental communication.

Of all POP-related projects in Vietnam, there was no specific project for communication, education, and awareness raising for POPs led to implementation of POPs awareness raising in Vietnam has been limited.

It is clear that the active supports in finance, engineering and human resources from international organizations are a remarkable in POP-related activities in Vietnam. Thus, in principle, POP-related communication, education and awareness raising shall also receive crucial supports from outer sources for success. Besides, diversified and effective development of environmental communication shall be the important foundation for the implementation of POP-related environmental communication. And it shall be the decisive factor in the achievement of POP-related communication, education and awareness raising activities for social groups.

Article 43 of the Constitution of Socialist Republic of Vietnam (2013) defined rights and obligations of individuals and organizations in environmental protection. It shall be the basis for mobilizing wide participation of social, community and professional groups in environmental protection. Thus, from a socializing perspective, POP-related environmental protection, especially communication, education, and awareness raising can be widely

implemented in which it is necessary to have participation of national non-governmental organizations (NGO), social unions and organizations such as Vietnam Farmer's Union, Vietnam Woman Union, and other Unions.

Thus, it is crucial for the implementation of the 'Communication, education and awareness raising for POPs, hazardous and poisonous substances' project. There are bases for the implementation of project's activities. Groups of targets are determined. The connection between project's activities and Vietnam National Implementation Plan for Stockholm Convention is defined. Remains are to answer following questions: How to organize and implement the project? What shall be the properties and levels of activities for each group of target?

Up to now, there was no overall POP-related awareness raising program implemented. Meanwhile, Stockholm Convention regulates on the management of 28 groups of POPs in associated to different sectors from industry, agriculture, public health, domestic and civil uses. Besides initial 12 groups of POPs with 09 groups of pesticide, there was not much information about new POPs such as PBDEs, HBCD, PFOS, PCNs, HCBD, SCCPs, etc. in Vietnam. Moreover, it is linked to different sectors and targets, and required understanding of different stakeholders. Thus, it limited awareness raising for different stakeholders.

Hence, in the following phase in Vietnam National Implementation Plan for POPs, a systematic communication strategy shall be built and implemented to meet the requirement for strengthening management efficacy and risk prevention for POPs on the environment and public health.

2.3.13. Reporting mechanism in accordance with Article 15 on implementation of the Stockholm Convention and information exchange with other Parties to the Convention

Vietnam has conducted requirements of the Stockholm Convention such as requirements before COPs, organization of policy and technical group in COPs, updating POPs management, participating webinars, etc.

As the national leading agency for the implementation of Stockholm Convention on POPs in Vietnam, MONRE has implemented regulations in the Article 15 of the Stockholm Convention on reporting mechanism as follow: Information collection, summary, updating and exchange for reporting POPs management; information gathering from ministries, sectors, localities, organizations and individuals in association with the NIP 2006 implementation and output; following reporting regime for meeting among parties and as required by the Convention's Secretariat; tracking, updating and revising contents in the Implementation plan in pursuant to new Convention's requirements and practical conditions in Vietnam, in the regions as well as in the world.

On November 22th, 2010 and April 21, 2017 Vietnam has completed and delivered to the Stockholm Convention Secretariat, through Electronic Reporting System, its second and third report pursuant to Article 15 of the Convention.

In many forums and activities, Vietnam has conducted discussions and experience sharing with other countries about Stockholm Convention implementation on main sections such as: Management of POP pesticides, industrial POPs, strengthening POPs-related monitoring and controlling capacity, promulgating norms and standards on controlling POPs, mobilizing sources for implementation including international supports. Vietnam has actively and positively participated in the operation of information exchange related to POPs such as the exchange of information with the parties to the Stockholm Convention, exchange information on the scope of Southeast Asia, Asia through forums and activities in the ASEAN cooperation framework and other relevant activities.

To conduct Stockholm Convention's regulations, Vietnam has deployed different solutions

such as promulgating regulations on POPs management in the Law on Environmental Protection and other relevant legal documents, establishing implementing unit for controlling chemical pollution (including POPs), building capacity and encouraging POPs treatment, etc.

Currently, Stockholm Convention has added many new POPs along with new requirements for POPs management and control as well as reporting regime. Thus, to secure optimal implementation, Vietnam shall establish a specialized implementing unit along with National Steering committee for Stockholm Convention with aims for support and consultation for the Stockholm Convention implementation in Vietnam.

2.3.14. Relevant activities of non-governmental stakeholders

During the implementation process of POP-related activities, non-governmental stakeholders including national and international organizations participated in activities in many forms.

2.3.14.1. Industries and industrial associations

Being one of the major objects of POPs management, in years, industries have participated in the implementation of Stockholm Convention in Vietnam at different levels depending on specific POP-related issues. They participated in activities from development of regulations on POPs to implementation of such regulations after promulgating. Some industries working in cementing, waste incineration, steel production have participated in implementing BAT/BEP for reduction of UPOPs. Some enterprises have studied and invested for treatment of PCBs, some others focus on development for providing services of POPs monitoring.

Recently, following the trend as Vietnam has deeply integrated in economic development of the world with new generation international agreements, industries have changed in their activities for more concentration on Vietnam advantage products such as textile, electronic products, etc. Together with the advantage, industries have to follow requirements of the agreements which include environmental issues as the Stockholm Convention added industrial POPs. Therefore, industries should have more important role in implementing NIP update. They should be involved more in awareness raising activities, more active in implementation of POPs regulations and actively participated in POPs activities organized by state management agencies or other organizations.

2.3.14.2. Research organizations

As a result, from awareness raising activities and the need of environment protection, research organizations have been an important part contributing to POPs management in Vietnam. POPs related issues have been included in research topic of some universities, institutes and research centers such as Hanoi University of Sciences (VNU), Hanoi University of Natural Resources and Environment, Institute for Environmental Technology – Academy of Science and Technology of Vietnam, Center for Environment and Sustainable Development Studies (CETASD), etc. In Hanoi University of Natural Resources and Environment, POPs become a lecture of the University that creates the demand for students and lecturers to focus on POPs.

In the resources for development of research on science and technology and resources from cooperation projects, universities, institutes and research centers have conducted many researches on POPs such as assessment of POPs in water of Vietnam (by VNU in scope of UNU project), assessment of some POPs in rivers of central Vietnam (by Hanoi University of Natural Resources and Environment), research on PBDEs in environment and human in e-waste recycling villages (by CETARD), etc.

Besides the results of the governmental agencies on POPs, the results from research organizations have provided useful information and data for assessment and management of POPs in Vietnam. In the future, their participation should be promoted and their resources should be utilized for better implementation of Stockholm Convention in Vietnam.

In science and technology, studies and assessments of POPs from industrial and agricultural activities; POPs in the environment, products, foods, etc. have been conducted. Many universities, institutes and research centers are involved in this sector such as Hanoi University of Sciences, Hanoi University of Natural Resources and Environment, Institute for Environmental Technology – Academy of Science and Technology of Vietnam, Center for Environment and Sustainable Development Studies, etc. as well as other Vietnamese, Korean and Japanese companies focus on POPs studies and assessment, and POPs processing technologies in Vietnam.

2.3.14.3. Civil society organizations

In Vietnam, there have quite many civil associations on sectors such as economic associations (steel, paper, packaging, cement, textile, rubber, wood processing, aquatic products, automobile, shoe, etc.), social associations (women, youth, farmer, etc.), science associations (chemicals, nature and environment), etc. Among these, science associations have proved the relation to POPs as they have some activities on POPs such as integration of POPs in chemicals management, environmental incident prevention. However, POPs issues are not the major and regular topic in their concerns.

In addition to national organizations, international organizations in Vietnam have conducted activities on POPs. In awareness raising for POPs, NGOs participated in activities at different levels such as: POPs and hazardous chemicals-related communication activities by Pan Nature; International POPs Elimination Network (IPEN) with workshops to introduce and provide information on hazards of pesticides (included POPs) on women, etc.

There are consulting companies actively participated in this activity such as Environmental SOS Ltd. Company with training activities on preventing and dealing with environmental incidents associated with PCBs and other POPs; EPRO Consulting JSC with relevant communication activities, etc.

Association of Chemistry with communication and training activities for risks from hazardous chemical (including POPs) and activities in leveling social responsibility of chemical enterprises, Vietnam Association for Conservation of Nature and Environment with environmental protection activities.

2.3.14.4. Media

Obviously, media plays an important role in POPs management in Vietnam. Media means have participated in various activities on different POPs issues such as dioxin, POP pesticides, PCBs, etc. The number of articles and information on POPs has been increased by years with various media means such as television programs, radio, internet, newspaper articles, magazines, etc. Media has not only contributed in awareness raising but also directed public opinion to environmental issues including POPs. Several typical cases in Vietnam as treatment of PCBs wastes in Quang Ninh province in 2014 or dioxin emission from waste incinerators showed the useful contribution of media.

Since 2006, the implementation of NIP and relevant projects and activities on POPs has involved a number of reporters. Participating in these activities, they have either received various information, data on POPs or been trained for recognizing POPs related issues. Therefore, the participation of media in implementation of NIP update should be one of the crucial factors. However, media should have suitable approaches in bringing information to the society in order to ensure the correct of reported information and will not over control that may severely impacts on the development of relevant stakeholders.

2.3.14.5. Communities

The participation of communities in environmental management in general and POPs in

particular in the past were limited. Because of technical and unpopular issue, POPs have not been much interested by communities. In the Law on Environment Protection 2014, the rights of community are clearly regulated. According to that, they have the right to ask the company' owners to provide information of environmental protection; to supervise and evaluate the implementation of environment protection activities of enterprise; to collect and provide information to competent agencies; to ask management agencies to provide results of investigation, inspection and handling of the entities. These are the legal basis to encourage the involvement of communities in environmental management including POPs.

Thus, in implementation of NIP update, it is necessary to include communities in the POPs management as much as possible. They may participate in providing information of enterprise's activities for further assessment of POPs production and use. They also have great contribution to reduce the use of POPs articles as well as in sustainable consumption.

2.3.15. International cooperation for Stockholm Convention implementation

Safe management of POPs is an international issue with global environmental benefits and objectives for environmental protection and public health worldwide. Thus, activities in associated with Stockholm Convention implementation in Vietnam are receiving concerns and supports from international community.

GEF is a major Stockholm Convention's financial mechanism which started funding for POP-related projects from Cycle 4 (2006 to 2010) through GEF-assigned agencies such as UNDP, UNEP, UNIDO, WB and other international organizations.

By participating in Stockholm Convention on POPs, Vietnam has actively joined in international cooperation activities in associated with POPs management. According to report of GEF, Vietnam was the 3th rank in Asia after China and India in attracting POP-related projects. In the period of 2005-2015, international cooperation activities in Vietnam in POPs management were strongly and widely conducted with links to most of POP-related sectors such as management of pesticide and PCB-transformed oil, controlling and dealing with dioxin pollution, building capacity for monitoring POPs pollution, handling and eliminating POPs wastes, etc.

In bilateral cooperation, Vietnam has diversified cooperation activities with other countries such as Japan, Korea, United Kingdom, Germany, United State, Slovakia, Thailand, etc. in monitoring pollution and POPs wastes treatment.

To mobilize international funds for Stockholm Convention implementation, MONRE has actively built overall POPs management programs and proposed specific projects for mobilizing supports from GEF and other donors. For years, MONRE has coordinated with relevant agencies to organize meetings, consulting workshops and missions with donors such as UNDP, WB, UNIDO, FAO, WHO, ADB, SDC, UNEP and other interested countries to establish cooperation programs for POPs management projects. GEF's representative office in Vietnam has actively supported POP-related projects by national dialogue workshops on GEF's projects in the GEF Cycles 4, 5 and 6. Other international cooperation agencies such as departments of International Cooperation in ministries (MONRE, MPI, MOF), and department of international affairs (in the Governmental Office) have actively supported international cooperation activities, mobilizing funds, and arrangement of funds for Stockholm Convention implementation in Vietnam.

With the initiative coordination among agencies in period of 2004-2014, Vietnam has received remarkable supports from international community for the implementation of activities in associated with safe POPs management. Vietnam has mobilized a diversified number of POPs management projects including 08 national projects from GEF, participated

in 03 regional GEF-funded projects, and some bilateral projects funded by other countries and organizations such as Switzerland, Slovakia, United State, Canada, Bill & Melinda Gate fund, and Ford fund. With a strategy towards the approval of NIP 2006 and other governmental environmental protection policies, POPs projects are established in continuity and support each other to obtain overall targets.

In 2012, after success mobilization of GEF fund for Vietnam, the GEF's Secretariat had a separate activity in Vietnam to assess the effectiveness of GEF fund in implementing supporting activities for global sustainable development and environmental protection. Individual assessments from projects and overall consideration from GEF's Secretariat agreed on contribution of GEF's projects and fund in positive changes in making strategy, building capacity and implementing environmental protection in Vietnam, and contributing to global environmental protection. Projects' effectiveness is shown in specific activities such as building technical capacity, making policies and laws, awareness raising for POPs and chemicals pollution, encouraging environmentally technological transfer, pollution processing in hot spots, mainstreaming and supporting international integration, etc.

In general, international tendency, non-refundable financial supports for environmental projects in Vietnam will be largely reduced in the future. On the other hand, we are all aware that management and treatment of POPs and hazardous substances are long-term and costly processes. Thus, it is required to reevaluate and revise strategies for international cooperation and funding mobilization in a new context and condition. Based on achievements in POPs management, especially in analyses, monitoring and communication for POPs, bilateral cooperation with other regional countries, participation in making and implementation of global POP projects funded by multilateral international organizations are feasible solutions. Besides, we shall consider combining POPs management activities to support projects using other loans or investment for environmental protection to keep mobilizing resources for projects.

Thus, international supports in large quantity in combining with mobilization of national resources made changes in both quantity and quality for POPs management and environmental protection for chemicals in Vietnam including monitoring pollution monitoring, risk detection and management, and elimination of POPs. To keep these positive changes, appropriate strategies, solutions and mechanisms are required. They shall help for generating more positive results, maintaining motivation and development in the future.

POPs and their risks exist and spread out in our life. Thus, Stockholm Convention implementation on POPs will be continued worldwide and Vietnam is and will be an active member. International cooperation, mobilization and exchange resources are major factors for the effective implementation of Stockholm Convention. Besides, diversified mobilization for resources from state budget, loans for environmental protection, from the market or stronger community participation shall be the trend for maintaining and extending POPs management activities in specific and environmental protection and public health due to dispersion of hazardous and poisonous chemicals, in general.

2.3.16. Overview of technical infrastructure for POPs assessment, measurement, analysis, alternatives and prevention measures, research and development – linkage to international programs and projects

2.3.16.1. Monitoring capacity for controlling POPs

Since POPs are hard to detect and have associated risks even at very low concentration due to their high and chronic toxicity and biological accumulation, pollution analysis and monitoring abilities at trace and super-trace amount are important. In the past, Vietnam had some laboratories with basic to very advanced equipment that were able to sample and analyze POPs. In a very long time, however, for reasons, assurance of analysis quality is still very

limited. In years, POPs management projects had checking, assessment, education, and training activities for POPs sampling and analysis in laboratories including hard-to-detect samples such as dispersed POPs from chimney, POPs in base air or in biological samples.

Statistics on infrastructure for monitoring POPs showed the limited number of laboratories in Vietnam qualified for POPs analyses. They are mainly located in research institutes, universities or specialized laboratories in state agencies such and Ministry of Agriculture and Rural Development (MARD), Ministry of Science and Technology (MOST) and MONRE. There are some laboratories in Vietnam participated in international cooperation in monitoring POPs monitoring. They are listed as follow: Vietnam – Russia Tropical Center, Dioxin Laboratory (VEA), Institute of Marine Environmental Resources (IMER), Institute of Environment and Resources (IER), Center for Education and Development in chromatography (EDC), Quality Assurance and Testing Center 3 (QUATEST 3), Quality Assurance and Testing Center 2 (QUATEST 2), Institute for Environmental Technology (Vietnam Academy of Sciences and Technology), Military Institute of Forensic Medicine (MIFM), Hoan Vu Center for Advanced Analysis Technology, Center for Environmental Technology and Sustainable Development Studies (CETASD), National Institute of Labour Protection (NILP), etc.

Mentioned laboratories are equipped with analyzing equipment at different levels and modern technologies such as HRGC/HRMS, GC/MS, GC/MS/MS, LC/MS/MS, etc. Many laboratories, however, are lack of experiences in POPs analysis which led to insecure accuracy and confidence of the analyses.

Overall assessment on analysis capacity of POPs in laboratories.

- POP pesticides: Currently, there are nearly 30 laboratories have been granted for VIMCERTS on analysis of pesticides in which mainly chlorinated pesticides.
- PCBs: Around 10 laboratories in Vietnam are qualified for analyzing PCBs in water and sediment. Air and biological samples required more specialized equipment, thus laboratories in Vietnam are incompetent for.
- Dioxin/furan at polluted spots: Required advanced and modern equipment with sophisticated analysis techniques. At present, two laboratories working on dioxin/furan analysis at hot spots are the Vietnam – Russia Tropical center and Dioxin Laboratory of the VEA.

  Dioxin/furan from industrial sources: Currently, there are some laboratories in Vietnam qualified for sampling and analyzing with secured confidence & quality.
- New POPs: There are some laboratories such as Dioxin Laboratory, and laboratory of CETASD are qualified for PBDEs and PFOS analyses in water, sediment and air. There are some initial POPs analyses in food and human milk.

Thus, there are some units dealing with POPs analyses in Vietnam. Confidence in analyses, however, is hard to assess due to improper obedience of strict procedures for quality assurance, lack of national inter-correlated laboratories controlling programs, and individual laboratories rarely participate in inter-correlated controlling programs at regional and international levels. There are only few laboratories participated in international inter-correlated laboratories assessment.

POPs analysis in materials and products are limited due to the lacks of equipment, high-skilled human forces, and analysis procedure and experiences. Besides, to guarantee impact assessment of POPs on people health, it is required to build POPs analysis capacity in milk, blood and food chain, which is a very limited sector in Vietnam.

Scales of implemented POPs monitoring programs

Expense for POPs monitoring program is not included in the national monitoring program due to high expense for sampling and analyzing. Up to now, they are only implemented in few monitoring programs under international cooperation projects from 3 to 6 years in small-geographic scale areas such as coastal estuary or lagoon. Thus, POPs data is incoherent, non-systematic and difficult for an assessment of the status for a wide area as well as tendency for POPs existence and transformation status in the environment.

Laboratories qualified for POPs analyses and monitoring is under different Ministries and sector (such as MONRE, Vietnam Academy of Science and Technology, other ministries and Universities, etc.). Monitoring and analyzing programs in those agencies have no coordination or information sharing.

Gaps in POPs analyses and monitoring capacity in Vietnam include:

Laboratory's equipment and conditions: Lack of budget for the laboratory operation, synchronous equipment for POPs analyses and monitoring, laboratories are mixed used for different purposes (both large and trace amounts) leading to spoiling analysis process and caused errors or inaccuracies in analyses.

Analysis method and procedure: Sensitivity and accuracy are not sufficient due to asynchronous equipment and lacking of expenditure for purchasing the expensive standard chemicals, different laboratories are using different analysis method and procedure for different samples (soil, water, sediment, and biological samples, etc.) which are impossible for comparing results and quality.

National and international laboratory controlling procedures: Awareness of staffs about the importance of quality assurance and control (QA/QC) in laboratory works as well as serious implementation is insufficient, obedience of QA/QC criteria in analysis procedure was not implemented strictly due to lack of finance and time, laboratories do not regularly participate in international inter-correlated laboratories quality controlling programs to assess output accuracy as well as stability.

Human resources: Quality and quantity of staffs involving in POP-related laboratories are limited especially the need for advanced and high-skilled staffs, laboratories are coping with challenges in recruiting and training staffs in POPs monitoring and analysis with high expense.

Cooperation mechanism among laboratories: Due to the lack of a management system for national laboratories for POPs analysis and monitoring, analysis and monitoring works are individual and separated, laboratories qualified for POPs monitoring are under different ministries and sectors led to sparsely archived and collected of relevant data; there was no cooperation among units in inter-laboratories cross-checking especially, there was no referee laboratory for checking results from different laboratories, and no inter-laboratories quality checking for strengthening quality of POPs database system.

Based on analyses and assessments on the need for POPs analysis and monitoring as well as existing infrastructure, equipment and human resources in Vietnam, developing capacity for POPs monitoring and analysis in the future should concentrate on three trends as follow:

1. Building a network consisting of specialized POPs monitoring laboratories and one national reference laboratory: This is to take advantage of existing resources and experiences and solve the difference among analysis results of laboratories by the reference

laboratory with activities as analysis control samples, building and implementing an inter-laboratories quality controlling program, etc.

Task for managing the national POPs monitoring network shall be gathered by VEA in consulting with a council with representatives from relevant ministries and sectors. To make optimal selection for laboratories to participate in the national POPs monitoring network, it is required to organize workshops for laboratories to introduce about their capacity, and have concrete assessments as well as consult with relevant international and experienced experts. After laboratories have been selected to participate in the network and make it work well, following tasks shall be done:

- Re-assessment on laboratories' equipment and conditions, and upgrading
- Staffs education and training
- Building and preparing specific monitoring programs
- Implementing monitoring programs
- Other activities in associated with the operation and efficacy of the monitoring network such as building standards, emission coefficient, modeling existing and transformation status of POPs in environmental components, impact assessment of POPs on public health, building regulations for information, experience and data exchange among laboratories in and out of the networks and other international laboratories.

2. Developing labor forces: By training of new equipment and techniques, specific analysis skills, quality control and assurance in laboratories, data archives and processing; building POP-related projects and actively mobilizing funds to provide appropriate payment for staffs in order to sustain laboratory operation.

3. Strengthening international cooperation: Building and implementing multilateral and bilateral cooperation programs and projects in POPs monitoring and analysis for training staffs; diversifying investment, technical support and technological transfer as well as information and experience updating and exchange; building and maintaining connection with international experienced consultants in POPs during establishing process of monitoring network implementing monitoring program; connecting with regional and international referee laboratories for joining in international inter-laboratory quality controlling programs and to get a higher referee if needed.

2.3.16.2. Technical infrastructure on assessment of POPs alternatives

POPs alternatives issue is quite new in Vietnam in both policy and technical aspects. It has not been directly mentioned in any existing regulations. However, the alternative of POPs is integrated in several relevant practices such as organic farming, replacement of chemical pesticides by biological pesticides.

In Vietnam, companies in pesticide production are switching to the market of less toxic pesticide including medical herbs, microorganism. This trend has proved its advantage as lower price, suitable with sustainable development of the country. Nevertheless, it should be supported by policies and other supporting tools to encourage consumption. In organic farming, Vietnam has promoted this application by issuing regulations such as establishment of Organic Farming Association, inventive for organic products, good farming practice, etc.

For industrial POPs like PFOS, PBDEs, HBCD, etc., Vietnam does not have assessment, research and development of alternatives yet. In implementation of the NIP update, these activities should be promoted by both regulations and incentive policies in order to increase the research, development and application of industrial POPs alternatives with the

participation of research institutes and industries. In addition, international researches and experiences shall be one of the useful sources for success application.

2.3.17. Assessment of POPs management and treatment in Vietnam

2.3.17.1. Development and cooperate in implementation of POPs management policies and regulations

The Plan 2006 gives out tasks on developing POPs management policies and regulations such as: Interdisciplinary management on chemical safety including POPs; encouraging activities of reducing, replacing and eliminating POPs; giving preferential treatment, assistance for reducing, replacing and eliminating POPs; monitoring and periodically report of UPOPs monitoring results; environmental standards for safe management and destruction of POPs; publishing information on POPs pollution and mechanism of public engagement in POPs supervision and safe management.

From 2006 to now, relevant agencies in Vietnam have cooperated in releasing some regulations and policies on the above mentioned fields. The fields having no regulation or only having fundamental regulations in the document system of Vietnam include:

- Interdisciplinary management of chemical safety and chemical pollution control: This content is currently specified under Article 78, Law on Environmental Protection 2014 and Chemicals Law but has no particular instruction for execution.
- Regulation on POPs replacement and preferential treatments, assistance in implementation: There is currently no regulation on this content.
- Monitoring and periodically report of UPOPs monitoring results: This regulation is combined with the regulation on monitoring and periodical report for production facilities.
- Publishing information on POPs pollution and mechanism of public engagement in POPs supervision and safe management: This content is stipulated under the Law on Environmental Protection 2014 but there is no particular instruction. Some contents are combined with regulations on environmental impact assessment.

With regard to groups of POPs, in the recent time, many policies and regulations have been developed in the fields such as pesticides, PCBs, dioxin/furan, and some new POPs and are summarized as follows:

For pesticides, regulations are developed in different forms of document such as Law (Law on Environmental Protection, Chemicals Law, Law on Plant Quarantine and Protection, etc.) and instructive documents, Resolutions of National Assembly, Decisions of the Prime Minister, Decrees, Instructive Circulars, national technical standards. These legal documents have stipulated for various contents related to pesticide management from export, import, production, and use to disposal and treatment. However, some substances have not been given to the regulations or stipulated insufficiently. At present, MONRE is working with MARD to develop regulations on environmental protection for pesticides which shall include POP pesticides management.

For PCBs, some particular and direct regulations on PCBs have been developed and issued such as National technical regulations on hazardous waste thresholds, industrial wastewater, co-processing of hazardous waste in cement kiln, and sediment quality, etc.

Currently, MONRE is cooperating with the MOIT and relevant agencies to develop regulations on environmental protection for chemicals. This regulation is expected to contribute to the efficient PCBs management and control in Vietnam, contribute to implementation of requirements in the Stockholm Convention and sustainable development

target in Vietnam.

For UPOPs, after Vietnam participates in the Stockholm Convention, many activities of inventorying, monitoring, assessing UPOPs released from different sources have been conducted, and then some regulations on dioxin/furan emission control have been issued such as national technical regulations on medical solid waste incinerators, industrial waste incinerators, co-processing of hazardous waste in cement kilns, industrial emissions of steel production.

For agent orange/dioxin from the war, this is a typical issue in Vietnam. The Government of Vietnam has developed and issued many policies in order to overcome the consequences of agent orange/dioxin such as regulations on standard level to define preferential benefits, allowances for people affected by chemical toxicants (dioxin) from the war; Action plan for overcoming consequences of chemical toxicants used by USA during the war in Vietnam; National Action Plan for overcoming consequences of chemical toxicants used by USA during the war in Vietnam. Some standards, regulations are also developed and issued such as standards on dioxin thresholds in soil and sediment, dioxin limits in wastewater, exhaust gas from residual dioxin pollution treatment; national technical regulations on allowable limit of dioxin in some types of soil.

For new POPs, there are not many particular regulations for these substances. The regulations on new POPs management and control are combined with hazardous chemicals under Law on Environmental Protection, Chemicals Law and some relevant documents. Some particular regulations for new POPs are: Provisional regulations on allowable content of some hazardous chemicals in electric, electronic products (regulations for PBDEs); regulations on prohibition of use, regulations on content of some new POP pesticides (lindane, endosulfan, pentachlorophenol) in the environment. Table 11 below summarizes current regulations on POPs:

Table 11. Current regulations on POPs

No.	Name of POP	Annex	Current regulations
1	Aldrin	A	- Prohibition of use; - Limited level in soil (0.01 mg/kg); - Processing thresholds by land use purposes (0.04 to 2.7 mg/kg)
2	Chlordane	A	- Prohibition of use; - Limited level in soil (0.01 mg/kg); - Limited level in sediment (8.9 μg/kg for sediment in fresh water, 4.8 for sediment in salt water, brackish water); - Regulations on sludge from water treatment (absolute content 0.6 ppm; leaching content 0.03 mg/l); - Processing thresholds by land use purposes (0.18 to 13.8 mg/kg).
3	Dieldrin	A	- Prohibition of use; - Limited level in soil (0.01 mg/kg); - Limited level in sediment (6,7 μg/kg for sediment in fresh water, 4.3 for sediment in salt water, brackish water); - Processing thresholds by land use purposes (0.08 to 2.7 mg/kg).
4	Endrin	A	- Prohibition of use; - Limited level in soil (0.01 mg/kg); - Limited level in sediment (62.4 μg/kg);

No.	Name of POP	Annex	Current regulations
			- Regulations on sludge from water treatment (absolute content 0.4 ppm; leaching content 0.02 mg/l); - Processing thresholds by land use purposes (0.11 to 5.5 mg/kg)
5	Heptachlor	A	- Prohibition of use; - Limited level in soil (0.01 mg/kg); - Limited level in sediment (2.7 μg/kg); - Regulations on sludge from water treatment (absolute content 0.2 ppm; leaching content 0.01 mg/l); - Processing thresholds by land use purposes (0.08 to 13.8 mg/kg).
6	Mirex	A	- Prohibition of use (in household, healthcare); - Processing thresholds by land use purposes (0.13 to 5.5 mg/kg)
7	Toxaphene	A	- Prohibition of use; - Limited level in soil (0.01 mg/kg); - Processing thresholds by land use purposes (2.3 to 50 mg/kg)
8	DDT	B	- Prohibition of use; - Limited level in soil (0.01 mg/kg); - Limited level in sediment (4.8 μg/kg); - Processing thresholds by land use purposes (1.1 to 50 mg/kg)
9	Hexachlorobenzene (HCB)	A, C	- Prohibition of use; - Limited level in soil (0.01 mg/kg); - Processing thresholds by land use purposes (0.51 to 46 mg/kg)
10	Polychlorinated biphenyls (PCBs)	A, C	- Hazardous waste standard; - Dangerous good transportation; - Business condition; - Co-treatment in cement kiln; - Limited level in sediment (277 μg/kg for fresh water, 189 μg/kg for sea/brackist water) - Limited level in industrial wastewater (0.003-0.01 mg/l) - Limited level in oil after recycling (≤ 5ppm)
11	Polychlorinated dibenzo-p-dioxins (PCDD)	C	- Limited level in soil (40-1200 ng/kg TEQ); - Limited level in sediment (21.5 ng/kg TEQ); - Limited level in emission from medical waste incinerator (2.3 ng – TEQ/Nm^3); - Limited level in emission from industrial waste incinerator (0.6-1.2 ng TEQ/Nm^3); - Limited level in emission from steel furnace (0.1-0.6 ng/Nm^3); - Limited level wastewater from paper

No.	Name of POP	Annex	Current regulations
			production (15-30 pgTEQ /l)
12	Polychlorinated dibenzofurans (PCDF)	C	- Limited level in soil; - Limited level in sediment (21.5 ng/kg TEQ); - Limited level in emission from industrial waste incinerator (0.6-1.2 ngTEQ/Nm^3)
13	Chlordecone	A	- Processing thresholds by land use purposes (0.05 to 13.8 mg/kg)
14	Alpha hexachlorocyclohexane	A	- Prohibition of use
15	Beta hexachlorocyclohexane	A	- Prohibition of use
16	Lindane	A	- Prohibition of use; - Limited level in soil (0.01 mg/kg); - Limited level in sediment (1,4 μg/kg for fresh water, 01 for sediment in salt water, brackish water); - Regulations on sludge from water treatment (absolute content 6 ppm; leaching content 0.3 mg/l); - Processing thresholds by land use purposes (0.33 to 50 mg/kg)
17	Technical endosulfan and its related isomers	A	- Prohibition of use; - Limited level in soil (0.01 mg/kg)
18	Pentachlorophenol, its salts and esters (PCP)	A	- Prohibition of use; - Limited level in soil (0.01 mg/kg); - Processing thresholds by land use purposes (0.88 to 27.6 mg/kg)
19	Polychlorinated naphthalenes (PCNs)	A, C	- No regulation
20	Pentachlorobenzene (PeCB)	A, C	- Limited level in oil after recycling (≤ 60 ppm)
21	Hexabromobiphenyl (HBB)	A	- No regulation
22	Hexabromodiphenyl ether and heptabromodiphenyl ether	A	- Threshold in electric, electronic products (1,000 ppm)
23	Tetrabromodiphenyl ether and pentabromodiphenyl ether	A	- Threshold in electric, electronic products (1,000 ppm)
24	Hexabromocyclododecane (HBCD)	A	- Regulations on registration of using hazardous chemicals to produce industrial products, goods
25	Hexachlorobutadiene (HCBD)	A, C	- Regulations on hazardous goods transportation
26	PFOS	B	- No regulation
27	Decabromodiphenyl ether	A	- No regulation
28	Short-chain chlorinated paraffins (SCCPs)	A	- No regulation

Therefore, it can be seen that there are many regulations on POPs including regulations on

management and thresholds of some environmental components. However, there are not particular regulations on some POPs such as: No regulation on prohibition of chlordecone; no regulation on PFOS, HBB, PCBs management and control; regulation on PBDE threshold in electric, electronic products but no regulation on management, control or recycle of PDBE-containing materials, wastes in accordance with the Stockholm Convention; no regulation on controlling HCBD, HBCD, PeCBz emission, etc. For all POPs, there is no regulation on threshold in food/food chain while it is an important content in environmental health management. On the other hand, due to limitation of capacity and awareness, the implementation of the current regulations on POPs have not been effectively implemented including restrictions in the supervision of the authorities concerned.

To implement the Law on Environment Protection, as mentioned above, MONRE is working with MOIT, MARD and relevant organizations to develop new regulations on environmental protection for chemicals, pesticides and veterinary. These regulations are expected to include pollution control for not only chemicals, pesticides, veterinary in general but also POP pesticides, industrial POPs, UPOPs as well as POPs related articles. These regulations when issued shall sufficiently cover POPs management in Vietnam.

In Vietnam currently, POPs management conducted by ministries and sectors by specific stages of lifecycle are presented as follow:

Table 12. Stakeholders in POPs management

Stage / Stakeholder	Import	Transportation	Production	Distribution	Use	Disposal	Treatment, destruction
MONRE	+	+	+		+	+	+
MOH	+			+	+	+	+
MARD	+	+	+	+	+	+	+
MOLISA			+	+	+		
MOIT	+		+	+	+	+	+
MOF	+		+				+
MOT	+	+		+	+	+	
MOC				+	+	+	
MPS	+	+	+	+	+	+	
MOD				+	+		+
MOJ	+			+			
Industries, enterprises	+	+	+	+	+	+	+
Associations	+	+	+	+	+		+
Community	+	+	+	+	+	+	+

2.3.17.2. Strengthening capacity of POPs management

During the implementation of the Plan 2006, many activities of strengthening capacity of POPs management are carried out through the main contents such as: Establishment of POPs management organization; Training activities for strengthening management capacity; Capacity strengthening for POPs monitoring, POPs treatment.

2.3.17.2.1. Establishment of new organization having functions, missions on POPs safe management

In order to meet the actual demand on managing Environmental Protection in general and hazardous chemicals in particular, the MONRE has reported to the Government for permission of establishing some new units and reorganizing functions, missions of Vietnam

Environment Administration under Decision No. 25/2014/QĐ-TTg dated March 25, 2014 stipulating for functions, missions, rights and organizational structure of Vietnam Environment Administration directly under the MONRE. Under this Decision, the function on chemical pollution control and national focal point in implementing the Stockholm Convention are specified in accordance with the commitment of the Government to the Stockholm Convention.

Vietnam Environment Administration established Division of chemical pollution control, environmental incidents and environmental health under the Department of Pollution Control (PCD), which has function of consulting and assisting PCD and VEA in implementing the governmental management on chemical emission control, prevention, emergency response, recovery of environmental incidents in accordance with laws and managing environmental health in nationwide. This is also the standing unit for domestic and international contact, for consulting leaders and coordinating activities of implementing the Stockholm Convention in Vietnam.

With regard to establishing and reinforcement of the interdisciplinary cooperation mechanism, executing the direction of the Prime Minister, the MONRE has established the National Steering Committee for the Stockholm Convention (Decision No. 1883/QĐ-BTNMT).

Under the Decision No. 184, the Prime Minister also assigned missions and clear cooperation mechanism among Governmental agencies in different fields, by groups of POPs and in conformity with functions, missions of each agency.

In recent years, the role of decisive and active focal point can be realized in assisting the Government to manage POPs activities of the MONRE. The relevant units of the MONRE, especially VEA, have directed, cooperated with many relevant agencies, entities, individuals to carry out POPs management activities in a diversified manner such as establishment and application of legal documents, strengthening of technical capacity, enhancement of awareness, support in development of POPs pollution treatment infrastructure, POPs monitoring, promotion of inspection activities, development of lab network for controlling POPs and other hazardous chemicals, issuance of technical instructions and organization of training sessions, instructions for implementation.

Many Ministries and sectors are also active in cooperation with the MONRE in implementing assigned missions such as: PCBs management (MOIT, Vietnam Electricity); medical POPs management (MOH); management and reduction of harmful effects of residual pesticides in the environment (MARD); some relevant activities on Agent Orange/dioxin pollution treatment at hot-spots (MOD); management and control of importing POP/hazardous chemical products into Vietnam (MOF, General Department of Vietnam Customs); activities on mobilizing and managing international funds (Ministry of Planning and Investment); approval and implementation of some researches on applying advanced technology in POPs management and pollution treatment and combination in issuing some Vietnam Standards and Technical Regulations related to POPs (MOST).

Besides, the broad deployment of POPs management activities nationwide also supports, promotes the cooperation among central agencies and local authorities such as activities of inventories, assessment and treatment of chemical stockpiles, PCBs inventory and management, or control of dioxin/furan released from waste incinerators.

However, there still exist some issues on interdisciplinary cooperation, overlapped responsibilities among managerial agencies in environmental management related to chemicals and chemical safety including POPs in some different fields. The cooperation between the Central and the localities and among localities in deploying environmental management activities for POPs and hazardous chemicals should be more strengthened. Some

orientations in developing interdisciplinary, regulations on environmental protection for industrial chemicals, pesticides, veterinary drugs, medical wastes are also defined and implemented gradually. These issues should be solved by the Ministries and sectors in the coming time.

With the increasing need to address issues related to POPs in Vietnam together with the continuous addition of new POPs and the corresponding requirements of the Stockholm Convention, the coordination of implementation of the Stockholm Convention in Vietnam is facing many difficulties due to lack of specialized department performing administrative support activities and techniques for the implementation. Therefore, this content should be prioritized during implementation to ensure effective implementation of the requirements of the Stockholm Convention and the requirements on environmental protection in Vietnam.

2.3.17.2.2. Training activities

Together with operations in establishing policies, laws, technical instructions in POPs management, activities of training, policy and information dissemination are also performed widely.

During the process of implementing the Stockholm Convention, competence enhancement is regarded as an important activity for information and knowledge supply, connecting the Parties and attracting community participatory in POPs safety management, simultaneously supporting implementation and compliance toward the Decision No. 184. In addition, with the direction of considering the POPs management as typical hazardous substances, competence enhancement of POPs management is also working on one of environmental management and waste management in general.

Figure 20. Joint-training of Environment – Customs - Environmental Police

With support from projects like GEF/WB - PCB and GEF/UNDP - pesticides, Vietnam Environment Administration has organized training for thousands of officials from Departments of Natural Resources and Environment, Environmental Protection Agencies, Departments of Industry and Trade, Fire Prevention and Control Police, General Departments and Departments, Customs and officials of market administration. Various scientific research companies and organizations and individuals attended such workshops and training courses. Contents of training and information exchange in the workshops and training course are either diversified, directly related to POPs management or contribute to awareness enhancement in environmental management in general. Some contents of training are as follows:

- Transfer of technical knowledge, the best POPs management methods appropriate in Vietnam condition like determining, reviewing, sampling, analyzing, waste treatment, remediation for pollution stockpile and POPs risk management, etc.
- Training on POPs materials import/export control with target of knowledge and

competence enhancement of customs officials in order to determine and obstruct POPs, materials, equipment or waste to come into Vietnam as well as improper export of these substances to other countries.

- Training on PCBs incident response and prevention, in which competence of officials from the VEA, the Department of Natural Resources and Environment, Environmental Protection Agency, Police of Environmental Crime Prevention and Control, Fire Prevention and Control Police and some power companies were enhanced to prepare and respond accident or incident of PCBs overflow. In such training operation, general information was exchanged and specific topic/actual situation regarding hazardous chemicals use management and treatment was also analyzed.
- Training on POPs management policy is also frequently implemented for officials from Department of Natural Resources and Environment, Department of Industry and Trade, Department of Labor Invalid and Social Affairs, Customs Agency, Electricity of Vietnam and other waste source owners.

In addition, training materials, presentation, news in POPs management and project operation are also publicized and updated on POPs portal and specific website of each project.

In the general evaluation on training, competence enhancement for the Parties, it shows that with significant investment sources including the State budget and international project, the training activities helped in competence enhancement for relevant officials, contributing actively in establishment and implementation of policies and regulations of POPs safety management and environmental protection in general.

2.3.17.3. POPs treatment and treatment technologies

In recent years, in order to enhance the capacity of POPs treatment and destruction, the MONRE cooperated with international and local experts, organizations, and technology companies to review and assess different technologies to consider their possible transfer and use in Vietnam. To evaluate and possibly licensing different technologies for POPs treatment and destruction, the technology review and evaluation has used different approaches such as synthetize the information in reports, laboratory scale testing and pilot and full scale testing. The evaluation considered the principle of the technologies, the effectiveness of the treatment, the availability of commercial scale, the engineering requirements, human resource requirements, the safety and the cost among others as basis to choose appropriate technology solutions.

Despite all these assessments of a technology, it needs to be emphasized that POPs destruction project need a rigorous monitoring frame best with continuous sampling of releases and an overall toxicity assessment[82].

Co-processing in cement kiln

In cement kilns with very high temperature at kiln inlet (> $1,800^0$C), a high thermal stability, alkaline conditions, oxidation and long burning residence time ensure the conditions for destruction of POPs. In 2011, the Holcim Company has applied successfully in treatment of two tonnes of transformer oil containing PCBs at high concentrations (mean PCBs concentration was 40,000 ppm, the highest concentration was 76,500 ppm). The results were high destruction removal efficiency (99.99992%) and the emission limits for PCDD/Fs were met (0.1 ng TEQ/Nm^3). They have been licensed to process the PCBs in cement kilns. In 2014, Holcim handled nearly 7,000 liters of transformer oil containing PCBs from Cai Lan

82 Weber R. (2007) Relevance of PCDD/PCDF Formation for the Evaluation of POPs Destruction Technologies – Review on Current Status and Assessment Gaps. Chemosphere, 67, 109-117.

Port in Quang Ninh province.

This technology is highly effective, which is suitable for POPs stockpiles such as pure pesticides, waste oil containing PCBs and safe for environment if the waste is fed at the appropriate position in the kiln; otherwise, high POPs levels can be released from cement kilns[83].

For POPs wastes, such as soil contaminated with pesticide POPs with the average content from several hundred to several thousand ppm, the treatment is still effective but it should take into account the cost of collecting, transporting, burning which are calculated by the total volume of waste to get the appropriate solutions. Furthermore, soil and other solid wastes are normally fed at the "cold end" of the kiln (temperature between 800^0C to $1,000^0$C) and it needs to be assured that sufficient high and residence time exist; otherwise, POPs fed into the kiln can be released from cement kilns at high levels as recently discovered in a HCB waste destruction project in an Austrian BAT cement kiln[84].

High temperature incineration

Hazardous waste incinerator is the technology which has treated most of the PCBs and other POPs stockpiles the last 40 years.

In Vietnam, the disposal of POP-pesticides in small scale hazardous waste incinerators has been experimented with mobile or fixed two-stage incinerators. High POPs destruction efficiency and short disposal time are two strengths of the incineration. However, it requires high temperature (>1,100^{o}C), require high consumption of thermal energy, which is a main factor for the relative high costs. For non-BAT incinerators and small scale units not operated continuously with frequent start-up and shut down PCDD/F and other unintentionally POPs van be formed and released to air, ash and other effluents that standards might not be met.

Figure 21. A hazardous waste incinerator made in Vietnam

The Centre for Technology and Environmental Treatment, under the High Command of Chemical (MOD), has manufactured mobile incinerators for POP-pesticide stockpile disposal since the late 1990s in Vietnam. POP-pesticide 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^{o}C (primary chamber) and 850-1,200^{o}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 cycle and is treated with carbon-based adsorbents. All of the ash is mixed with lime, disinfection substances and additional microbes and then carried disposed. The incinerators are mobile units and are able to be carried to treat POPs on site, avoiding the transportation of POPs.

Due to higher demand for waste treatment in Vietnam, many incinerators for domestic,

83 Weber R, Schlumpf M, Vijgen J (2015) The need for better management and control of POPs stockpiles Environ Sci Pollut Res Int. 22, 14385-14390 http://link.springer.com/article/10.1007/s11356-015-5162-7/fulltext.html

84 Weber R, Schlumpf M, Vijgen J (2015) The need for better management and control of POPs stockpiles Environ Sci Pollut Res Int. 22, 14385-14390 http://link.springer.com/article/10.1007/s11356-015-5162-7/fulltext.html

industrial, hazardous and healthcare waste treatment have recently been constructed with various capacities. They are equipped with relatively modern technology, the off-gas is normally treated by a wet scrubber and then by activated carbon spray to control the release of PCDD/PCDF. Many companies have also imported different type of incinerators to treat waste - particularly healthcare waste - in Vietnam.

Thermal desorption

In order to dispose dioxin-contaminated soil at Da Nang airport, American experts have tested and applied in-pile thermal desorption technology at the airport. Dioxin contaminated soil was put into a furnace of 70 m width, 6 m height and 80 m length, which is firstly electrically heated at about 6 MW to over 700^{o}C that the soil temperature can reach at least 335^{o}C. The pollutants released from the soil are collected under negative pressure and transferred into an adsorption unit 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[85], Terra Term, one supplier of the technology, claim that the process has been improved to ensure that the thermal desorption occurs at the same time with thermal decomposition when the dioxin-containing vapor 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, soil and residue will be analyzed to ensure the fulfillment of Vietnam environmental standards. The environmental monitoring of PCDD/PCDF generated surrounding the disposal site has been also thoroughly undertaken by VEA.

Mechano-chemical destruction (ball milling)

Mechano-chemical destruction technology is based on mechano-chemical energy transfer to facilitate chemical process leading to the destruction of POPs and other pollutants. 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 results in the dehalogenation and other destruction of chlorinated organic molecules.

In Vietnam the ball mill technology was tested by EDL in Bien Hoa 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 tonnes 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 experiments, 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. However, the technology was less effective for soil contaminated at the levels of "high" and "low" PCDD/F load.

The technology has the potential to destroy PCDD/F (and other POPs) under certain conditions. However, the development from the scale of testing to that of practical disposal for the contaminated soils will require close attention to various factors such as the concentration of pollutants, pre-processing methods, operating parameters and additional

[85] Scientific and Technical Advisory Panel (STAP) of the Global Environment Facility (GEF). 2011. Selection of Persistent Organic Pollutant Disposal Technology for the Global Environment Facility.

measures to restrict and control the secondary pollution like odor, dust, noise and solid waste generated from (pre-)treatment. Furthermore, the large volume of soils as input material is a limitation for this technology. It is also worth noting that the soil after treatment cannot be reused directly because the soil size is very fine and it is sterile. The soil thus requires post-processing steps to be reused.

Chemical-based techniques

The basic principle of the chemical-based technology for POPs disposal is dehalogenation from POP molecules by chemical reactions using reduction agent such as sodium dispersed oil, alkali hydroxide in mineral oil, and nascent hydrogen among others. Chemical-based technology, in particular sodium-technology, has been used to dispose PCB-containing oil in many countries. In recent years, a number of international companies have introduced their technology to Vietnam, conducting market research and carrying out necessary legal procedures in order to be licensed to treat POP-pesticides and PCBs in the country.

Furthermore, a number of research studies on the potential of applying such technologies in Vietnam have been conducted and published. 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 established a pilot plant (20 litres/batch) to dispose PCBs in transformer oil, in which NAOH solution (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 benzophenol to create aryl ketyl compounds [(Ar)-, Me+], which can dispose PCBs containing transformer oil.

Additionally, advanced oxidation techniques like using Fenton and Feroxon for POPs oxidative decomposition have been researched by 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 POPs contamination disposal in Vietnam.

For technologies which do not mineralize POPs a detailed assessment of the toxicity of the residues is needed (Weber 2007).

Bioremediation

This technique relies on living organisms (bacteria, fungi) to achieve the decomposition of pollutants to the concentration lower than permitting thresholds. In comparison with the above technologies, this technique would have advantages such as lower costs without altering structures of the surroundings if it can be applied. However, the biggest drawback of this technology is that it can normally only treat pollutants at low concentration, the processing time is relatively long and sometimes the degradation in the field does not work as tested in the laboratory.

In 2009, MOD completed remediation in Z1 area in Bien Hoa airbase by landfill method which isolated 4 hectares of heavily contaminated dioxin from 1.2 to 1.4 m in depth. There were 3 lots of 3,384 m^3 applied micro technology which named “active landfill”, developed by Institute of Biology, Vietnam Academy of Sciences and Technologies (VAST). Most of analyzed samples in Z1 area in study 2010 by Hatfield Consultant and Office 33 exhibited low TEQ concentration, the highest TEQ was 3,120 ppt. This proves that remediation effort by Vietnam is effective. However, this perimeter of Z1 area required more study, especially

by depth[86].

Plant-based disposal technique (Phytoremediation)

This is a technology using plants for on-site degradation or absorption of pollutants in/from soil or sediment. Some plants can be used to extract/accumulate heavy metals, pesticides, organic solvents, explosives, oil or organic materials containing aromatic rings from contaminated soil. The plant-based technique has been applied in different countries, as the technology might be useful in areas that can be treated with long-term environmental recovery. Since for e.g. heavy metals phytoremediation is only a transfer to the plant, further management of contaminated plants are needed.

In Vietnam, there has been some initial laboratory research that uses plants to treat pollution.

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/hydroperoxit, 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 liter. 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-pesticide 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 POPs release to the air, and the ability to totally isolate the landfilling area of treated waste from the surrounding environment.

Thus, there are a range of technologies rated to handle POPs in Vietnam. Several technologies have been licensed to be applied for destruction (such as Co-processing PCBs in cement kiln) while some others are still being tested for their applicability. In the context of Vietnam, demand for treatment of POPs will focus on handle POP pesticides in residue forms and soil and other pollution. For PCBs; oil, materials, equipment and other wastes containing PCBs need treatment. For unintentional POPs in particular the Agent Orange/dioxin hotspots need

[86] MONRE (Office 33). 2013. Comprehensive report agent orange/dioxin contamination at three hotspots: Bien Hoa, Da Nang and Phu Cat airbases

further treatment. For PBDE and PFOS the stocks of products/articles need to be treated. In addition, contaminated areas with these industrial POPs might need remediation.

To meet this requirement, the research, evaluation, transfer and application of technology to safely handle POPs in the future should be accelerated.

2.3.18. Identification of impacted populations or environments, estimated scale and magnitude of threats to public health and environmental quality, and social implications for workers and local communities

Due to stability and lipophilic properties, POPs are stored in fatty tissue and bioaccumulate in the food chain. Most POPs have long half-lives in humans, can cross the placenta, and are excreted in breast milk, resulting in exposure of offspring.

2.3.18.1. POP pesticides

Though POP pesticides as DDT, HCB, HCH, etc. were banned from the use in the field in Vietnam, however, because of their persistence, the recent studies have still detected them in the environment components and in organisms with different concentration. Human breast milk samples collected in 2007-2008 in Hanoi, Vietnam were analyzed for POPs such as DDTs, chlordane-related compounds (CHLs), hexachlorocyclohexanes (HCHs), hexachlorobenzene (HCB), PCBs and PBDEs. Comparing with previous surveys, the present study indicates that the DDTs in breast milk had gradually decreased during the last decade, but were still higher than those in other nations[87].

In addition, Vietnam has more than thousands of POP pesticides stockpiles and contaminated sites causing risk to environment and human especially local people living near these areas. As mentioned in the previous section, the large amount of pesticides used for agriculture in Vietnam has raised the necessary for better management of both initial POP pesticides and newly added ones in order to minimize their impacts on farmer and communities.

2.3.18.2. PCBs

Humans are exposed to PCBs at work (contacting with skin, eating or breathing air contaminated with PCBs during assembly, maintenance of equipment and materials containing PCBs), at home (eating food contaminated with PCBs, contacting skin or air when using or dismantling with old electronic equipment and materials containing PCBs), from ambient (Exposure to soil, sediment, waste containing PCBs, breathing air with PCBs in PCBs contaminated areas)

PCBs exposure does not cause bad effects on health instantaneously. PCBs are accumulated in the body up to a certain threshold in order for the symptoms to be recognizable. According to some studies, the liver is the first organ to take the impact of PCBs; PCBs exposure will cause injuries, such as acnes burned skin, burned eyes, etc. PCBs are chemicals belong to group 2A – Long considered as "probably carcinogenic to humans," PCBs were recently declared as carcinogens. PCBs may be caused following impacts to human health:

+ Acute and chronic impacts on health, PCBs have the ability to inhibit the immune system and are the factors causing Non-Hodgkin's lymphomas.

+ Reproductive system effects: Researches on the impacts on the reproductive system have also been done. Children born from mothers working in PCB- infected environment have lighter weight, shorter gestation period.

+ Nervous system effects: Observation of PCB-exposed people shows considerable and long-

[87] Haraguchi K. 2009. Levels and regional trends of persistent organochlorines and polybrominated diphenyl ethers in Asian breast milk demonstrate POPs signatures unique to individual countries.

term defects of the development of the nervous system, including impaired visual recognition, poor short-term memory

+ Endocrine system effects: PCBs have been proved to cause effects on thyroid hormones of human and animals, affects the growth and development.

+ Carcinogenicity Toxicological: PCBs have recently been listed as carcinogen Class 1 by the International Agency of Research on Cancer (IARC).

In Vietnam, the main sources of high-risk PCBs emissions include waste oils from electrical equipment (transformers, capacitors), the recycling of electronic waste and ship breaking activities. Recycling of electronic waste in Vietnam is mainly performed manually. The research conducted by Shin Takahashi and colleagues from National Institute of Environmental Science, Japan (2012) showed that PCBs were present in indoor dust within the area of electronic waste recycling in Vietnam ranging from 3, -320 ng/g; in the air was 33-1,800 pg/m^3 [88]. PCBs concentrations in the serum of the people living in the area of electronic waste recycling was 420 pg/g and higher than in people living elsewhere (290 pg/g)[89].

In 2015, the preliminary research on PCBs in some foodstuffs in Vietnam was conducted with representative of foods in 8 geographic regions of Vietnam. The results showed the presence of PCBs in some foodstuffs. These should be further investigated to have appropriate solutions to minimize their impacts on human.

2.3.18.3. PBDEs

The impact of PBDEs to human and animals including: To endocrine system, mainly to thyroid; neurotoxic; hepatotoxic; causes immunodeficiency; affect to reproduction and development; and to cause cancer. Breathing air and absorbing dust contaminated with PBDE are two PBDE exposure routes into the human body.

Some researches on the levels and the distribution of PBDEs in the environment have shown that recycling electronic waste cause high risk of PBDE emissions into the environment. The spontaneous e-waste recycling areas are highest potential areas contaminated with PBDEs. Thus, people who live and work in EEE recycling areas and PBDEs contaminated areas can be potentially exposed to PBDEs. Some researches in Vietnam on PBDEs levels in the human and breast milk detected that PBDEs level in the breast milk of women who recycle of electronic waste in Bui Dau village are 30-150 times higher than the women in other areas. With PBDEs level average of 84 ng/g and highest level of PBDEs of 250 ng/g, the recycling of electronic waste in Bui Dau villages can cause potential risks to workers and their children health[90].

2.3.18.4. PFOS

PFOS has been shown to have a range of toxic effects. PFOS bind to protein in the blood and liver and therefore accumulate in protein rich organs such as liver and spleen and in blood[91]. In addition, other PFASs have been found in the blood, plasma, breast milk and liver, and in the nail[92]. Studies show that PFOS affect the reproductive health of human such as reducing healthy sperm count[93] and delay in pregnancy[94]. PFOS and PFOA**Error! Bookmark not defined.**

[88] Shin Takahashi et al. 2012. Contamination of indoor dust and air by polychlorinated biphenyls and brominated flame retardants and relevance of non-dietary exposure in Vietnamese informal e-waste recycling sites

[89] Kei Nomiyama et al. 2015. Residue profiles of organohalogen compounds in human serum frome-waste recycling sites in North Vietnam: Association with thyroidhormone levels

[90] Vietnam NIP Update Project. 2015

[91] Jones et al. (2003) Binding of perfluorinated fatty acids to serum proteins. Environ Toxicol Chem. 22(11):2639-2649

[92] Kannan, K., S. Corsolini, J. Falandysz, G. Fillmann, K. S. Kumar, B. G. Loganathan, M. A. Mohd, J. Olivero, N. V. Wouwe, J. H. Yang,, and K. M. Aldous. 2004. "Perfluorooctanesulfonate and Related Fluorochemicals in Human Blood from Several Countries." *Environmental Science & Technology* 38: 4489–4495

[93]. *Joensen et al. (2009)* Do perfluoroalkyl compounds impair human semen quality?. Environ Health Perspect.;117 923-927.

exposure can reduce the growth of fetus. Children exposed to certain PFAS have also observed the symptoms of attention deficit hyperactivity disorder. Humans can be exposed to PFOS through drinking water and eating foods contaminated with PFOS. Other exposure might result from (house) dust and breathing related contaminated air.

There is a large uncertainties on the toxicity of most PFAS and considering their high persistence the Madrid Statement ask for appropriate action to control PFOS and other PFAS[95].

According to some researches, the mean value (ng/L) of PFAS levels in surface water at 5 locations with specific activities in Hanoi and Hung Yen provinces shows that PFCs levels trend to increase in order: (1) rural areas: 9.40; (2) waste water discharge sites: 12.2; (3) recycling heavy metals from batteries and accumulators: 17.1; (4) domestic waste landfill sites: 43.9; and (5) e-waste recycling sites: 56.5. In which, the wastewater samples taken from household waste landfill sites contain highest PFCs level (363 ng/L), following by waste water from electronic waste recycling sites (169 ng/L). Such recycling of electronic waste and household waste landfill sites has high potential emissions of $PFAS^2$ into the environment[96].

The analytical results of 40 breast milk samples of the women in Ho Chi Minh City collected in 2000 and 2001 showed that PFOS levels ranged from 16.9 to 393 ng/L, average of 75.8 ng/L, PFOA levels ranged from 42.5 to 89.2 ng/L[97]. Another research, serum samples from 37 women aged 20-40 in Hanoi has been taken for analysis, PFOS level ranges from 6.78 to 1.89 and PFOA level ranges from <0.2 to 1.57 μg/L[98].

2.3.18.5. AO/dioxin, UPOPs

The amount of 95,112,688 kg of herbicides were sprayed over 2.63 million hectares, accounting for 15.2% of total area of Southern Vietnam (172.54 million hectares, according to SIPRI (1971)). The area sprayed by the herbicides containing 2,4,5-T was 1.68 million ha, accounting for 9.7% area of Southern Vietnam[99].

Base on above data, the spraying density can be estimated as following: Overall average chemicals density were 36 kg/ha, in which the Agent Orange with the volume of 49,268,937 liters, equivalent to 63,064,240 kg, spraying over area of 1.68 million ha was the density of 37.5 kg / ha. This spraying density was 17 times higher than the one used for agriculture (i.e. 2.2 kg/ha under the guidance of the U.S Force, Vietnam-Russia tropical center, 1995, p.52). At this density, the herbicides become toxic and could destroy the crops.

During US-Vietnam War, more than two millions hectares of forests were affected at different levels: It was reported that more than 90 million m^3 of timber (Phung Boi Tuu et al, 2002), and 150,000 ha of mangrove forests were destroyed (Phan Nguyen Hong, 2002), and the ecosystem in Southern Vietnam was severely damaged.

According to National Academy of Sciences (2003) and Stellman (2003), 3,181 villages among 20,585 registered villages were directly sprayed. The number of people exposed to dioxin was 2.1 - 4.8 million. In addition, other 1,430 villages were reportedly sprayed but the

[94] Fei C et al (2009) Maternal levels of perfluorinated chemicals and subfecundity. Hum Reprod. 24(5):1200-1205.

[95] Blum et al (2015) The Madrid Statement on Poly- and Perfluoroalkyl Substances (PFASs). Environ Health Perspect 1235 A107–A111.

[96] Isobe T. et al. 2012. Determination of perfluoroalkyl compounds in aqueous samples from Northern Vietnam. Interdisciplinary studies on Environmental Chemistry - Environmental Pollution and Ecotoxicology. TERRAPUB, 2012.

[97] Tao, L. et al. 2008. Perfluorinated compounds in human breast milk from several Asian countries, and in infant formula and dairy milk from the United States. Environ Sci Technol 42, 8597-8602

[98] Harada K. H. et al. 2010. Levels of perfluorooctane sulfonate and perfluorooctanoic acid in female serum samples from Japan in 2008, Korea in 1994-2008 and Vietnam in 2007-2008.

[99] Stellman J.M., Stellman S.D., Christian R., Weber T., Tomasallo C. (2003), The extent and patterns of usage of agent orange and other herbicides in Vietnam. Nature 422, 681-687.

affected population was not known.

The huge amount of remnant dioxin from the war to the environment of Southern Vietnam has seriously affected the health of millions of people and veterans in whole country. Millions of victims of Agent Orange suffer a variety of diseases: Cancer, immunodeficiency etc. Especially, at some airbases, such as Bien Hoa, Da Nang and Phu Cat, Agent Orange/dioxin concentrations are still very high. These areas are considered as "hotspots" of dioxin contamination. In those areas, the concentration of dioxin (especially 2,3,7,8-TCDD) in soil, sediment is extremely high, several hundred times higher than national standard (i.e. 1,000 ppt TEQ for soil, 150 ppt TEQ for sediment and sludge), and several thousand times higher than the normal background levels.

2.3.19. System of assessment and listing of new chemicals

The Chemical industry is a relevant sector which has the potential for environmental pollution. The production volumes of chemicals are increasing globally. The Emissions of chemicals into the environment may occur along the life cycle of chemicals – production, use and disposal. Releases might occur to wastewater, as waste gas and as solid waste. Particular high releases might result from chemical incidents (fire, explosion, leakage ....). New chemicals are potentially high risk on environment and human health because of their hazardous properties. A country like Vietnam can hardly assess comprehensively new chemicals in a short time because of the limited size and capacity of evaluation.

According to the Article 44 of the Law on Chemicals in 2007, new chemical will be used on the market after the results of the evaluation of the assessment organization of new chemicals. Simultaneously, the Circular No. 28/2010/TT-BCT of the MOIT regulated that the organizations and individuals producing or importing new chemicals must be registered with the MOIT (Vietnam Chemicals Agency). Additionally, new chemicals before importing must be assessed by a qualified organization which is specified by MOIT if the chemical is not in the 02 categories of foreign chemicals. However, until now, the MOIT has no specific provision on the criteria to assess the new chemicals.

Now, in order to strengthen the management of the chemicals, which are imported and produced, MOIT is implementing the Project "Building the national list of chemicals and national chemical database" which is approved by the Prime Minister on the Decision No. 768/QD-TTg dated on August 22, 2012. Accordingly, during the period 2012-2014, MOIT chaired and cooperated with the other relating ministries to submit the national list of chemicals. However, until now, the national list of chemicals has not been issued and there is no effective coordination mechanism between MOIT and other ministries including the MONRE (The Ministry in charge of environmental protection and pollution control), which cause great difficulties in the identification and assessment of new chemicals being imported and circulated on the market. Thus, the legal provisions as well as tools for managing new chemicals currently are inadequate leading to difficulties in controlling the new chemical.

2.3.20. System of evaluation and management of chemicals on the market

In Vietnam, the Globally Harmonized System of Classification and Labelling of Chemicals (GHS) was first mentioned in the Decree No. 68/2005/ND-CP dated on May 20, 2005 on chemicals safety and then more detailed in the Law on Chemicals in 2007 and Decree No. 108/2008/ND-CP dated on October 07, 2008 and Circular No. 04/2012/TT-BCT dated on February 13, 2012 on regulations on the classification and labeling of chemicals.

Production, trading and use of chemicals are thriving in recent times. Most manufacturing companies in the mining industry, food and beverages industry, tobacco industry, textile products, garments, leather among others are using chemicals. In recent years, production,

sales and use of chemicals are also major contributors to the economic development of Vietnam. Besides the economic benefits, the chemical production and use is also one of the causes of the rising pollution and the risk of chemical incidents affecting seriously to the environment and human health in recent times.

For the industrial chemical, to strengthen the management of chemicals, the Law on Chemical was passed by Congress and has been in effect since 2007 with the leading role in the management of chemicals are allocated to the Ministry Industry and Trade. Also in recent years, many laws were enacted to manage activities related to chemicals. Accordingly, the Law on Chemicals was divided into 9 groups of chemicals on the nature and specific features. The current regulations focus on management of chemicals according to the catalog, including:

- The banned chemicals include 14 groups of chemicals having the toxic properties and extreme danger which are promulgated under Annex III of Decree No. 113/2017/ND-CP.
- The chemicals under the restrictions of production and trading of the provisions of the Annex II of Decree No. 113/2017/ND-CP include 217 chemicals group.
- The chemicals having the conditions include 819 chemicals which specified in Appendix I of the Decree No. 113/2017/ND-CP . Accordingly, the production and business facilities of the chemicals in this list need to ensure adequate conditions of infrastructure, technical facilities, personnel and capacity which are certificated by the DOIT.
- The dangerous chemicals which must be declared when production, business and importing of includes 1,156 chemicals are defined in Annex V of Decree No. 113/2017/ND-CP.

In addition, for a number of hazardous chemicals including 117 types (defined in Annex I of the Circular No. 07/2013/TT-BCT), the production, sales and use facilities have to register by document with the DOIT within fifteen (15) working days before the start of use.

For chemical labels, now MOIT has specified in Circular No. 04/2012/TT-BCT (except chemicals under the jurisdiction of the MOST, MOH, MARD). Accordingly, the organizations and individuals producing or importing chemicals are responsible for the labeling of chemicals before they are used in the market. Chemical labels are specified of the location, size, color, language and information on the label.

For the management of chemicals in some products, goods, today, MOIT has developed and issued a circular on the threshold levels of certain hazardous chemicals in electronic products (including 6 chemicals in Circular No.30/2011/TT-BCT) and the toilet paper (includes 4 types of chemicals are: Formaldehyde, Pb, Cd and mercury in Circular No. 36/2015/TT-BCT).

As stipulated in Circular No. 21/2015/TT-BNNPTNT, for chemicals management under the jurisdiction of the MARD, all plant protection products used to control harmful organisms of plants; plant growth regulators; preservation of plant; warehouse disinfection; termite damage buildings and dykes; herbicides on non-arable land; increase the safety and efficiency when using (with trade names separately) must be the Plant Protection Department, MARD and testing licenses. The biological effect tests of the drug to be done on a large scale and small scale by institutions eligible material and industrial engineering by the MARD recognized. Organizations and individuals that produce active substances and plant protection drugs or drug product specifications must register on the list of plant protection drugs permitted for use in Vietnam.

The transport of plant protection products is also tightly controlled with prescribed conditions on the carrier, packaging, container and transport of the drugs. Simultaneously, the organizations and individual transporting of plant protection drugs must be licensed by the

Department of Plant Protection. Furthermore, the process of storing, preservation of plant protection products also has strict requirements on infrastructure conditions of warehouses, yards and personnel management system. The labels of plant protection drug are also closely managed in accordance with specific regulations on location, size labels, colors, symbols and safety information and warnings on the label.

Therefore, now, the regulations on the import, export, production, sales of industrial chemicals, chemicals used in medicine, agriculture has been completed basically. However, most of the new regulations focus only on administrative management (application tools such as registration, licensing, effect tests, effective drugs,). They do not focus on environmental and human health issues due to the production and use of these chemicals. Simultaneously, Vietnam have not the specific regulation, programs to inventory and assess the impact, effects of chemicals, especially those toxic chemicals, which may cause gene change, the cancer to human health and the environment.

2.4. THE IMPLEMENTATION STATUS OF THE STOCKHOLM CONVENTION

Within the framework of the implementation of the Stockholm Convention, many activities have been conducted with a focus on the following main tasks:

- Establishing policies and regulations on POPs management
- Strengthening capacity of POPs management
- Promoting researches and applying science and technology solutions in safe management, reduction, destruction and elimination of POPs.
- Enhancing awareness, role and responsibility of levels, sectors, residential community.
- Strengthening and diversifying investment funds.
- Expanding and improving the efficiency of international cooperation.

The level of compliance with the Stockholm Convention requirements is compiled in Table 13 below with emphasize to the "initial POPs" and the new listed pesticides in the Convention. As currently the measures for reduction with the aim of final elimination of the new listed POPs have started, the compliance with the SC provision in respect to new listed industrial POPs will be carried out and presented in the future NIP updates. The action plans for the new listed POPs and initial POPs is in Chapter 3.

Table 13. Stockholm Convention requirements and level of compliance of Vietnam

Convention Article	Level of compliance	Comments
ARTICLE 3 Measures to reduce or eliminate releases from intentional production and use	For POP pesticides see section 2.3.1	Inventory of stockpiles has been almost done. Many regulations have been issued, 14/15 POP pesticides have been banned; no production in the country. Vietnam has identified 1,562 residual areas, pesticide pollution and need to be handled in the future. The new plant protection chemicals added to the Convention can still be used in Vietnam in the coming time therefore need to develop and implement the provisions of the management and control of plant protection chemicals include POP pesticides, chemicals like POPs and highly toxic pesticides.
	For PCBs see section 2.3.2.	The third inventory has been conducted focusing on electric equipment but there has many equipment, materials and waste have not been evaluated. Therefore, PCBs will still be issue for strictly management in the future. Vietnam is continuing to develop regulations and plan for PCBs management.
	For DDT see section 2.3.4	Vietnam did not produce DDT and has banned DDT since 1992. DDT was previously used mainly in military, medical and agriculture. Currently, DDT exists mainly in areas of residual and polluted areas. Up to now, Vietnam has detected 1,562 areas polluted and residue, which mainly DDT mixed with lindane. These areas need to be treated and restored. Vietnam has been implementing measures to treat, recover with funds from the central budget, local and international resources. In the near future should speed up the handling of these areas in order to limit the impact of pesticides on the environment and human health.
ARTICLE 4 Register of exemptions	See section 2.3.7 Vietnam has registered specific exemption for tetrabromodiphenyl ether and pentabromodiphenyl ether	The demand for registration exemptions will be made based on synthesis, evaluation and consider the needs of the domestic industry for the use of POPs are allowed to register

Convention Article	Level of compliance	Comments
	for recycling purposes within 05 years.	an exemption under the provisions of the Stockholm Convention.
ARTICLE 5 Measures to reduce or eliminate releases from unintentional production	See section 2.3.6	In Vietnam, UPOPs emission primarily from incinerator, metallurgy, uncontrolled combustion, thermal electricity. UPOPs inventories have been conducted for sectors of cement kiln, waste incineration, steel manufacturing, and paper production. The BAT/BEP projects for reducing UPOPs were conducted for industrial sector and health care sector. Implementation requirements of the Stockholm Convention, Vietnam will continue to implement measures to reduce emissions while taking into account integration of UPOP reduction with relevant activities such as energy use efficiency effective, cleaner production etc. Continued focus on reducing UPOPs emissions from industries and living activities (uncontrolled burning).
ARTICLE 6 Measures to reduce or eliminate releases from stockpiles and wastes	See section 2.3.8	Vietnam has found many stockpiles and contaminated sites of POP pesticides, some PCBs and PFOS polluted areas. Dioxin/AO polluted sites still remain in the country and need to be managed and disposed of safely. Pollution caused by AO/dioxin is a peculiar problem of Vietnam with activities have been conducted as treatment, environmental restoration, etc. and need to be continued in the near future to reduce the impact on health human health. Problems of stockpiles and pollution of other POPs should be evaluated in a comprehensive manner so that we can develop appropriate management measures. POP substances should be paying attention to are: - PCBs: Detected some PCBs contaminated sites and preliminary assessment has found PCBs in some foods. - PFOS: PFOS detected at some landfills and areas use fire-fighting foam - this is consistent with international

Convention Article	Level of compliance	Comments
		experience; PFOS detected in the area of e-waste recycling. Hence, the need to expand the scope and scale of assessment to identify and manage polluted areas. - PBDE: Initial assessment has found PBDEs in some areas of e-waste recycling. In the future, need to expand the scope of evaluation in order to determine the polluted areas to have appropriate management measures.
ARTICLE 7 Implementation plans	Vietnam approved first NIP in Decision No. 184/2006/QD-TTg dated on 10th August 2006 and submitted to the Conference of the Parties of the Stockholm Convention in 2007	
ARTICLE 8 Listing of chemicals in Annexes A, B and C	Up to now Vietnam has not submitted a proposal on the listing of new chemicals in Annexes A, B and C to the COP.	
ARTICLE 9 Information exchange	See section 2.3.12	The exchange of information has been made with various sizes as discussed with the Stockholm Convention, the parties to the Convention, in the framework of the activities in Southeast Asia, Asia, etc. and the active exchange of information within the country. These activities will be promoted in the coming period in order to manage more effectively POPs. The requirements for the exchange of information is increasing therefore measures to strengthen this activity in the future will include of strengthening the capacity of the focal point in order to effectively implement the synthesis of information, press statements and information exchange among sectors of the country, between countries and with the Stockholm Convention.
ARTICLE 10 Public information, awareness and education	See section 2.3.12 Various activities on POPs communication and awareness raising have been conducted in Vietnam with participation of stakeholders such as policy makers, enterprises, associations, reporters, etc.	Public information, awareness and education should be continued in the future in which focus on state management authorities, sectors and communities.

Convention Article	Level of compliance	Comments
ARTICLE 11 Research, development and monitoring	See section 2.3.9 In Vietnam, some programs on POPs analysis and monitoring have been implemented in cooperation with international research agencies. Several POPs (UPOPs, PCBs, PBDEs, PFOS/PFAS, DDT…) have been monitored in main matrices of the environment and living organisms.	Vietnam has not implemented national monitoring programs on hazardous chemicals in general and POPs. POPs monitoring activities in recent years conducted in a number of agencies, different units and have no connection with each other therefore not assess the fate of POPs in the environment. In the future, it is necessary to implement POPs monitoring programs at the national level, integrated with hazardous chemicals in order to assess the status of POPs in the environment while serving the Stockholm Convention report as prescribed.
ARTICLE 12 Technical assistance	Vietnam is a recipient developing country Party. Since the first NIP, Vietnam has received technical assistance from the some developed countries (USA, Japan…) /international organizations: UNEP, UNIDO, UNDP, WB, etc. with many sectors related to POPs, such as industries, health care, waste management, capacity building in POPs monitoring, etc.	Technical assistance should be promoted in the future to ensure the sound management of POPs.
ARTICLE 13 Financial resources and mechanisms	As of March 2016, according to the Status of Contribution compiled by the SC Secretariat, Vietnam has no unpaid pledges for 2015 and prior years	
ARTICLE 15 Reporting	See section 2.3.13	The reporting has been conducted. With reporting requirements increasing, Vietnam needs to strengthen the capacity of national focal agency for implementation of the Stockholm Convention to ensure effective implementation of the requirements of the Stockholm Convention.
ARTICLE 16 Effectiveness evaluation	Vietnam has participated in the regional POPs monitoring project carried out by UNEP.	The data on human milk and air will be generated by the project. POPs monitoring capacity in Vietnam should be further strengthened in the coming period to ensure support to assess the effectiveness of the management of POPs.
ARTICLE 17 Non-compliance	As the procedures and institutional mechanisms for determining non-compliance are not yet approved and developed, the countries compliance cannot yet be	

Convention Article	Level of compliance	Comments
	verified by the Conference of Parties/Compliance Committee	
ARTICLE 19 Conference of the Parties	Vietnam is a party to the Stockholm Convention and participating in all Stockholm Convention COPs	
ARTICLE 21 Amendments to the Convention	Vietnam has accepted all the Stockholm Convention amendments	
ARTICLE 22 Adoption and amendment of annexes	Vietnam has accepted all the Stockholm Convention amendments	
ARTICLE 24 Signature	Vietnam signed the Stockholm Convention on 23 May 2001	
ARTICLE 25 Ratification, acceptance, approval or accession	Vietnam ratified the Stockholm Convention and became the 14th Party on 22 July 2002	
ARTICLE 26 Entry into force	The Stockholm entered into force for Vietnam on 17 May 2004.	

3. THE NATIONAL IMPLEMENTATION PLAN

Chapter 3 has the following main contents: The formal policy statement, the implementation strategy for the NIP, the objectives of the NIP and action plans, prioritized programs and projects. The implementation strategy sets out contents related to stakeholder involvement and integrates POPs/chemicals with management of natural resources and waste, with chemicals conventions and other international agreements and actions, links POPs to sustainable production and consumption and SDGs implementation and includes gender policy.

3.1. POLICY STATEMENT

This plan was built on the viewpoint of performing requirements of the Stockholm Convention on POPs, which Vietnam is an active member. As one of the earliest countries signing and ratifying the Stockholm Convention and the first plan was issued in 2006 and now the updated plan, Vietnam represents a responsible country within the international community.

In Vietnam, in order to implement effectively the programs and activities on the management of POPs, this Plan was made on the basis of mobilizing the participation of stakeholders to reduce the production, use, release and other problems related to the POPs in the field of industry, agriculture, public health, consumer goods. This is very important when the status of POPs in Vietnam sets out many problems to be solved, such as issues related to PBDEs, PFOS, PCBs, pesticide residue, dioxins and other UPOPs and other environmental health issues.

Considering the socio-economic impacts of the POPs, as mentioned above, this plan should be implemented with the goal of maximizing the benefits of the reduction and elimination of POPs while minimizing the impact of the use of materials, products and wastes containing POPs to the environment and health. Among subjects vulnerable to the impact of the POPs, women and children are subjects that need attention. This will achieve the best performance while integrating it with the program on gender and women's health and children in Vietnam.

Besides, to the trend of harmonization, integration the implementation of the Stockholm Convention to the treaties on the environment, chemicals and waste as the Basel Convention, Rotterdam Convention, Minamata Convention, SAICM and the other relevant conventions, this plan was built on perspectives inherited from the results of the 2006 plan and the concerned programs and activities. Simultaneously, measures and tasks to implement the content of the plan will be integrated with other relevant programs and strategies of Vietnam such as environmental protection strategy, Sustainable Development Strategy, Green Growth Plan and related fields such as sustainable production, sustainable consumption and climate change in order to maximize the efficiency of implementation.

The plan was also built taking into account the priorities of the international organizations and donors to facilitate the mobilization of international assistance in this field. Actually, the implementation of the plan in 2006 showed the importance of mobilizing international resources besides the domestic funding. One of the priorities included in this plan is to match its priorities with the priorities of the GEF 6 programming. Accordingly, the fields of chemicals, waste and climate change are the fields of concern and need to be considered in an integrated manner when applying for funding, such as when reducing UPOPs combined with greenhouse gas emissions, waste management aimed at reducing emissions of POPs; POPs emissions incorporating mercury emissions, etc.

3.2. IMPLEMENTATION STRATEGY

3.2.1. The participatory approach of stakeholders

This plan inherited the results of the first NIP, with the involvement of ministries in managing and controlling the initial POPs while implementing the requirements of the Stockholm Convention on new POPs. Therefore, the quantity and participation level of ministries, branches and localities will be increased. At the central level, all relevant ministries will be involved in the NIP update in which each stakeholder will play different roles according its function. At the local level, provinces and sectors will deploy necessary resources for implementation of the Plan.

With the addition of industrial POPs in the Stockholm Convention, this plan requires the participation of the industry and businesses. The state should develop regulations and policies to mobilize these components effectively participate in various activities on the management of POPs as: Reducing use during production, waste management, implementation measures to reduce emissions, involved in the market providing consulting services, treatment and rehabilitation of the environment, etc. related to POPs.

In addition, the involvement of other organizations and community in the management and control of POPs are also important factors. Communities will be involved in many activities in environmental protection (as defined in the Law on Environmental Protection) in general and in the management of POPs in particular. This field should have the involvement of community on aspects such as sustainable consumption, feedback information about the consumer articles and products that may contain POPs and their avoidance and substitution and appropriate end of life management.

3.2.2. Integrating the management of POPs/chemicals and policies on management of natural resources and waste

As mention above, the integration of managing POPs/chemicals and policies on management of natural resources and waste is in line with the objectives of international priorities and meet the requirements of development in Vietnam. In the current laws of Vietnam, Law on Environmental Protection 2014, the Law on Water Resources, the Law on Chemicals 2007 regulates the management of chemicals and wastes resources including chemical wastes like POPs. Therefore, the updated national implementation plan built on the integration of management of POPs within general chemicals management and the management of POPs containing waste integrated in general waste managing. It considers the reduction of POPs emissions by improving the operational management of waste disposal. The plan also consider to not recycle waste containing POP-BDEs with the aims to recover POP-BDEs in line with the provisions of the Stockholm Convention. The plan also aims to integrate the reduction of UPOPs with the reduction of greenhouse gas emissions and with the implementation of cleaner production.

With the strategies, current plans of Vietnam on waste management, environmental protection, natural resource management, the content of POPs will be an important and integrated part and can be used as one criterion of the effect assessment of the strategies and plans. This will ensure the mobilization of the most effective way of domestic resources and international support.

3.2.3. Integration with the implementation of chemicals conventions and other international agreements and actions

With the integration content on management of POPs/chemicals, waste and resources, the Convention on the chemical and related treaties to which Vietnam is a contracting party

should also be integrated. Here we should take into account the important conventions such as the Basel Convention, Rotterdam Convention, Minamata Convention, SAICM, and Paris agreement against climate change.

This integration will contribute to improving the efficiency of the relevant conventions through maximum mobilization of available resources into the implementation of the objectives of the Convention. These contents are expressed as follows:

- Integration POPs within hazardous chemical management and linking the Stockholm Convention implementation and SAICM implementation and Minamata Convention. The proactive management of hazardous chemicals will create prerequisites for the management of POPs when the Stockholm Convention continuously adds POPs in portfolio. Vietnam has developed a National Action Plan for the Sound Management of Chemicals[100]. An aim is to integrate the implementation of this SAICM action plan within Stockholm Convention activities where appropriate.
- The Stockholm Convention, the Basel Convention and the Rotterdam Convention was implemented with integration through operations of control on import and export of chemicals, and through controlling of wastes, including POPs waste, waste movements and their disposal.
- The Stockholm Convention, Minamata Convention and Agreement on climate change prevention have cross cutting issues in a range of industrial emission reduction where an integrated implementation can be facilitated through the reduction of emissions of UPOPs, mercury and Greenhouse Gas (GHG) from industrial activities, such as thermal power, cement industry, waste incineration and steel and other metal industries.

Furthermore, there are close links between POPs control and GHG control. For example, the release of unintentional POPs and release of short lived climate change pollutants in particular carbon black and methane are closely linked. Activities like open burning or industrial emissions contribute to UPOPs and carbon black and can be addressed by a common approach in waste management improvements, BAT/BEP measures and awareness on open burning. Further links between POPs and climate change have been compiled in a UN publication. For example, the increased flooding leading to increased released mobilization from POPs from reservoirs[101] and will be assessed as Vietnam has upcoming projects on this topic.

3.2.4. Linking to sustainable production and consumption and SDGs implementation

In accordance with the provisions of the Article 7(3) of the Stockholm Convention, "Parties shall endeavor to utilize and, where necessary, establish, the means to integrate national implementation plans for persistent organic pollutants in their sustainable development strategies where appropriate"

The contamination of several potential recycling flows by POPs (e.g. industrial oils, plastic, PUR foam, paper) revealed the unsustainable impact of POPs and the threat for a more circular economy and related resource conservation. In addition, the negative affect of halogens in high calorific fractions such as PBDEs/BFRs and PVC in WEEE plastic or polymer fraction of end of life vehicles are hampering or restricting the thermal recovery of these high calorific fractions and lead to associated problems.

Vietnam is aiming to address POPs in connection to sustainable consumption and production

[100] T. Conway (2014) Vietnam Five Year National Action Plan for Sound Management of Chemicals. (Pending for approval)
[101] http://chm.pops.int/Implementation/PublicAwareness/PressReleases/UNFCCCCOP16ClimateChangeCancun7Dec2010/tabid/1269/Default.aspx

(SCP) efforts to promote sustainable development. In general orientation, Vietnam has the National Strategy for Green Growth approved by the Prime Minister at Decision No. 1393/QD-TTg dated September 25, 2012, the National Action Plan for Green Growth in period 2014-2020 approved by the Prime Minister at Decision No. 403/QD-TTg dated March 20, 2014. Vietnam has also issued a national action program on production and sustainable consumption to 2020, vision 2030 under Decision No. 76/QD-TTg dated 11 May 2016 01 of the Prime Minister. This content has been stipulated in the Law on Environmental Protection 2014 which assigned the MONRE to build and organize the implementation of policies, programs, experimental models of production and sustainable consumption. Besides, in the strategic direction for sustainable development, the Vietnamese Government has identified issues related to POPs are rapidly increasing trend related to the waste of industrial origin, such as plastic, metal recycling and persistent chemical residues.

Here synergies between the chemical convention and future SCP activities will be evaluated with the aim of common implementation where appropriate. One key is the substitution of POPs and other hazardous chemicals by more benign substances. Here Vietnam aims for an assessment of alternative chemicals considering green and sustainable chemistry principles for protection of the health and for improving the recyclability and therefore supporting the waste hierarchy and SCP. Vietnam considers the use of green/sustainable alternatives to POPs and hazardous chemicals as a business opportunity. Currently, Vietnam is implementing Project on green chemistry aiming at promoting the minimization of use and hazardous chemical releases.

In addition, Vietnam aims to link the management of POPs and other hazardous chemicals and wastes to the implementation of Sustainable Development Goals where close links exist. Here Goal 12 on Sustainable Consumption and Production has the mentioned close links by e.g. the shift to more green and sustainable chemicals and materials. Goal 3 on Good Health and Well-Being is closely linked with reduction of health impacts by controlling and phasing out POPs and hazardous chemicals. POPs and other hazardous chemicals have also a strong impact on water pollution (in particular PFOS and related substances) and therefore Goal 6 on Clean Water.

Results to assess the status of POPs have shown their presence in the environment and humans in Vietnam. This set up an urgent request to have the appropriate management measures of which the replacement and elimination of POPs in the production and use play the most important role. This should be done according to the roadmap, in accordance with the conditions of Vietnam through technological solutions, following the impact assessment of the alternative substances to the environment, health as well as considering socio-economic effects.

3.2.5. Gender policy in NIP development and implementation

Efforts to ensure sound management of chemicals, including POPs have important gender dimensions, because in daily life, men, women, and children are exposed to different kinds of chemicals in varying concentrations[102]. Biological factors, notably size and physiological differences between women and men and between adults and children, influence susceptibility to health damage from exposure to toxic chemicals. In addition, social factors, primarily gender-determined occupational roles, also have an impact on the level and frequency of exposure to toxic chemicals, the kinds of chemicals encountered, and the resulting impacts on human health[103].

[102] UNDP (2011) Gender & Chemicals. Energy & Environment Practice Gender Mainstreaming Guidance Series

[103] United Nation Development Programme, Gender Mainstreaming. A Key Driver of Development in Environment and Energy, Energy and Environment Practice. Gender Mainstreaming Guidance Series

Vietnam will take care that these gender dimensions to be reflected in the implementation of the NIP and in the sound chemical management. The gender analysis is used to identify, understand, and describe gender differences and the impact of gender inequalities on a sector or program at the country level. Gender analysis - examining the roles of men and woman and the different impacts - is a required element of strategic planning and is the foundation on which gender integration is built. Gender analysis identifies disparities, investigates why such disparities exist, determines whether they are detrimental, and if so, looks at how they can be remedied[104]. Gender issues will be considered for integration with programs, activities related to environmental health in Vietnam in order to maximize resources and benefits.

Consistent with the GEF Policy on Gender Mainstreaming and the GEF-6 approach on gender mainstreaming, GEF projects funded under this strategy will not only acknowledge gender differences within their design but determine what actions are required to promote both women and men's roles in chemical management, disproportionate chemical exposure and vulnerability, as well as sustainable alternatives.

3.3. OBJECTIVES

Overall objectives:

Safe life-cycle management, pollution control, reduction, treatment and finally elimination of POPs in Vietnam to meet the requirements of the Stockholm Convention on POPs, contribute to protecting human health and environment, toward sustainable development in Vietnam and international integration.

Specific objectives:

1. Appropriate institutional capacity, regulatory frame and stakeholder coordination for POPs and hazardous chemical management and substitution.
2. Enhanced capacity in science and technology for monitoring, understanding and management of POPs and hazardous chemicals in the life cycle with appropriate knowledge and information management and related infrastructure.
3. Broad stakeholder awareness on POPs and other hazardous chemicals, on environmental health problems related to POPs and POPs management solutions (restrict use, replace, phase-out, disposal and destruction).
4. Synergistic implementation of relevant conventions and SDGs where appropriate and integration in national chemical and waste management and the sustainable development strategy.
5. Control and safely manage POP pesticides.
6. Eliminate the use equipment containing PCBs in concentrations equal to or greater than 50 mg/kg by 2025.
7. Control, limit use, and substitute by sustainable alternatives and safe management of industrial POPs.
8. Control the risk, treat, recover and monitor environment in the area of dioxin contamination from toxic chemicals used by the US during the Vietnam War.
9. Continuously reduce the emissions of UPOPs from productions, business, and livelihoods; control risk of UPOPs to the environment and human health.
10. Identify, environmentally sound manage and dispose POPs stockpiles; identify, secure and remediate POPs polluted areas.

[104] United States Agency for International Development. 2011. Tips for Conducting a Gender Analysis at the Activity and Project Level. Additional Help for ADS Chapter 2011

3.4. ACTION PLANS, ACTIVITIES AND PRIORITY PROJECTS

3.4.1. Developing, supplementing and enhancing the effectiveness of regulations, policies and institutions to meet the new requirements of the Stockholm Convention

To fulfill the requirements of environmental protection, community health protection and commitments to the Stockholm Convention, the Vietnam Government should continue to develop, supplement and enhance the effectiveness of regulations, policies and institutional to meet the new requirements of the Stockholm Convention with the major contents presented in the Table 14.

Vietnam currently has some regulations on POPs management. However, there has few quantitative regulations and control emissions of POPs from industrial activities, lack of regulations for POPs management in products, waste containing POPs. Therefore, this is an urgent requirement should be implemented in the near future the next time through priority construction regulations (see item 3 in the Table).

Table 14. Legislative, institutional and regulatory action plan

Activity/ Group	Description	Responsible Institution		Time frame
		Main Responsibility	Partial	
General	1. Developing, supplement legislation and enforcement for management of POPs integrated in management of hazardous chemicals and waste.	MONRE	MOIT, MOH, MOC	Regularly
	2. Develop and improve regulations and policy on safe management and environmental protection in export, import, production, use, collection, storage, transport and handling of POPs and materials, equipment and waste containing POPs	MONRE	MOIT, MOF, MARD, MOH	Regularly
	3. Develop, review, adjust and supplement the standards, national technical regulations on environmental, occupational safety, hygiene and health aspects related to POPs and hazardous chemicals	MONRE	MOST, MOH	Regularly
	4. Identify and supplement the provisions on responsibilities and coordination mechanisms of the ministries, agencies, branches and local authorities for a safe life cycle management of POPs	The Government	Line ministries	2018-2019
	5. Develop regulations on assessing the health impact and environmental impacts related to contact and exposure to POPs and other hazardous chemicals; develop policies to support science and technology research on assessment of environmental and health impacts; identification, warning and remedial action	MONRE	MOH, MOIT MOLISA	Regularly

	6. Develop and/or update policies to support and promote research and assessing the socio-economic impact of POPs and hazardous chemical reduction/elimination	MONRE	MOST MOH MOIT MARD MOD	Regularly
	7. Develop regulation and policies on strengthening the monitoring, risk control, safe management and remediation of POPs and contaminated areas.			
	8. Study and revise financial mechanisms and initiatives for promote POPs management, contaminated site clean up and elimination.	MOF	Line ministries	Regularly
	9. Establishment of Stockholm Convention Unit in Vietnam	MONRE		2018-2019
Custom Control	10. Assess the gaps in import of POPs and hazardous substances as chemical and related articles and improve custom control	Vietnam Customs	MOIT, MOF	Regularly
	11. Update Customs Office system and databases to track chemicals that are imported to the country (CAS numbers; GHS)			
	12. Provide training for Customs staff in respect to the identification and control of POPs containing articles/products	MOIT, MOF	MONRE, Provinces	Regularly
POP pesticides	13. Update the existent regulations in respect to the new listed pesticides by banning and regulating of the new listed pesticides	MARD	MONRE	Regularly
	14. Assess the need and possibly, listing of exemptions	MONRE	MARD	Regularly
	15. Revise the Decision 1946/QD-TTg for POP pesticides national action plan	MONRE	MARD Provinces	2018-2020
PCBs	16. Develop and improve regulations for management of PCBs life – cycles.	MONRE	MOIT, EVN	2018-2020
	17. Develop and implement incentives for PCBs owners to comply with the control and phase-out of PCBs	MONRE MOF	MOIT, EVN	2018-2020
	18. Strengthen the control/inspection of the PCBs containing equipment in use, the interim storages and disposal facilities	MONRE MOIT	Industries, provinces	No later than 2025
POP-BDEs	19. Regulations in management of POP-BDEs and related articles	MONRE	MOIT	2018-2020
	20. Assess the need of use, recycling of POP-BDEs containing plastics/articles/EEE for exemption registration	MONRE	MOIT	2018-2019
PFOS	21. Develop legislation to ban the production, use (except for the purposes Vietnam registered for permitted specific exemptions/acceptable purposes), import and export (except for the purpose of environmentally sound disposal)	MONRE	MOIT, relevant ministries and sectors	2018-2020

	22. Develop regulations for management of PFOS in accordance with requirement of Stockholm Convention			
UPOPs	23. Develop/update laws/regulation/policy on management which aim to reduce UPOPs	MONRE	MOIT MOT MARD	2018-2020
	24. Develop, supplement emission standards for UPOPs in air emission.			
	25. Develop policies for promotion of BAT/BEP to reduce UPOPs and mobilize involvement of industries and enterprises in science and technology sector.	MONRE, MOIT	Relevant sectors	Regularly

3.4.2. Safe management and pollution control of POP pesticides

Regarding on the plant protection chemicals as POPs, since 1994, the Ministry of Agriculture and Rural Development has issued regulations banning the circulation and use of POP pesticides (except chlordecone). However, some POP pesticides as DDT and lindane stockpiles remain an issue that has been polluting the environment.

In addition, issues related to pesticides circulation, the distribution, sales and use would be managed. These will be performed through strengthening the implementation of uniform measures to control and safely manage, limiting the risk to the environment and health in the circulation and use of pesticides, including the case for smuggled POP pesticides, no labels or illegal circulated pesticides. The main activities to be implemented include of following activities:

Table 15. Action plan for POP pesticides

Group \Activity	Description	Responsible Institution		Timeframe
		Main	Partial	
Legislative measures	1. See action plan on Legislative, institutional and regulatory			
Update detailed POP pesticides inventory	2. Update detailed inventory of POP pesticide inventory	MONRE	MARD, provinces	2018-2022
	3. Assess and develop action plans for management and treatment at provincial level	Some provinces	MONRE	
Pesticides management (in synergy with SAICM and PIC Convention)	4. Strengthen the control the importation, sales, use, storage and transport of POP pesticides and highly hazardous pesticides	MARD	Farmer Union, MONRE	Regularly
	5. Establishing/enhancing capacity to address environmental incident relative to POP pesticides and highly hazardous pesticides	MARD, MONRE	Provinces, research institutes	Regularly
	6. Providing training for farmers in respect to the safe and sustainable use of pesticides	MARD	MONRE, universities, research institutes	Regularly
	7. Promoting the use of alternative substances to POP	MARD	MONRE, MOST,	Regularly

	pesticides and highly hazardous pesticides		universities, research institutes	
	8. Ensuring the development and implementation of good agricultural practices, IPM and promoting the organic agriculture.	MARD	MONRE, MOST, universities, research institutes	Regularly
Monitoring	9. See the action plan for POPs monitoring			
Handling, storage, transfer and disposal of POP pesticides	10. Finalizing destruction of obsolete POP pesticides stockpiles and disposal of empty packaging and highly contaminated soil	MONRE	MARD, provinces	2017-2030
	11. Establishing of proper temporary pesticide storage before destruction and set up an empty container management system	MONRE	MARD, provinces	2017-2022
	12. Promote technology assessment and selection for remediating pesticide contaminated sites (for medium and low contaminated soil)	MONRE	MOST, research institutes	Regularly
	13. Risk assessment and management of POP pesticides and highly hazardous pesticides to the environment and human health in Vietnam	MOH, MONRE	MARD, MONRE, Universities	Regularly
Awareness raising	14. See also the action plan for awareness raising for POPs			

3.4.3. Safe management and pollution control of PCBs

Although not manufacture PCBs, Vietnam is a country having imported (and possibly importing) equipment potentially contaminated with PCBs oil. PCBs are used as additives for insulating oil in electrical equipment such as transformers or capacitors. In addition, PCBs also likely exist in other applications such as hydraulic oil, lubricant, sealant, used in construction, plastic additives, etc.

According to the preliminary inventory results, the total volume of PCBs contaminated oil in transformers in Vietnam is about 1,342 tonnes. Besides, there are many oil capacitors, oil circuit breakers, oil industries; oil stored in the warehouse of facilities and EVN transformers, which have not been evaluated for PCBs levels. This shows that there exist PCBs oils and other stocks in Vietnam and the overall volume might be larger. The inventory need to be continuously updated and applied inventory methods of equipment records combined with analytical samples to obtain sufficient and more accurate data and the respective labelling and database for a sustainable future management. Thus, in order to assess the status and for safe management of PCBs, Vietnam will implement the following activities:

Table 16. Action plan for PCBs

Activity	Description	Responsible Institution		Timeframe
		Main	Partial	
Legislative measures	1. See the action plan on Legislative, institutional and regulatory			
Comprehensive inventory and assessment of PCBs	2. Inventory equipment, materials, waste containing PCBs, and develop/operate database for PCBs management	MONRE MOIT	EVN, enterprises, provinces	2018-2020
	3. Assessment of PCBs in open applications (combine with PCN and SCCP assessment)	MONRE	MOT, MOC	2018-2022
Management, storage and transfer of PCBs, PCB-containing equipment and PCBs wastes	4. Control and monitor interim storage and disposal facilities for PCBs containing equipment and wastes	MONRE	EVN, MOIT	2017-2028
	5. Strengthen evaluation and application of technologies for treatment of equipment and wastes containing PCBs.	MOST	MONRE	2017-2020
	6. Eliminating in use equipment containing PCBs ≥ 50 mg/kg by 2025; dispose all materials, equipment and waste containing PCBs ≥ 50 mg/kg by 2028	MONRE MOIT	EVN, Enterprises	2017-2028
	7. Monitoring the progress on the PCBs phase-out	MONRE	MOIT, provinces	2017-2028
	8. Proving training for operators, owners of PCBs containing equipment, government and custom authorities on ESM and disposal of PCBs	MONRE	MOIT, provinces, sectors	Regularly
Monitoring	9. See the action plan for POPs monitoring			
Destruction and disposal of PCBs	10. See action plan for destruction and disposal of POPs			
Awareness raising	11. See action plan for awareness raising on POPs			

3.4.4. Safe management and pollution control of POP-BDEs

Vietnam did and does not produce PBDEs but only has imported and uses materials, products containing PBDEs such as electrical, and electronics products, fire resistant materials, vehicles and possibly other appliances. Preliminary inventory results showed the presence of PBDEs in electrical and electronics products, in the transport sector and in environmental components and human milk. Some areas have detected PBDEs at high concentrations as in the landfills and the areas of electronic waste recycling. In the future, should conduct the inventory of PBDE in products and sectors concerned and the implementation of safety management measures which including decabromodiphenyl ether newly added in the Stockholm Convention.

Based on the above contents, the main activities to be implemented within the coming time include:

Table 17. Action plan for POP-BDEs

Activity/group	Description	Responsible Institution		Timeframe
		Main	Partial	
Legislative measures	1. See the action plan on Legislative, institutional and regulatory			
Listing of exemptions	2. See the action plan on Legislative, institutional and regulatory			
Inventory	3. Inventory of total EEE/WEEE and assessment of current WEEE collection and management 4. Carrying out an overall inventory of the transport sector including an inventory of end-of-life vehicles 5. Determining material flow of WEEE and transport sector including resources and hazardous substances (including POP-BDEs)	MONRE	MOIT, MOT, industrial sectors	2017-2022
Monitoring	6. See action plan for POPs monitoring			
Environmentally sound management in use of POP-BDE containing articles and materials	7. Restrict the import of WEEE and the import of second hand EEE older than 4 years and used vehicles older than 10 years 8. Control the export of materials, products of POP-BDEs groups, focus on electronic products, electronics, fire-retarded materials, vehicles, and appliances. 9. Assessment of recycling activities of WEEE plastic, technologies used and pollutants present 10. Apply BAT/BEP collection, recycling and safety treating of POP-BDEs containing materials (within WEEE, ELVs etc. management). 11. Storage of POP-BDE containing materials in an environmentally sound manner.	MONRE MOIT MOF	Vietnam customs, provinces	Regularly
Identification of contaminated sites	12. See the action plan on contaminated sites			
Destruction and disposal of POP-BDE containing materials/waste	13. See the action plan for destruction and disposal of POPs			
Awareness raising	14. See the action plan for awareness raising on POPs			

3.4.5. Safe management and pollution control of PFOS

Vietnam does not produce PFOS. However, at present, Vietnam has no provisions on management or ban circulation and use of PFOS and PFOS-containing products. Based on international experience and Vietnam in reality, the use of PFOS in fire-fighting foam and possibly surface treatment quite common.

According to the Stockholm Convention, parties produce and use these substances for the

purpose of being allowed to register have to apply the guidelines to reduce emissions, reports every 4 years on implementation eliminate PFOS to the Conference of the Parties. At the same time, the Conference of the Parties to encourage replacement of these substances when plans and to emphasize risk factors on human health and environmental impacts of such alternatives. Therefore, the content needs to manage PFOS concentration include: Inventory and comprehensive review the current state of PFOS in Vietnam to take measures to reduce the use and replacement; assess the PFOS stockpiles and PFOS polluted areas to take measures to manage the risks to the environment and health.

The plan will provide management operation of PFOS, specifically including:

Table 18. Action plan for PFOS

Activity / Group	Description	Responsible Institution		Timeframe
		Main Responsibility	Partial	
Legislative measures	1. See the action plan on Legislative, institutional and regulatory			
Register for exemptions	2. See the action plan on Legislative, institutional and regulatory			
Inventory	3. Inventory of PFOS use and stocks in fire-fighting foams, chromium plating, oil drilling and aviation hydraulic fluid and assessment of the need of any exemptions	MONRE	MOIT, sectors, provinces	2018-2025
	4. Inventory of PFOS in synthetic carpets and textiles			2018-2022
	5. Screening of suspected imported consumer products and articles for PFOS			2018-2022
	6. Assessment of the use of other PFAS (synergy with SAICM)	MONRE	MOIT, research institutes	2018-2022
Use and management	7. Control export and import of materials, products, equipment containing PFOS	MOIT, MOF	MONRE	Regularly
	8. Implementation of the guidance on BAT/BEP for the use of PFOS for exempted uses.	MOIT	MONRE	Regularly (before expire date for exemption)
	9. Control and reduce PFOS emission from industries	MONRE	MOIT, industries, associations	Regularly
	10. Assessment and promotion of sustainable alternatives for the replacement of PFOS	MOIT, MOST, MONRE	Industries	Regularly
Storage and disposal of PFOS containing articles and wastes	11. Environmental safe storage of PFOS-containing materials	MONRE	Enterprises	Regularly
	12. Limit and stop recycling and reuse of PFOS containing articles			2020-2025

Destruction of PFOS wastes	13. See general action plan POPs destruction			
Assessment and management of hotspots and contaminated sites	14. See general action plan contaminated sites			
Awareness raising	15. See general action plan on awareness			

3.4.6. Safe management and pollution control of HBCD, HCBD, PCPs, PCNs and SCCPs

These POPs were added in 2013 (HBCD), 2015 (HCBD, PCP and PCN) and 2017 (SCCP) to the Stockholm Convention. Under the provisions of the Stockholm Convention, except that HCBD is not registered for specific exemption, the remaining POPs can be registered exemptions for use with some purposes under the provisions of the Convention.

These chemicals have not been assessed in this NIP update and not much information is available. Therefore, an inventory and assessment of the status is needed and a plan for their management and control. Therefore, an action plan has been included for these recently listed POPs.

Table 19. Action plan for HBCD, HCBD, PCP, its salts and esters, PCNs and SCCPs

Activity/ Group	Description	Responsible Institution		Time frame
		Main	Partial	
Inventory and assessment of HBCD, HCBD, PCP, its salts and esters, PCNs and SCCPs	1. Conduct a preliminary assessment and inventory of the presence/quantity/number of materials, products, wastes and contaminated areas containing HBCD, HCBD, PCP, PCNs and SCCPs	MONRE	MOIT, MARD, provinces	2018-2022
Safety management HBCD, HCBD, PCP, its salts and esters, PCNs and SCCPs	2. Take legislative measures to ban the production, use, export and import of the chemicals and materials, products, wastes containing of HBCD, HCBD, PCP PCN, SCCPs for which no specific exemption exists	MOIT MONRE	Sectors	2018-2020
	3. Control export and import of materials, products, and wastes containing HBCD, HCBD, PCP, its salts and esters and PCNs and SCCPs (considering and possibly listing of exemptions)	Vietnam Customs	MOIT, sectors	Regularly
	4. Safely manage and reduce the use of chemicals containing HBCD, PCP, its salts and esters, PCNs and SCCPs in production and business; identification and promotion of appropriate alternatives.	MONRE, MOIT	MOST, sectors, research institutes	Regularly
	5. Implement of BAT/BEP in the use,	MONRE	Relevant	2019-

	storage, labeling, transportation and safety treatment of materials, products, and wastes containing HBCD, HCBD, PCP, PCNs and SCCPs		ministries, sectors, research institutes	2025
Specific exemptions	6. Evaluation and consideration to register Vietnam for specific exemptions for PCP, its salts and esters, PCNs, HBCD and SCCPs if needed	MONRE	Relevant ministries, sectors	2018-2020

3.4.7. Registration of specific exemptions/acceptable (Article 4)

In the coming time, Vietnam should implement activities to further assess the status and needs for production/use of POPs listed with specific exemptions/acceptable purposes for considering and registering at the Convention Secretariat, in the following order of priority:

1 PFOS: Consider registering to use for permitted specific exemption/acceptable purposes (except the canceled specific exemptions for use in carpets, leather and apparel, textiles and upholstery, paper and packaging, coatings and coating additives, rubber and plastic);

2 POP-BDEs (recycling of articles that contain or may contain PBDEs);

3 Polychlorinated naphthalenes (intermediate in production of polyfluorinated naphthalenes, including octafluoronaphthalene),

4 Pentachlorophenol, its salts and esters (utility poles and crossed arms),

5 Hexachlorobenzene (closed system site limited intermediate),

6 Hexabromocyclododecane (expanded polystyrene and extruded polystyrene in insulation for buildings),

7 SCCPs, and

8 Decabromodiphenyl ether.

The registration of specific exemptions/acceptable purposes for these substances is being done based on the following key activities:

- Assess the status, production, use, trends at the national scale of the substances.
- Assess the impact of the registering or unregistering for a/an specific exemption/acceptable purpose.
- Submit the notification for the registration of specific exemptions/acceptable purposes to the Stockholm Convention Secretariat.
- The report the management of POPs that registered exemptions to Stockholm Convention about POPs
- Submit a notification to the Convention Secretariat for the withdrawal of the registration for the respective POPs, where the situation requires (e.g. the specific exemption/acceptable purpose is not needed anymore; alternatives have been implemented etc.).

3.4.8. Control and reduction of emissions of UPOPs from industrial activities and other anthropogenic activities

The purpose of this activity is the implementation of the Stockholm Convention requirements (Article 5) to minimize the formation and release of unintentionally POPs (UPOPs) from the industrial productions. Since 2006, some activities for control and reduction of UPOPs have

been conducted with results not as expected. These activities only focused on some industrial sectors with limited scope. Thus, in the future we should concentrate for control and reduce UPOPs from industries and domestic sector in which concentrate on burning activities and waste incinerators.

The content of specific activities of Action Plan on UPOPs is described below:

Table 20. Action plan for UPOPs reduction

Activity /group	Description	Responsible Institution		Time frame
		Main	Partial	
Establishment of policy and legal framework for prevention/reduction of UPOPs	1. See the action plan on Legislative, institutional and regulatory			
Overall inventory of UPOPs	2. Overall inventory of UPOPs releases form main sources by using toolkit (the latest version) and monitoring data	MONRE	Sectors, provinces	2018-2022
Reducing releases of UPOPs into the environment from waste burning and biomass burning	3. Introduce and encourage sound management of waste (including reduce, re-use, recycle, principles and waste separation practice)	MONRE	MOIT, MOH, MOC, MARD, enterprises, research institutes	Regularly
	4. Control landfills to reduce UPOPs emission (integration with relevant activities)	Provinces	MONRE	2017-2025
	5. Promote using agriculture residues in energy production (biogas and boilers)	MARD	Relevant ministries, provinces	Regularly
	6. Encourage investment in generated bio waste, e.g. production of organic fertilizers, compost and others.	MONRE, MOF	MARD MOIT	Regularly
	7. Identify BAT and BEP for incineration and open burning	MOST	MONRE, MOIT, research institutes	2017-2020
	8. Develop and run continuous awareness programme for waste management operators on the impacts of waste burning within their education agenda	MONRE, MARD	Provinces, society associations, communities	Regularly
	9. Develop route map for control emission from waste incinerator	MONRE	Provinces	2017-2019
Adoption of BAT and BEP in Ferrous and non-Ferrous production and	10. Detailed assessment of the individual industries for BEP options for UPOPs reduction and need and options for BAT	MONRE, MOST, MOIT	Provinces Sectors, research institutes	Regularly
	11. Introduce and effectively implement			

minerals production processes to reduce/eliminate release of UPOPs	Guidelines on BAT and BEP to release sources of UPOPs (existing and new industry)			
	12. Removal of barrier of introduction of technology that minimize UPOPs through introduction of management practice			
	13. Promote technical institutions to support the implementation of cleaner production and BAT/BEP technologies			
	14. Apply the concept of environmental impact assessment for key industrial sources			2017-2020
	15. Assessing synergies for the reduction of unintentional POPs, GHG, mercury and other priority pollutants and where possible address these pollutants together.			Regularly
Reducing/ eliminating release of UPOPs from incineration of medical waste	16. Develop guidelines for sound management of medical waste including improvement of the current incineration of waste	MONRE, MOH, MOST	Provinces, Hospitals	2017-2020
	17. Strengthen institution and human resource capabilities to implement medical waste management and establish respective guidelines for medical waste management			Regularly
	18. Assessment of technologies to treat medical waste			2017-2020
	19. Selection and introduction of the most appropriate technologies to treat medical waste			2017-2020
Supporting alternative for household	20. Promote the use of charcoal and wood alternative in cooking, like gas, solar system and ovens	MARD, MONRE, MIC	Provinces, Research institutes, households	Regularly
	21. Conduct research on alternative for energy sources in households			2017-2020
Incorporating UPOPs issues in national strategic plan and development plan	22. Develop clear programme for reduction or elimination of UPOPs from the identified sources	MONRE	Other ministries	2017-2018
	23. Domestication and implementation of the Stockholm Convention			Regularly
Awareness raising	24. See specific action plan on awareness raising			

3.4.9. Safe management and pollution control of POPs containing stockpiles and wastes (Article 6)

As Stockholm Convention states, it will be necessary to develop strategies for reducing or eliminating releases from stockpiles and wastes in accordance with Article 6 of the Convention, coordinating the actions and measures with action plans for each of the groups of POPs. For the effective implementation, Vietnam will consider coordinating its actions on POPs with its wider programs and initiatives on the management of hazardous chemicals and hazardous wastes.

In addition to continuing sound management and control of POP pesticides, it is necessary to focus on assessment, determination and treatment of POP stockpiles and waste related to PCBs, PBDEs, PFOS, etc.

Action plan for POPs containing stockpiles and wastes is presented below:

Table 21. Action plan for safe management and pollution control of POPs containing stockpiles and wastes

POPs Group	Description	Responsible Institution		Timeframe
		Main	Partial	
General for all POPs groups	1. Overall improving of management of POPs and other hazardous waste	MONRE	MOIT, MARD, provinces	2017-2025
	2. Monitoring all stockpiles and sort the stockpiles according to pollution level			2017-2022
	3. Setting up regulatory measures for interim storage and/or disposal facilities of POPs containing stockpiles and wastes			2017-2020
	4. Assessing the options of destruction capacity for individual POPs (cement kilns, option of incinerators and possibly other technologies)	MONRE	MOST, research institutes	Regularly
	5. Implement the Basel guidance of environmental sound management of POPs containing stockpiles and wastes waiting for disposal.	MONRE	Relevant sectors, provinces, research institutes	Regularly
POP Pesticides	6. Establishing of proper pesticide storages in nationwide	MONRE	MARD, provinces	Regularly
	7. Securing the pesticide storages	MARD, provinces	MONRE	Regularly
	8. Disposing of obsolete POP pesticides stockpiles and remediating the sites contaminated	MONRE, MARD, provinces		2017-2025
PCBs	9. Assessment/establishment of interim storage and disposal facilities for PCBs containing wastes	MONRE	MOIT, EVN	2017-2020
	10. Promote the development of PCBs treatment service			2017-2025

POPs Group	Description	Responsible Institution		Timeframe
		Main	Partial	
	11. Implementing existent Convention/Vietnam guidelines for environment sound management of PCBs			2017-2025
	12. Establishing regular inspection/control on the handling, storage, transfer and disposal of PCBs, PCBs containing materials and PCBs wastes			2017-2020
	13. Proving training for operators, owners of PCBs containing equipment, government and custom authorities staff on environment sound management and disposal of PCBs			2017-2028
POP-BDEs	14. Management of WEEE	MONRE	MOIT, sectors, research institutes	Regularly
	15. Assessment for improving/changing the recycling technology of WEEE plastic			Regularly
	16. Storage of POP-BDE containing materials in an environmentally safe manner			2017-2025
	17. Assessment of current status and destruction options for POP-BDE containing WEEE plastic			2017-2020
	18. Assessment of existing capacity, current status and options for disposal of polymers from end-of-life vehicles			2017-2022
	19. Implementation of BAT/BEP for treatment and disposal techniques for POP-BDE containing materials			2017-2025
	20. Integration of the management of POP-BDE containing articles and materials in overall WEEE management, end of life vehicles and other possibly impacted waste fractions.			2017-2025
PFOS	21. Environmental safe storage of PFOS-containing materials	MONRE	MOIT, relevant sectors	2017-2025
	22. Stop recycling and reuse of PFOS containing articles (in case such activities are discovered)			2017-2022
	23. Assessment of destruction option of PFOS containing stocks and waste			2017-2025

POPs Group	Description	Responsible Institution		Timeframe
		Main	Partial	
	24. Disposal of fire-fighting foam containing PFOS; development of guidance for collection and treatment of run-off water from fire incidents where PFOS containing foams are used			2017-2025
	25. Disposal of aviation hydraulic fuel; establishing a system for management of waste oils as well as maintenance work with aviation hydraulic fuel including an established frame for environmentally sound disposal			2017-2030

3.4.10. Pollution control and environment remediation for POPs polluted areas (Article 6)

This activity aims to reduce emissions of POPs into environment from the stockpiles and waste burial sites containing POPs (as defined in Article 6 of the Stockholm Convention). The action plan is described in the Table below:

Table 22. Action plan for pollution control and environment remediation for POPs polluted areas

Activity /Group	Description	Responsible Institution		Timeframe
		Main	Partial	
General activities POPs contaminated sites	1. Develop/update legislation to set criteria for determining if a site is contaminated, including liability issues related to contamination and clean-up procedures.	MONRE	Ministries, provinces, universities, research institutes	2017-2020
	2. Develop/update POPs contaminated sites inventories and make prioritization based on risk assessment			Regularly
	3. Set up a central contaminated sites database including a pollution map of all potentially contaminated sites identified			Regularly

	4. Develop/implement guidelines for identification and assessment of POPs contaminated sites, including prioritization of the sites (considering risk) for further assessment and clean-up			2017-2022
	5. Training in identification and management of contaminated sites			Regularly
	6. Monitoring including analytical confirmation of POPs contamination for identified locations (prioritization list) and monitoring approach for cleaned sites.			Regularly
	7. Develop strategies for the environmentally sound management of POPs contaminated sites			Regularly
	8. Identification of clean-up measures and initiate clean-up procedures for the high priority contaminated sites			Regularly
	9. Take measures to secure the contaminated sites waiting clean-up			Regularly
	10. Organize implementing measures of environmental remediation, renovation and restoration in the serious environmental pollution areas caused by POPs and hazardous chemicals			Regularly
POP pesticides	11. Identification of all POP pesticides use and storage/disposal locations	MONRE	MARD, Universities and Research Institutions	2017-2022
	12. Identify the level of contamination of soil and ground water			2017-2022
	13. Secure and possibly monitor locations up to remediation process takes place			Regularly

PCBs	14. Identification of PCBs contaminated sites	MONRE	MOIT, EVN, Universities and Research Institutions	2017-2022
	15. Identify the level of contamination of soil	MONRE	MOIT, EVN, Universities and Research Institutions	2017-2022
	16. Secure and monitor locations up to remediation process takes place	MONRE	MOIT, EVN, Universities and research institutes	Regularly
POP-BDE	17. Compilation of potentially POP-BDE contaminated sites	MONRE	MOIT, MOH, research institutions	2017-2022
	18. Assessment of the sites and health risks and potential securing and remediation activities needed considering all pollutants (e.g. hazardous chemicals in WEEE and transport sector)			2017-2024
	19. Assessment if PBDD/PBDF are potential co-contaminants (thermal treatment of POP-BDE containing wastes) and link to dioxin/UPOPs contaminated site inventory			2017-2022
PFOS	20. Compilation of potentially PFOS contaminated sites. Investigation of the training and equipment testing and training exercise sites, the areas where fire drills, stockpiles storage, as well as accidental spills or leakages occur for determining the contamination with PFOS fire-fighting foams. Investigation of the maintenance sites, stockpiles storage areas where accidental spills or leakages occur from aviation hydraulic fluids	MONRE	MOIT, sectors, research institutions	2017-2022

	21. Secure and monitor locations up to remediation process takes place			Regularly
PCDD/PCDF and UPOPs	22. Investigation application sites of PCDD/F containing pesticides and chemicals, textile and leather factories, locations where PCBs were and are stored, locations were fire accidents took place, deposits of sediments, contaminated flood plains, dumps of wastes/residues of category 1-9 UNEP Toolkit	MONRE, provinces	MOIT, research institutions	2017-2022
	23. Secure and monitor locations up to remediation process takes place	MONRE	MOIT, research institutions	Regularly
	24. Monitor implementation of action plan in polluted areas			
Agent Orange	25. See specific action plan on Agent Orange contaminated sites below			

3.4.11. Continuous treatment, improvement and remediation of environmental pollution in the area seriously contaminated with Orange Agent/dioxin

Currently, treatment, improvement and remediation of environmental pollution continue to be performed in the Orange Agent/dioxin hotspots and have achieved some results. Nevertheless, Orange Agent/dioxin is still need to be solved in the future. Therefore, the major activities and aspects should be conducted are presented in the table below:

Table 23. Action plan for AO/dioxin

Activity group	Description	Responsible Institution		Time frame
		Main	Partial	
Assessment of AO impact to environment and human health	1. Comprehensively assessment the scope, residual level, risk and long-term consequences of Agent Orange/dioxin on the environment and human health	MONRE, MOH, MOD	Research institutions	2017-2022
	2. Implementation of environmental and health monitoring in highly dioxin polluted areas that has been and will be treated			2017-2025
Remediate seriously Dioxin polluted areas	3. Strengthen implementation of policies and measures to remediate seriously dioxin polluted areas originating from	MOD	MONRE, Office of the National Steering	2017-2025

	Vietnam War		Committee 33	
	4. Sound/sustainable management of seriously dioxin polluted areas while the areas have not been remediated			2017-2020
	5. Remediate seriously dioxin polluted areas originating from Vietnam War			2017-2025
	6. Strengthen technological research to thoroughly treat residual Agent Orange/dioxin, consistent under Vietnam conditions			2017-2022
	7. Environmental recover and care for the victims of Agent Orange/dioxin.			Regularly
Awareness raising	8. Raise awareness, encourage and promote the participation of the international community and to strengthen the monitoring capacity, treat contaminated areas, limit the harm and overcome the consequences of Agent Orange/dioxin; 9. Providing training/ raise awareness regarding to safe living activities for people around the AO polluted areas.	MONRE	MOD, communication agencies,	Regularly

3.4.12. Action plan for management of environmental health related to POPs

In Vietnam, the management of environmental health has been defined in the Environmental Protection Law 2014. The assessment results showed the presence of POPs in the environment components and in some foods. The impact of a number of POPs stockpiles in the region, such as regional pollution contaminated by AO/dioxin and pesticides has been posing a problem for human health. To assess and limit the impact of POPs on human health, the following activities will be implemented:

Table 24. Action plan for management of human health related to POPs

Activity group	Description	Responsible Institution		Time frame
		Main	Partial	
Develop regulations, institution	1. Develop and issue regulations, policies on environmental health including POPs and hazardous chemicals; 2. Develop standards and technical regulations, management process, environmental health impact assessment of POPs and hazardous chemicals; 3. Develop and legitimize coordination mechanisms	MONRE	MOH, MOIT, MOJ, provinces	2017 - 2025

	between ministries, sectors and local environmental health related to POPs and hazardous chemicals; 4. Develop and integrate environmental health impact assessment related to POPs and hazardous chemicals into the process of evaluation and approval of investment projects; 5. Establish and strengthen the network of research facilities, training of environmental health for POPs and hazardous chemicals. 6. Develop contents of environmental health for POPs in the national action plan on environmental health. 7. Develop guidelines for management of environmental health related to POPs and hazardous chemicals. 8. See action plan on regulations and institution.			
Warning, preventing, reducing the impact of POPs on human health	9. Investigate and research epidemiology, assessment scale, the degree of influence of POPs (in products, materials and food, at the contaminated areas) on public health; 10. Develop an overall plan and implement interventions to reduce the extent and scope incur health risks for people in the sites contaminated by POPs and hazardous chemicals. 11. Develop technical guidelines for risk assessment, environmental health impact assessment related to POPs. 12. Develop national environmental health report, environmental health profile including POPs and hazardous chemicals.	MONRE/Provinces	MOH, MOIT, MARD, research institutes	2017 - 2022
Develop and strengthen environmental health manageme	13. Strengthen the management network and implement environmental health projects. 14. Capacity building for staff working on environmental health. 15. Strengthen infrastructure and	MONRE	MOH, MOHA, provinces, research institutes	Regularly

nt	information systems in the field of environmental health management.			
Raise awareness and promote activities of community on environmental health	16. Develop programs to raise awareness of community on environmental health related to POPs and hazardous chemicals; propaganda and warn about the harmful effects of POPs and chemicals hazardous to human health. 17. Organize and integrate training activities to raise awareness and understanding on environmental health related to POPs and hazardous chemicals to officials, political and social organizations.	MONRE	MIC, communication companies, political and social organizations	Regularly

3.4.13. Stakeholder awareness, training and education about the risks caused by POPs and hazardous chemicals (Article 10)

Based on the requirements of Article 10 of the Convention and the need to protect the environment and the health of the nation, activities to strengthen and improve public awareness on POPs; incorporated into the education system of the issues related to the risk of POPs to the environment and public health.

The general awareness activities and the POPs specific awareness activities are listed below.

Table 25. Action plan for awareness raising on POPs

Group	Description	Responsible Institution		Timeframe
		Main	Partial	
General for all POPs groups and hazardous chemicals (SAICM synergy)	1. Develop education and training materials on POPs and hazardous chemicals tailor made for each target group	MONRE	MOIT, MARD, MOH, universities, communication organizations	2017-2020
	2. Raise the level of management, treatment POPs for organizations, experts, trainers to become the hub for programs of increase awareness and education about POPs and hazardous chemicals and wastes			Regularly
	3. Implement training activities and programs for teachers, lecturers, doctors about toxicology, environment and ecology issues related to POPs			Regularly
	4. Training and guidance for groups that directly exposed, treating equipment and waste containing POPs			Regularly

	5. Implement communication activities, raise awareness about POPs; exchange and dissemination of information on POPs.			Regularly
	6. Implement the activities to raise awareness and training for environmental inspectors; environmental customs, environmental police, border guards, market management, on the contents related to POPs management			Regularly
POP pesticides	7. Provide awareness and training to farmers on: Risks imposed by the unsustainable use of pesticides; health risks of imposed by pesticides; differences between original pesticides and fake pesticides; management of empty containers; good agricultural practices; alternatives available on the market to replace POP pesticides	MONRE	MARD, universities, communication organizations	Regularly
	8. Provide training to the custom officers on the list of banned/allowed pesticides to be imported/exported in order to prevent illegal traffic			Regularly
	9. Provide training to the pesticides importers/retailers/exporters on the differences between original pesticides and fake pesticides			Regularly
	10. Create awareness and educate the population on the health and environment risks imposed by pesticides and pesticides contaminated areas			Regularly
	11. Create awareness and educate the of farmers for integrated pest management and organic farming including effect of ecosystem services, biodiversity and soil health and also on market opportunities			Regularly
PCBs	12. Provide training to PCBs containing equipment owners on the environmentally sound management, storage, transport	MONRE	MOIT, EVN universities, communication organizations	2017-2025

	and disposal of these equipment			
	13. Provide training to the custom officers in order to increase the traceability of PCBs containing equipment and to stop the import of such equipment in the country. 14. Provide training for workers handling PCBs oils and PCBs containing equipment to minimize exposure and releases to the environment	MONRE	MOIT, EVN universities, communication organizations	2017-2025
POP-BDEs	15. Conduct awareness raising activities for industry, manufacturers, informal sector, importers, exporters, retailers, policy makers, implementing agencies, custom authorities and public on industrial POPs and hazardous chemicals in consumer products (including SAICM synergies chemical in products).	MONRE	MOIT, MOLISA, MIC universities, communication organizations	Regularly
	16. Communicating the challenge of POPs (and other PBT substances) in the recycling flow, as an obstacle for sustainable production and circular economy (POP-BDE as a case study).			2017-2025
	17. Awareness raising of consumers on POPs in articles in the frame of education on sustainable consumption			2017-2025
	18. Provide training for formal and informal recycling sector of WEEE/end-of-life vehicles on best available techniques and best environmental practices			Regularly
PFOS	19. Development of education and awareness materials for selected stakeholders in Vietnamese	MONRE	MOIT, MPS, MIC, MOLISA, communication organizations	Regularly
	20. Inform and sensitize stakeholders (e.g. fire fighters; users of aviation fluids) and public on the environmental and health impact, environmentally sound management and on alternatives of PFOS (in particular in exempted uses).			Regularly

	21. Training of fire fighters in the case of use of PFOS containing foams, as well as on alternatives to PFOS containing foams			2017-2020
	22. Sustainable training/education of customs authorities on POPs and other hazardous substances in articles and products.			Regularly
	23. Provide training for industry on best available techniques and best environmental practices for the use of PFOS.			Regularly
UPOPs	24. Sensitize the public and stakeholders on the environmental and health impact of UPOPs.	MONRE, MOIT	MOH, MOD, communication organizations	2017-2025
	25. Develop an education and awareness materials on the health and environmental effects of UPOPs.			2018-2025
	26. Establish free access web and database on UPOPs and BAT/BEP			2017-2025
	27. Organize awareness raising campaigns on UPOPs through media outlets and direct action to poor community and vulnerable people focusing on particular open burning processes and household heating and cooking			Regularly
	28. Provide training for industry on BAT/BEP to reduce UPOPs emissions. Combine education on BAT/BEP with larger education on integrated pollution prevention and control			Regularly

3.4.14. Information exchange and reporting on the implementation of the Stockholm Convention

This activity is supporting and establishing a system for exchanging information on POPs at national, regional and international scale. Referring to Articles 9 and 10 of the Convention, the Parties must provide the access to information to the community and constantly update the information on POPs.

The information exchange between the Parties of the Stockholm Convention it is performed via the National Focal Points and with the support of the Secretariat of the Stockholm Convention.

Regarding the content of the information exchange, the Parties to the Convention exchange information on the activities directed to reduce or eliminate POPs and on the risk imposed by

POPs to humans and environment, including information of involved socio-economic costs. Under the provisions of the Convention, information on the safety and human health or environmental risks is not considered as confidential information, but information exchange Party may request confidential information on consensus basis.

Under the provisions of the Convention, Vietnam Government has appointed MONRE (Vietnam Environment Administration) as a focal agency and Pollution Control Department under VEA as the national contact agency.

The scope and requirements of information exchange on POPs includes:

- Information exchange on international scale:

+ Collect information on activities conducted for the implementation of the Convention and the requirements of the Conference of the Parties of the Convention;

+ Exchange information directly with the Parties or through the Convention Secretariat;

+ Collect, review and update information on government agencies and organizations implementing related activities in the framework of other international treaties.

- The information exchange within the country:

+ Report on POPs levels to the involved/interested organizations and at the request of individuals;

+ Stats and collect information from organizations on the use, import, and disposal for POPs listed in Annexes A and B of the Convention;

+ Information on the amount of unintentional emissions POPs in accordance with Appendix B of the Convention;

+ Report on the results of monitoring activities on the management of POPs.

+ Report on research about POPs.

In order to follow the above requirements, the below major contents should be conducted:

a) National focal agency implementing for following major contents: Preside and coordinate collecting, updating and exchanging information with the Stockholm Convention under the provisions of the Convention; develop reports on the safety management for POPs under the Stockholm Convention's provisions; collect information from the ministries, branches, localities, organizations and related individuals; periodically reports to the Government the implementation and its results; collect information and implement mechanism national report for the Conference of the Parties and the request of the Secretariat of the Convention on POPs management activities in Vietnam; monitor, update, adjust for the plan contents according to the new requirements of the Convention and the actual conditions in Vietnam, the region and in the world; collect information; assess the risks, impacts and feasibility for the proposed or approved proposals from other countries on the addition of new POPs to the list of the Convention.

b) Agencies, organizations and individuals concerned shall summarize and exchange, and share information on: Results of inventory and life-cycle management of POPs; results of evaluation and risk management of POPs, research about POPs and product replacing POPs; communication activities, raise awareness about POP.

Report of implementation results the Stockholm Convention in Vietnam

This activity aims to meet the obligations of the Convention on reporting the activities relating to POPs management at the national level. The specific contents include:

- Develop and submit national reports to the Conference of the Parties, in accordance with Article 15 of the Convention, and reply to other requirements of the Convention Secretariat.
- Develop a report on the inventory and emission reduction of POPs, including POPs unintentionally formed and emitted.
- Develop a report on the results of PCBs eliminating status.
- Develop a report on the continued need for the specific exemptions/acceptable purposes registered by Vietnam.
- Develop of periodic reports to the Government on the implementation status of the National Plan.
- Develop a report on the adjustments/updates needed by the National Plan taking into account the new requirements of the Convention and particularities of practical implementation.

3.4.15. Strengthen capacity of research, development, monitoring, risk management, management and safe treatment of materials, products and wastes containing POPs and other hazardous chemicals

This is one of the important contents should be conducted to ensure capacity in determination, control and elimination of POPs according to requirement of the Stockholm Convention. The major contents in the aspect are:

Table 26. Action plan for Strengthen capacity of research, development, monitoring, risk control, management and safe treatment of materials, products and wastes containing POPs and other hazardous chemicals

Activity/ Group	Description	Responsible Institution		Time frame
		Main	Partial	
General POPs research/ monitoring topics	1. Compilation of monitoring data of new and initial POPs and priority list of monitoring data need for Vietnam	MONRE	MOIT, MOST	2017-2022
	2. Supporting/participating in international and regional on POPs and PTS monitoring and research to support associated conventions	MONRE	Laboratories/ Universities	Regularly
	3. Organize POPs monitoring and research networks to establish research and monitoring of POPs in Vietnam	MONRE	Laboratories/ Universities	2017-2022
	4. Development of monitoring capacity for the POPs	MONRE	Laboratories/ Universities	Regularly
	5. Strengthening the capacity of laboratories for analysis, monitoring and risk assessment of the environment and health threats caused by POPs	MONRE	Laboratories/ Universities	Regularly
	6. Conduct research on sustainable/green alternatives chemicals, materials, products and equipment to replace and reduce the use of POPs and POPs containing materials, products and equipment.	MONRE MOIT	Laboratories/ Universities	Regularly

	7. Monitoring POPs level in POPs contaminated sites and stockpiles	MONRE	Laboratories/ Universities	Regularly
	8. Regularly monitoring the emissions and accumulation of POPs in different environmental components and in food; integrate information in the report about the environmental status of provincial and national levels	MONRE, MOH	Laboratories/ Universities	Regularly
	9. Integrating POPs studies with health studies and exposure	MONRE MOH	Laboratories/ Universities	Regularly
POP pesticides	10. Identify, strengthen and improve capacity (laboratory infrastructure) to deal with POP pesticides (analytical, modelling, accreditation, risk assessments, etc.).	MONRE	MARD, Laboratories/ Universities	Regularly
	11. Monitoring and establishing a POP pesticide monitoring programme (food, soils, water, occupation, consumer etc.)			2017-2025
	12. Provide remediation monitoring for contaminated sites			Regularly
	13. Supporting implementation and research on the use of alternatives as a measure for reducing POP pesticides use.			Regularly
	14. Conducting a risk assessment for POPs and highly hazardous pesticides and their alternatives specifically aimed at determining the risk to humans and biota			2017-2025
PCBs	15. Developing an integrated environment and health monitoring for assessing the PCBs presence in humans, environment and biota, as well as food mainly the animal products (priority potentially contaminated/affected sites & imports)	MONRE	MOIT, EVN, Laboratories/ Universities	Regularly
	16. Assessment of occupational exposure in some working positions	MOLISA, MONRE	MOIT, MOH, Laboratories/ Universities	Regularly
POP-BDEs	17. Monitoring of PBDEs in the techno-sphere and in environmental compartments	MONRE	MOIT, Laboratories/ Universities	Regularly
	18. Monitoring in articles and products: E-waste plastic, plastic used in TVs; PUR foam; articles produced from recycled plastic materials or PUR foams	MONRE, MOIT	Laboratories/ Universities	2017-2022
	19. Monitoring of human exposure:	MOLISA,	Laboratories/	2017-2022

	Occupational exposure (recycling sector; disposal including certain secondary metal industries); Consumer exposure (indoor, food and other)	MONRE, MOH	Universities	
	20. Monitoring of cattle and wildlife (including fish) having potential exposure (near selected industries) and background exposure	MONRE	MOH, Laboratories/ Universities	2017-2025
	21. Monitoring of potentially POP-BDEs contaminated site (within general POPs contaminated site assessment)	MONRE	MOH, MOIT Laboratories/ Universities	2017-2022
PFOS	22. Monitoring of PFOS and related substances in Vietnam	MONRE	MOIT, Universities and research institutes	2018-2025
	23. Improvement of inventory by monitoring approach where knowledge gaps have been found			2018-2022
	24. Conduct research on the level of contamination dredged sediment near dump sites			2018-2025
	25. Monitoring of chemicals and chemicals in products/articles, waste suspected to contain PFOS.			2018-2022
	26. Monitor of potentially PFOS contaminated sites and related exposure			2018-2025
PCDD/PCDF and other UPOPs	27. Establish and strengthen the national capacity for UPOPs monitoring	MOH, MOIT, MONRE	Laboratories/ Universities/ Research institutes	Regularly
	28. Conduct research on the level of pollution at potential sites			2018-2022
	29. Assessment of monitoring results for environmental and foods samples for PCDD/PCDFs (including samples on human exposure for residents around suspected hot spot).			2017-2025
	30. Monitoring of major sources generating and releasing PCDD/F, HCB and PCBs			2017-2022
	31. Monitoring of PCDD/F, PCBs and HCB emission and related articles.			2017-2022
	32. Monitor UPOPs in waste treatment stages			2017-2022

3.4.16. Prioritized programs and projects

Based on the objectives and action plans, activities for implementation of the Plan, the priority programs and projects are described in the following table.

Table 27. List of national priority programs/projects

No.	Priority Programs/Project	Duration	Main information	Main responsible organizations	Coordinating organizations
1	Developing, supplementing and enhancing the effectiveness of regulations, policies and institutions to meet the new requirements of the Stockholm Convention	2018-2022	***Objective:*** Develop, supplement regulations, and strengthen institutional capacity to implement regulations on management, control of POPs. ***Main activities:*** - Review and assess the current regulations on the life - cycle management and control of POPs in Vietnam. - Research, refer to international experience to develop/ supplement regulations on life - cycle control of POPs, develop of environmental standards and regulations on emissions. - Review and assess the institutional capacity in POPs management and propose and implement measures to strengthen the capacity. ***Expected outcome:*** Regulations and policies on the management and control of POPs; tools for POPs management; the proposed plan for strengthening institutional capacity for POPs management. ***Priority level:*** Highest priority ***Estimated fund:*** 10 billions VND	MONRE	Relevant ministries, sectors, provinces

2	Pollution control, treatment and rehabilitation of the environment in areas contaminated with POP pesticides	2017-2030	***Objective:*** Sound manage, pollution control, treat and rehabilitate the environment in areas contaminated with POP pesticides ***Main activities:*** - Review, assess and implement measures for sound management and pollution control in areas contaminated with POP pesticides - Identify areas contaminated with POP pesticides and make prioritization of the areas for clean – up and environmental restoration. - Develop and take measures for environmental remediation and restoration. - Monitor and assess the areas after taking measures for environmental remediation and restoration. - Develop plans on land use in the remediated and recovered areas. ***Expected outcome:*** The areas contaminated with POP pesticides to be remediated, recovered, and used for other purposes. ***Priority level:*** Highest priority ***Estimated fund:*** 5.000 billions VND	Provinces, MONRE	Relevant ministries, sectors
3	Assessment, control and treatment of areas seriously contaminated with Orange Agent/ Dioxin	2017-2025	***Objective:*** Control and remediate areas seriously contaminated with Orange Agent/ Dioxin ***Main activities:*** - Assess and implement measures for sustainable management of areas contaminated with Orange Agent/ Dioxin - Develop and implement plans for treatment and environmental restoration. - Monitoring and assess the areas after taking measures for treatment and restoration. - Develop plans on land use in the remediated and recovered areas. ***Expected outcome:*** The areas contaminated with Orange Agent/ Dioxin controlled and treated ***Priority level:*** Highest priority ***Estimated fund:*** 10.000 billions VND	MOD	MONRE and provinces

4	Sound management, pollution control and reduce impacts of PCBs on the environment and human health	2018-2030	***Objective:*** Sound management, pollution control of PCBs for reducing impacts of PCBs on the environment and human health ***Main activities:*** - Inventory PCBs in applications in the whole country and classify and labeling according to PCBs level; eliminating in use equipment containing PCBs ≥ 50 mg/kg - Establish the safety storage sites for PCBs containing oil, materials, equipment and wastes. - Implement measures to enhance capacity for treatment of PCBs containing oil, materials, equipment and wastes. - Safe treatment of PCBs containing oil, materials, equipment and wastes under the priority. - Assess and identify PCBs contaminated sites to develop and implement measures for environmental remediation, restoration and risk management to environment and health. - Research, assess the impact of PCBs on human health in Vietnam to propose and implement risk management measures. ***Expected outcome:*** The safety storage sites and treatment units of PCBs will be licensed; PCBs containing materials, equipment, waste will be treated; PCBs contaminated areas will be identified, managed and remediated and environmental restored; the impact and risk of PCBs will be minimized ***Priority level:*** Highest priority ***Estimated fund:*** 50.000 billions VND	MONRE	MOH, MOIT, MOLISA, research institutes

5	National inventory, control and reduce UPOPs emissions in Vietnam	2017-2020	***Objective:*** To have data on UPOPs emissions in Vietnam and to continuously reduce UPOPs emission ***Main activities:*** - Inventory UPOP emission from industrial, transport, livelihoods activities, fire incidents and identify areas polluted with UPOP emissions. - Assess and identify UPOP emission sources for priority reducing emissions. - Develop and adopt management practices and techniques to reduce UPOP emissions. - Set up and operate the monitoring system and manage information on UPOP emissions in Vietnam. ***Expected outcome:*** Data on UPOPs emissions in Vietnam; measures for UPOP emission reduction applied to the emission sources; information systems on UPOP emissions. ***Priority level:*** Highest priority ***Estimated fund:*** 200 billions VND	MONRE/MOIT	MOT, MARD and relevant ministries, provinces and industries
6	Investigation, assessment, database development and treatment of areas polluted by POPs residual and other hazardous chemicals	2017-2030	***Objective:*** To identify and treat the areas polluted by POPs residual and other hazardous chemicals ***Main activities:*** - Assess and identify areas polluted by POPs residual and other hazardous chemicals and implement measures for sound management and pollution control of the areas - Identify the priority areas polluted by POPs residual and other hazardous chemicals for treatment. - Implement measures for environment restoration and monitoring and assessment of the areas. ***Expected outcome:*** Areas polluted by POPs residual and other hazardous chemicals identified and treated. ***Priority level:*** High priority ***Estimated fund:*** 10.000 billions VND	Provinces/ MONRE	Relevant ministries, research institutes

7	Development and implementation measures for management and improvement of environmental health related to POPs	2017-2025	***Objective:*** To develop and implement measures for management and improvement of environmental health related to POPs ***Main activities:*** - Research, assesse the impact of POPs on human health in Vietnam to propose and implement measures for risk management and improvement of environmental health. - Develop regulations, policies and tools for management of environmental health including issues related to POPs and hazardous chemicals. - Implement measures to strengthen the institutional capacity for environmental health management. - Develop national environmental health profile for POPs and hazardous chemicals. - Raise awareness and community involvement in environmental health related to POPs and hazardous chemicals. ***Expected outcome:*** Results of research on the effects of POPs on human health in Vietnam; measures for management and improvement of environmental health related to POPs; national environmental health profile for POPs ***Estimated fund:*** High priority ***Estimated fund:*** 300 billions VND	MONRE, MOH	MOLISA, MOIT, MARD, MOD, civil associations, research institutes

8	Reduction of use of materials, articles containing POP-BDEs, HBCD and PFOS in Vietnam and selection of sustainable alternatives	2017-2025	***Objective:*** To reduce use of materials, articles containing POP-BDEs, HBCD and PFOS in Vietnam. ***Main activities:*** - Assess and determine the use status of POP-BDE, HBCD and PFOS in industry and products in Vietnam. - Assess and select alternative substances in industrial production and products. - Develop and apply measures to promote the alternatives of POP-BDE, HBCD and PFOS. - Develop regulations and policies to continuously reduce and eventually eliminate use of POP-BDE, HBCD and PFOS in the industry in Vietnam. ***Expected outcome:*** Use status of POP-BDE, HBCD and PFOS in industry and products in Vietnam; Measures for reduction and alternatives of POP-BDE, HBCD and PFOS; measures for continuously reduction use of POP-BDE, HBCD and PFOS. ***Priority level:*** High priority ***Estimated fund:*** 3.000 billions VND	MOIT	MONRE, MOST, other relevant ministries, sectors, research institutes, relevant associations

9	Pollution control and treatment of materials and wastes containing POP-BDE, PFOS, HBB, HBCD, HCBD, PCP.	2017-2030	***Objective:*** To control and treat materials and wastes containing POP-BDE, PFOS, HBB, HBCD, HCBD, PCP in Vietnam ***Main activities:*** - Collect information and inventory materials, waste containing POP-BDE, PFOS, HBB, HBCD, HCBD, PCP in nation wide. - Develop and implement safety storage measures of materials, waste containing POP-BDE, PFOS, HBB, HBCD, HCBD, PCP. - Identify priority and implement treatment activities for the priorities. - Establish and maintain a system of collecting, storage and enhancement of treatment capacity of material and waste containing POP-BDE, PFOS, HBB, HBCD, HCBD, PCP. ***Expected outcome:*** Inventory results on materials, waste containing POP-BDE, PFOS, HBB, HBCD, HCBD, PCP in Vietnam; Storage sites and treatment units of materials, waste containing POP-BDE, PFOS, HBB, HBCD, HCBD, PCP licensed ***Priority level:*** High priority ***Estimated fund:*** 300 billions VND	MONRE, Provinces	MOIT, MARD, MPS, relevant ministries and provinces

10	Conduct education, communication, awareness raising and enhancing the involvement of individuals, organizations and community on risk related to exposure of POPs and other hazardous chemicals	2017-2030	***Objective:*** To raise awareness and enhance the involvement of related stakeholders in Vietnam on risks caused by POPs and other hazardous chemicals to environment and human health. ***Main activities:*** - Develop and implement synchronous and continuous solutions to provide information and knowledge about the risks caused by POPs and hazardous chemicals to the stakeholders in Vietnam. - Integrate and leverage existing programs, activities and projects and communication channels to provide information about POPs and chemical hazards to the community. - Establish a communication network with participation of experts, press, communication agencies, the community and relevant authorities in order to maintain and provide information. - Develop and implement mechanisms and policies to mobilize the active participation of the community, enterprises in supervising, providing information and implementing management measures for risks caused by POPs and chemicals hazardous to environment and health. ***Expected outcome***: Documents, programs, activities on communication, raising awareness on POPs and hazardous chemicals; mechanisms and policies to mobilize the participation of the community, enterprises in the management of POPs and hazardous chemicals; communication networks on POPs and hazardous chemicals. ***Priority level:*** High priority ***Estimated fund:*** 300 billions VND	MOET/ MONRE	MIC, MOH, MOF (General Custom Department), MPS, MOLISA, and provinces, and civil associations, research institutes and industries

11	Control of the POP-pesticides export, import and sound management of POP-pesticides	2017-2025	***Objective:*** Control and restrict POP-pesticide export, import and sound management of POP-pesticides in Vietnam ***Main activities:*** - Assess the situation of import and export of POP-pesticides in Vietnam. - Develop and supplement regulations related to control of POPs-pesticides and hazardous pesticides import and export. - Enhance control of business, use, storage and transport of POPs-pesticides and hazardous pesticides. - Sound management of pesticides including POPs-pesticides. - Develop and operate management system of import, export, manufacture, use and disposal of pesticides. ***Expected outcome:*** The situation of import and export of POP-pesticides in Vietnam; regulations related to control of hazardous pesticides import and export; sound management measures of pesticides. ***Priority level:*** High priority ***Estimated fund:*** 100 billions VND	MARD	MONRE, MOF, MPS, MOIT

12	Sound management of chemicals, materials, equipment and wastes related to POPs and mercury generated from health care sector	2017-2022	***Objective:*** Sound management and reduction of POPs and mercury generated from health care sector ***Main activities:*** - Assess and determine the situation of use and emissions of chemicals, materials, equipment and waste related POPs, mercury from health care sector. - Develop and implement safe measures for storage of identified chemicals, materials, equipment and waste related POPs and mercury. - Implement measures to reduce POPs and mercury emissions from medical activities. - Capacity building for developing and strengthening policy, legal, institutional frameworks and technical guidelines focus on management of POPs, mercury and other hazardous substances generated from health care sector - Raise awareness and enhance capacity of stakeholders for sound management of POPs and mercury generated from health care sector. ***Expected outcome:*** Situation of use and emissions of POPs and mercury from health care sector; measures and works for safe storage of POPs and mercury; regulation and measures for enhancement of the capacity of management and reduction of POPs, mercury and other hazardous substances emission, programs on awareness raising and capacity enhancement ***Priority level:*** High priority ***Estimated fund:*** 200 billions VND	MOH, MONRE	MOLISA, MOIT, MARD MOC and civil associations, research institutes

13	Research, assessment and implementation of safety measures for workers in contact with POPs and materials and articles containing POPs	2017-2022	***Objective:*** Minimize exposure to POPs for workers in Vietnam. ***Main activities:*** - Assess the situation and risk of contact, exposure to POPs for workers in some specific sectors in Vietnam. - Research, develop and apply measures to minimize exposure to POPs for workers. - Develop regulations and policies to minimize exposure and effects of POPs to workers' health. - Organize programs and activities to raise awareness. ***Expected outcome:*** Information on situation and risk of contact, exposure to POPs for workers in Vietnam; measures and regulations to minimize exposure and effects of POPs to workers' health; programs and activities to raise awareness ***Priority level:*** High priority ***Estimated fund:*** 100 billions VND	MOLISA	MOH, MONRE, MOIT and other relevant ministries, civil associations, research institutes and industries
14	Strengthening capacity of science and technology to control, replace and sound manage POPs	2017-2030	***Objective:*** Ensure capacity for sound management, control of POPs, and promote the replacement of POPs. ***Main activities:*** - Capacity building in POPs monitoring in environmental media, materials, waste and products. - Establish and maintain a monitoring network on POPs and hazardous chemicals. - Capacity building in risk assessment, sound management and treatment of POPs. - Develop regulations and tools to control POPs in the environment, materials and waste; technical guidelines on POPs monitoring. - Develop policies and technical guidance to promote the replacement of POPs; promote monitoring services. ***Expected outcome:*** Capacity building programs in monitoring, control and sound management of POPs; related regulations and policies ***Priority level:*** Highest priority ***Estimated fund:*** 500 billions VND	MOST	MONRE, MPS, MOIT and relevant ministries, research institutes

3.5. IMPLEMENTATION ARRANGEMENT

The Government unifies the management and direction of the implementation of the Stockholm Convention in Vietnam. The concerned agencies, organizations and localities shall have to carry out activities as assigned in this Plan.

In order to ensure the effective implementation of the requirements of the Stockholm Convention and this Plan, Prime Minister assigns specific responsibilities to agencies and organizations as follows:

a) The MONRE shall assume the prime responsibility for organizing the coordination of the implementation of the Stockholm Convention in Vietnam according to the Vietnamese Government's commitments to the Stockholm Convention and the tasks assigned in this Plan; assume the prime responsibility and coordinate with the concerned ministries and sectors in consolidating and maintaining the operation of the Stockholm Convention Steering Committee in Vietnam; strengthening the capacity of the specialized agencies to monitor and synthesize the implementation of the Stockholm Convention on POPs; regularly urging and inspecting the ministries, sectors and PPCs in performing the assigned tasks; periodically report to the Prime Minister and the Stockholm Convention on the implementation result of the National Plan and the Stockholm Convention.

b) The MOIT is responsible for carrying out inventory and evaluation of POPs used in industries; inventory of UPOP emissions from industry; applying measures to reduce, replace and reduce emissions of POPs in industry; provide information to the MONRE on the need POPs use in order to conduct exemption registration in accordance with the provisions of the Stockholm Convention; before December 31 annually, send the MONRE report on the implementation results in order to synthesize and report to the Prime Minister.

c) The MARD is responsible for strictly controlling the import and export of POPs used in agriculture; inventory and evaluate the use of POP pesticides and provide information to the MONRE for exemption registration in accordance with the provisions of the Stockholm Convention; before December 31 annually, send the MONRE report on the implementation results in order to synthesize and report to the Prime Minister.

d) The Ministry of Health (MOH) is responsible for strictly controlling the import and export of POPs used in the medical sector; before December 31 annually, send the MONRE report on the implementation results in order to synthesize and report to the Prime Minister.

e) The Ministry of Planning and Investment and the Ministry of Finance (MOF) balance and arrange funds from the State budget and from other sources in the annual and long-term plan for effectively implement the contents, programs and project of the Plan.

f) Concerned ministries and sectors shall, according to their assigned functions and tasks, have to elaborate and organize the implementation of programs and projects of the Plan as assigned; before December 31 annually, send the MONRE report on the implementation results in order to synthesize and report to the Prime Minister.

g) PPCs shall have to elaborate and organize the implementation of programs and projects assigned in the Plan; based on the contents of the Plan to allocate environmental non-business budget for the management and control of POPs and scientific non-business budget to support the capacity building for evaluation and treatment of POPs in the authorized area; instructing the Department of Natural Resources and Environment and other departments, committees and sectors in the locality to carry out the management and control of POPs; before December 31 annually, send the MONRE report on the implementation results in order to synthesize and report to the Prime Minister.

h) The Vietnam Environment Administration (MONRE) is the National Coordinating Agency for the implementation of the Stockholm Convention and responsible for assumes the prime responsibility for organizing the implementation of this Plan and periodically reports to the MONRE, the Prime Minister and the Secretariat of the Stockholm Convention on the results of the implementation of the Plan.

i) The research units, associations and associations concerned shall have to coordinate with the MONRE in implementing the contents of the Plan.

3.6. RESOURCES FOR THE IMPLEMENTATION OF THE PLAN

a) The resources for the implementation of the national plan are mobilized and optimized based on implementing the following contents:

- Coordinate with other programs and projects on sustainable development, climate change, natural resources management, waste management and programs, projects on science and technology and other relevant programs, projects and activities in order to attract more investment and increase efficiency of resources utilization.

- Mobilize various financial sources such as state budget, non-refundable ODA, loans and sponsored sources from organizations and individuals.

- Encourage investors, enterprises and social organizations to invest in pollution remediation projects through preferential policies on land, tax exemption, preferential credit, public-private partnerships in the management of POPs.

- Maximally take advantage of the financial resources of international financial institutions and countries such as mobilizing donors to attract funds for the National Plan, creating the legal basis to encourage international funding.

- Enhancing international cooperation should be implemented in various areas such as technical cooperation, non-refundable aid for project development, capacity building, institutional improvement, project support, addressing health and social welfare issues for stakeholders.

b) Allocation of budgets for implementation

- Budgets for implementation of programs and projects in Appendix 2 of this Plan are mobilized from the following sources:

+ The State budget (including ODA), including development investment capital, regular expenditures (non-business economy, non-business science, non-business education, non-business environment, administrative management, loans, technical assistance, etc.).

+ Legal fund and investment capital of national and international organizations and individuals inside and outside the country.

- Budget for implementation of programs, projects and activities not included in Appendix 2 of this Decision shall be allocated in the annual estimate expenditure of ministries, relevant agencies and organizations and localities according to the current state budget decentralization.

Based on the contents of the Plan and the list of programs and projects promulgated with this Decision, the ministries, sectors and localities shall make cost estimates based on the above funding source structure; sum up in the annual estimate budget of the ministries, sectors and localities and submit them to the competent authorities according to the provisions of the State Budget Law and guiding documents.

REFERENCES

1. Anh H.Q., Tri T.M., Mai P.T.N., Thao T.T., Huong N.T.A., Lieu T.T., Anh D.H., Viet P.H., Minh T.B. (2014). Contamination status and emission levels of Polybrominated diphenyl ethers (PBDEs) in plastic and house dust from some informal e-waste recycling sites in Vietnam. VNU Journal of Science: Natural Sciences and Technology, 30(5S):1-6.
2. Bailey R.E. 2007. Pentachlorobenzene - Sources, environmental fate and risk characterization. www.eurochlor.org
3. Brambilla G, D'Hollander W, Oliaei F, Stahl T, Weber R. 2015. Pathways and factors for food safety and food security at PFOS contaminated sites within a problem based learning approach. Chemosphere 129, 192-202
4. C.T.A. Moermond, E.M.J. Verbruggen, C.E. Smit. 2010. Environmental risk limits for PFOS
5. CHE/Commonweal. 2009. Hormone Disruptors and Women's Reproductive Health
6. Duong Thanh Nghi et al. 2012. Monitoring POP in coastal Vietnam and some results of Polychlorinatedbiphenyl (PCB) pollution status in the northeast coastal region and Red river delta, Vietnam
7. Environmental fate and risk characterization. www.eurochlor.org
8. European Environmental Agency. 2014. Progress in management of contaminated sites (LSI 003) - Assessment May 2014
9. Faber D. 2008. Capitalizing on Environmental Injustice. The Rowman & Litlefield Publishing Group, Inc
10. Fei C, McLaughlin JK, Lipworth L, Olsen. 2009. Maternal levels of perfluorinated chemicals and subfecundity. J Hum Reprod. 24, 1200-1205
11. Global Alliance on Health and Pollution (http://www.gahp.net/new/)
12. Greenpeace. 2013. Chemie für jedes Wetter Greenpeace untersucht Outdoor
13. Harada K. H. et al. 2010. Levels of perfluorooctane sulfonate and perfluorooctanoic acid in female serum samples from Japan in 2008, Korea in 1994-2008 and Vietnam in 2007-2008
14. Haraguchi K. 2009. Levels and regional trends of persistent organochlorines and polybrominated diphenyl ethers in Asian breast milk demonstrate POPs signatures unique to individual countries
15. Hatfield Consultants. 2011. Environmental and Human Health Assessment of Dioxin Contamination at Bien Hoa Airbase, Viet Nam: Final Report. August 2011
16. Herbstman et al. 2010. Prenatal exposure to PBDE and neurodevelopment. Environ Health Perspect 118(5): 712-719 http://ehp03.niehs.nih.gov/article/fetchArticle.action?articleURI=info%3Adoi%2F10.1289%2Fehp.0901340
17. Isobe T. et al. 2012. Determination of perfluoroalkyl compounds in aqueous samples from Northern Vietnam. Interdisciplinary studies on Environmental Chemistry - Environmental Pollution and Ecotoxicology. TERRAPUB, 2012

18. Joensen, Bossi R, Leffers H, Jensen AA, Skakkebaek NE, Jørgensen N. 2009. Do Perfluoroalkyl Compounds Impair Human Semen Quality? EHP 117:923–927. http://ehp03.niehs.nih.gov/article/info%3Adoi%2F10.1289%2Fehp.0800517

19. Jurewicz J, Hanke W, Radwan M, Bonde JP. 2009. Environmental factors and semen quality.Int J Occup Med Environ Health.22, 305-329

20. Kannan, K., S. Corsolini, J. Falandysz, G. Fillmann, K. S. Kumar, B. G. Loganathan, M. A. Mohd, J. Olivero, N. V. Wouwe, J. H. Yang,, and K. M. Aldous. 2004. "Perfluorooctanesulfonate and Related Fluorochemicals in Human Blood from Several Countries." Environmental Science & Technology 38: 4489–4495

21. Kei Nomiyama et al. 2015. Residue profiles of organohalogen compounds in human serum frome-waste recycling sites in North Vietnam: Association with thyroidhormone levels

22. Korucu MK, Gedik K, Weber R, Karademir A, Kurt-Karakus PB (2015) Inventory development of perfluorooctane sulfonic acid (PFOS) in Turkey: Challenges to control chemicals in articles and products. Environ Sci Pollut Res Int. 22, 14537-14545

23. Meironyté D. 1999. Analysis of polybrominated diphenyl ethers in Swedish human milk. A time-related trend study, 1972-1997

24. Michael F. Martin. 2015. U.S. Agent Orange/Dioxin Assistance to Vietnam. CRS Report prepared for members and committees of Congress. Congress Research Service 7-5700. November 13, 2015

25. Ministry of Environment, Food and Agriculture of United Kingdom. 2004. Report on strategy for minimizing risk and analysis advantages and shortcomings of PFOS.

26. Minh NH, Boivin Th, Canh PN, Son LK. Comprehensive assessment of dioxin contamination in Da Nang Airbase and its vicinities: Environmental levels, human exposure and options for mitigating impacts. *Interdisciplinary Studies on Environmental Chemistry — Environmental Research in Asia*, pp. 21–29. TERRAPUB, 2009.

27. MONRE (Office 33). 2013. Comprehensive report agent orange/dioxin contamination at three hotspots: Bien Hoa, Da Nang and Phu Cat airbases

28. MPI. 2014. Implementation of plan for development of economic zones, industrial zones in 2014 and plan for 2015

29. NIP Update Project. 2015. Report of new POPs inventories

30. Office of National Steering Committee 33. 2013. Agent orange/dioxin contamination at three hotspots: Bien Hoa, Da Nang and Phu Cat airbases

31. P. Grandjean & R. Clapp Perfluorinated Alkyl Substances: Emerging Insights Into Health Risks NEW SOLUTIONS: A Journal of Environmental and Occupational Health Policy 2015, Vol. 25(2) 147–163

32. PCBs Management Project in Vietnam. 2015. Study on daily intake and assessment of risk to environment and human health related to PCB

33. PCBs Management Project. 2013. Report CS3/ISEA: National inventories of PCB – Non EVN

34. Pham Manh Hoai et al. 2009. Recent levels of organochlorine pesticides and polychlorinated biphenyls in sediments of the sewer system in Hanoi, Vietnam

35. Pham Manh Hoai et al. 2011. Pesticide pollution in agricultural areas of Northern Vietnam: Case study in Hoang Liet and Minh Dai communes

36. Quang N.D. 2012. Study on the material flow analysis of some EEE in Vietnam.

37. R. J. Cooke. 2015. GEF/UNDP Project on Environmental Remediation of Dioxin Contaminated Hotspots in Viet Nam. Independent Expert Evaluation of Three Pilot/Laboratory Scale Technology Demonstrations on Dioxin Contaminated Soil Destruction from the Bien Hoa Airbase in Viet Nam. March 2015

38. Scheringer, M., Strempel, S., Hukari, S., Ng, C.A., Blepp, M., Hungerbühler, K. 2012. How many Persistent Organic Pollutants should we expect? Atmospheric Pollution Research, 3, 383–391

39. Scientific and Technical Advisory Panel (STAP) of the Global Environment Facility (GEF). 2011. Selection of Persistent Organic Pollutant Disposal Technology for the Global Environment Facility

40. Sharpe R. 2009. Male Reproductive Health Disorders and the Potential Role of Exposure to Environmental Chemicals http://www.chemtrust.org.uk/wp-content/uploads/ProfRSHARPE-MaleReproductiveHealth-CHEMTrust09-1.pdf

41. Shaw SD, Berger ML, Harris JH, Yun SH, Wu Q, Liao C, Blum A, Stefani A, Kannan K. 2013. Persistent organic pollutants including polychlorinated and polybrominated dibenzo-p-dioxins and dibenzofurans in firefighters from Northern California. Chemosphere. 91, 1386-1394

42. Shin Takahashi et al. 2012. Contamination of indoor dust and air by polychlorinated biphenyls and brominated flame retardants and relevance of non-dietary exposure in Vietnamese informal e-waste recycling sites

43. Silvia Giuliani et al. 2011. PCB in Central Vietnam coastal lagoons: Levels and trends in dynamic environments

44. Stellman J.M., Stellman S.D., Christian R., Weber T., Tomasallo C. 2003. The extent and patterns of usage of Agent Orange and other herbicides in Vietnam. Nature 422, 681-687.

45. Stockholm Convention. 2010. PCB Elimination Club (PEN) magazine. Issue 1 12/2010. http://chmpopsint/tabid/738/Defaultaspx. Accessed 19 Aug 2012

46. Tao, L. et al. 2008. Perfluorinated compounds in human breast milk from several Asian countries, and in infant formula and dairy milk from the United States. Environ Sci Technol 42, 8597-8602

47. The presentation "Vietnam Electricity (EVN) with PCBs management issues" of Board of Science Technology and Environment, Vietnam Electricity presented at the Workshop on Dissemination of information to journalists about the persistent compounds and PCBs compounds held in Hoa Binh city from 13-14 January 2011

48. The project Building Capacity to Eliminate POPs Pesticides Stockpiles in Vietnam. 2015. Report on current situation of pollution caused by POPs pesticides stockpiles in Vietnam

49. Thuong NV, Hung NX, Mo NT, Thang NM, Huy PQ, Binh HV, Nam VD, Thuy NV, Son LK, Minh NH (2015). Transport and bioaccumulation of Polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofuranes at the Bien Hoa Agent Orange Hotspot, Vietnam. Environmental Science and Pollution Research, 22:14431–14441.

50. Tue NM, Sudaryanto, A, Minh, TB, Isobe, T., Takahashi, S., Viet, P.H., Tanabe, S. 2010. Accumulation of polychlorinated biphenyls and brominated flame retardants in breast milk from women living in Vietnamese e-waste recycling sites. Science of the Total Environment, 408, 2155-2162

51. UNDP. 2011. Gender & Chemicals. Energy & Environment Practice Gender Mainstreaming Guidance Series

52. UNEP & WHO. 2013. State of the Science of Endocrine Disrupting Chemicals – 2012

53. United Nation Development Programme, Gender Mainstreaming. A Key Driver of Development in Environment and Energy, Energy and Environment Practice. Gender Mainstreaming Guidance Series

54. United States Agency for International Development. 2011. Tips for Conducting a Gender Analysis at the Activity and Project Level. Additional Help for ADS Chapter 2011;

55. US EPA. 2010. An Exposure Assessment of Polybrominated Diphenyl Ethers. EPA/600/R 08/086F, May 2010

56. Vietnam Government Portal, 2015

57. Vietnam National Assembly. The complete document of the National Assembly (Volume 2) in the period of 1984 – 1987

58. Vietnam Yellow Page

59. Vijgen J, Abhilash PC, Li Y-F, Lal R, Forter M, Torres J, Singh N, Yunus M, Tian C, Schäffer A, Weber R. 2011. HCH as new Stockholm Convention POPs – a global perspective on the management of Lindane and its waste isomers. Env Sci Pollut Res. 18, 152-162

60. Weber R, Schlumpf M, Vijgen J. 2015. The need for better management and control of POPs stockpiles Environ Sci Pollut Res Int. 22, 14385-14390 http://link.springer.com/article/10.1007/s11356-015-5162-7/fulltext.html

61. Weber R. 2007. Relevance of PCDD/PCDF Formation for the Evaluation of POPs Destruction Technologies – Review on Current Status and Assessment Gaps. Chemosphere, 67, 109-117

62. Weitao Wang et al. 2015. Seasonal characteristics and current sources of OCPs and PCB and enantiomeric signatures of chiral OCPs in the atmosphere of Vietnam

63. Wijegunasekara B, Ranpatige D, Hewawasam V, Werahera SM, Azmy SAM, Weber R. 2015. PCB inventory and management challenge & progress in Sri Lanka. Organohalogen Comounds 77, 519-522