

**The Republic of Yemen  
Ministry of Water and Environment  
Environmental Protection Authority**



**Stockholm Convention  
on Persistent Organic Pollutants (POPs)  
YEMEN  
NATIONAL  
IMPLEMENTATION  
PLAN**



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## List of Abbreviations

AQA	Analytical quality assurance
CFCs	Chloroflourocarbons
FAO	Food and agriculture organization
GC	Gas chromatograph
GCC	Gulf cooperation council
GDP	Gross domestic product
GTZ	German aid organization
HPLC	High performance liquid chromatography
NGOs	Non-governmental organizations
PCBs	Polychlorophenyls
PCDD	Polychlorodibenzodioxins
PCDF	Polychlorodibenzofurans
POPs	Persistent organic pollutants
UN	United nations
UNDP	United nations development program
UNEP	United nations environmental program
WB	World bank
WHO	World health organization
NIP	National Implementation Plan
POPs	Persistent Organic Pollutants
HCB	Hexechlorobenzene
DDT	1,1,1-Trichloro-2,2'-bis(p-chlorophenyl)ethane
PCBs	Polychlorinated biphenyls
KVA	Kilo-volt-ampere
TEQ	Toxic Equivalents
PPP	Polluter Pays Principle
GEF	Global Environment Facility
SC	Stockholm Convention
COP	Conference of the Parties
UNIDO	United Nations Industrial Deevlopment Organization
IARC	The International Agency for Research on Cancer
P.I.C	Prior Informed Consent
GAEP	General Authority for Electric Power
BAT	Best Available Techniques
BEP	Best Environmental Practices
GNP	Gross National Product
AQA	Analytical Quality Assurance
EF	Emission factors
HFO	Heavy fuel oil
CFC	Chloroflourocarbons
UK	United Kingdom
BP	British Petroleum
USAID	United States Aid
IVM	Integrated Vector Management
OCPs	organochlorinated pesticides



## **Executive Summary**

The National Implementation Plan (NIP) for the management and phase-out of the Persistent Organic Pollutants (POPs) in Yemen is compiled according to Article 7 of the Stockholm Convention on POPs. Yemen has ratified the Stockholm Convention in Dec. 5<sup>th</sup>. 2001 and is thus committed to manage and phase-out the POPs as stipulated in the Convention.

The main POPs substances are nine pesticides (Aldrin, Chlordane, Dieldrin, Endrin, Heptachlor, Hexachlorobenzene (HCB), Mirex, Toxaphene and DDT), polychlorinated biphenyls (PCBs), unintentionally produced polychlorinated dibenzo-p-dioxins and dibenzofurans. Scientific studies indicate that POPs chemicals are toxic, have a tendency to accumulate in fatty tissues and due to their persistence they are biomagnified in the bodies of animals at higher trophic levels and thus end up in humans through the food chain.

NIP was developed in 2004–2006 in a process funded by GEF and supported by UNDP by national, international experts and a large number of Yemeni stakeholders involved in different aspects of POPs. The agency guiding the NIP development has been the General Authority for Environmental Protection of the Ministry of Water and Environment.

NIP describes the background of the POPs issue in Yemen, the current situation of POPs substances and estimated emissions into environmental media, estimated impacts and how Yemen will meet its obligations under the Stockholm Convention.

Yemen's total population according to 2004 census is 19.685 million citizens, 71% of which is rural, and the ratio of unemployment is 16.3 %. The recent population growth figure is approximately 3.0 % per annum with increasing share of urban population. People under fifteen (15) years of age make approximately 45% of the total population. The average marriage age for both sexes is 21.9 years. The average number of family is 7.2.

Yemen has never produced any POPs chemicals and has not imported or exported any POPs chemicals since the year 1998 when DDT was last used for malaria control.

The final results of the inventory of POPs in Yemen showed the lack of circulation of any of the nine organic persistent pollutants, whether damaged or usable. It has been clearly demonstrated through the process of inventory the status of the POPs in the Yemen, as follows:

- 1) There is no any kind of manufacturing, re-packing or distribution of POPs in Yemen.
- 2) There are only two packing factories of household pesticides for pests like flies and cockroaches...etc. (aerosols). They import raw materials from abroad with the consent of the Ministry of Industry and Trade. These pesticides are not subject to supervision by the Ministry of Agriculture and Irrigation, both when they are imported or processed as long as they are concerning the fight against the scourges of public health.
- 3) Everything that exists in the market of pesticides of any kind are imported from abroad by the public, private and mixed sector, for pest control and public health pests.

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PCBs are used as dielectric liquid in electric transformers and condensers. The total numbers of transformers with different sizes that exist in the Yemen are 12129. The number of targeted transformers is 2098. Those are made before 1985. The inventory teams did not find any difficulty to inspect the oils in the transformers following the clear suggested directions. Two transformers were found containing PCBs; one in Khormaksar Power Station, Aden and the other at the yard of Dhahban Center, Sana'a. Only 52 transformers were suspected for containing PCBs among 2098 inspected and targeted in the study. The suspected oils were sent to Kuwait Institute for Scientific Research for testing. Only 11 transformers were found containing more than 1000 nanogram/gram PCBs. The rest of oils were mainly found containing traces of PCBs.

Yemen used transformers in the range 5-55000 KVA. The years of production of transformers ranged between 1930 and 2005. The older transformers were mainly found in the Southern Governorates: Aden, Lahj, Hadramaut, Abyan... etc. Transformers of the sizes 50, 500 and 1000 KVA were used intensively. The transformers with more than 1000 KVA and more are available in small numbers. The capacitors in Yemen are all depending on the dry technology.

DDT has not been used for agricultural purposes since the beginning of 1981. After that till 1998, DDT was used for malaria and vector control at an annual quantity not exceeding a few tons. At present there is no DDT stock in Yemen.

The releases of the unintentionally produced POPs, i.e. dioxins and furans are estimated at 1031.38 g TEQ (Toxic Equivalents) per annum. The main source of the release is the uncontrolled combustion consisting of 39 % of the total. Other essential release sources are disposal/landfill (24.68 % of the total), ferrous and non-ferrous metal production (15.94 % of the total) power generation and heating (10 % of the total), and waste incineration (8.2 % of the total). There are no remarkable hot spots but certain industrial processes and burning obviously present occupational risks. Urban population and especially people living at the outskirts of the urban areas are exposed to the release from waste burning. The annual releases are 44.18% as solid, 41.25% air and 14.58% as water releases.

Yemen is committed to manage and phase-out the POP chemicals as stipulated in the Stockholm Convention. However the current regulatory frameworks don't specifically address the POPs. The Environment Protection Act, The Environmental Health Act as well as certain labor protection regulations address risks similar to the risks of POPs but start to be a bit obsolete and do not go to a point matching the current level of knowledge. In general Yemen lacks the analytical capacity to study the impact of some POPs both in the ecosystem components as well as in humans. The regulatory framework should be continuously updated. Furthermore, Yemen has to applying the Polluter Pays Principle (PPP) to mobilize the economic and financial incentives in tackling the POPs emissions. In the overall strategy to reach the objectives and phase-out POPs according to deadlines, Yemen has proposed a combination of measures including Government's involvement, supportive local actions, market instruments like subventions and tax-breaks and extensive international cooperation including co-funding.

Yemen has set national priorities regarding the implementation of the POPs management and phase-out actions. Tackling the stocks of the obsolete POPs pesticides, the contaminated containers and the contaminated soil around the pesticide

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stores is considered a first priority. The second priority is to tackle the uncontrolled waste burning and all the subsequent waste management activities to reduce the emissions of dioxins and furans especially in the densely populated areas. The third priority of POPs management and mitigation actions to reduce and eliminate the risks related to the PCB containing electrical equipment.

The POPs issue in particular, has to be addressed as soon as possible. Activities addressing dioxins and furans releases, especially those regarding the uncontrolled burning of waste and municipal waste treatment deserve most urgent attention as long as it is responsible for 40% of the total equivalent of the annual releases.

The total cost of all the proposed actions is 65,260,000 USD.

Yemen expects that most of the proposed external funding will be available from the Global Environment Facility, UNEP, UNDP and related sources, but is actively seeking other sources of co-finance like international NGOs, private companies and donations.



## **1 Introduction**

### ***1.1. STOCKHOLM CONVENTION***

The objective of the Stockholm Convention is to protect human health and the environment from persistent organic pollutants (POPs). The Convention has been adopted and signing at the conference of plenipotentiaries in Stockholm in 2001 by 92 parties has signaled the end of negotiations that started in June 1998. These negotiations were called for in 1997 by the Governing Council of UNEP in recognition of the need for urgent global action to protect human health and the environment from POPs.

The Convention has identified twelve POPs components. It refers to nine chemicals used only as pesticides (Aldrin, Chlordane, Dieldrin, DDT, Endrin, Heptachlor, Hexachlorobenzene, Mirex and Toxaphane), two industrial chemicals: Polychlorinated biphenyls (PCBs) and Hexachlorobenzene (HCB) and four unintentional by-products (PCDD, PCDF, HCB and PCB). The Convention seeks the elimination or restriction of production and use of all intentionally produced POPs. The convention has entered into force February 17, 2004. The POPs chemicals referred to in the Convention are listed in Annexes A, B, and C of the convention. Continued use of DDT is allowed for vector control until safe, affordable and effective alternatives are in place. Countries must make determined efforts to identify, label and remove PCB-containing equipment from use by 2025, and manage those wastes in an environmentally sound manner not later than 2028. The Convention also seeks the continuous minimization, and where feasible, ultimate elimination of the releases of unintentionally produced POPs such as dioxins and furans. Stockpiles and wastes containing POPs must be managed and disposed of in an efficiently and environmentally safe manner, taking into account international rules, standards and guidelines. Each party is required to develop a plan for implementing its obligations under the Convention.

The Convention also imposes certain trade restrictions, and has a procedure for adding other POPs. Governments have set up an interim financial mechanism, with GEF as the principal entity, to assist developing countries and countries with economies in transition in their implementation of the Convention.

Article 7 of the Stockholm Convention covers the implementation plans. According to this article,

#### **1. Each party shall:**

- (a) Develop and endeavor to implement a plan for the implementation of its obligations under this Convention;
- (b) Transmit its implementation plan to the Conference of Parties within two years of the date on which this Convention enters into force for it; and
- (c) Review and update, as appropriate, its implementation plan on a periodic basis and in a manner to be specified by a decision of the Conference of the Parties.

**2.** The Parties shall, where appropriate, cooperate directly or through global, regional and sub-regional organizations, and consult their national stakeholders, including women's groups and groups involved in the health of children, in order to facilitate the development, implementation and updating of their implementation plans.



3. The 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 Government of Yemen has clearly noted the stipulations of the Stockholm Convention and especially those governing the NIP. Further, several guideline documents, compiled by UNDP, UNEP, UNIDO and World Bank have been consulted to make clear the requirements and formalities governing the NIP content and extent.

### ***1.2. Persistent Organic Pollutants***

The term “Persistent Organic Pollutants” (POPs) is used to describe a class of toxic chemical substances that can harm human health and environment. POPs are long-lasting toxic substances that are produced and released into the environment by human activity. Some POPs are produced for use as pesticides; some are for use as industrial chemicals; and some are produced as unwanted byproducts of certain chemical and/or combustion processes.

#### **1.2.1. Properties of POPs**

The characteristic properties of POPs are summarized in the following:

- Produced and mobilized into the environment as a result of human activity.
- Potential to cause harm to human health and/or to the environment.
- They are persistent in environment Long life in the environment and not easily or quickly broken down when they are in air, in water, in soil and in sediments.
- Bioaccumulate and become concentrated in the environment to levels of concern under circumstances where species accumulate POPs by eating smaller POPs contaminated organisms.
- Travel long distances in the environment through air, water or migratory species, and accumulate at locations that are distant from the sources of release.

#### **1.2.2. Sources of POPs**

Among these twelve POPs, some have been used as pesticides, some as industrial chemicals and some arise as unintentional by-products of chemical and/or combustion processes. To some extent these categories overlap. For example, PCBs were produced as industrial chemicals in large quantities, are also generated as unintentional by-products, hexachlorobenzene fits into all three categories; pesticides, industrial chemicals and unintentional byproduct.

#### **1.2.3. POPs - Pesticides:**

There are nine pesticides: Aldrin, Chlordane, Dieldrin, DDT, Endrin, Heptachlor, Hexachlorobenzene, Mirex and Toxaphane.

#### **1.2.4. POPs - Polychlorinated Biphenyl:**

PCBs are a class of chlorinated hydrocarbons that have been widely used as industrial chemicals since 1930. There are 209 varieties PCBs. The most commercial PCB applications are in the form of mixtures of varieties. Large quantities of PCBs were produced for use as a cooling and dielectric fluid in electric transformers and in large capacitors. These compounds have also been widely used as hydraulic fluids and as heat exchange fluids. PCBs applications have included use as a sealant, as paint additives, additives in some plastics, as a component of carbonless copy papers ...etc. These what can



also be formed and released as unwanted byproducts in some chemical and combustion processes.

PCBs are linked to reproductive failure and suppression of the immune system in various wild animals. Severe human intoxication occurred due to accidental consumption of PCB containing oils. The International Agency for Research on Cancer (IARC) classified PCB into Group 2B (possibly carcinogenic to human). International productions of PCBs were ended in most countries by 1980. The major exception to this was in the former Soviet Union countries and some Central European countries. No country presently reports intentional PCB production.

#### **1.2.5. POPs - Dioxins and Furans:**

Dioxins and Furans are two classes of chlorinated hydrocarbons. They have never been produced commercially or intentionally except in small quantities for laboratory purposes and/or as reference standards. There are 75 different dioxin congeners and 135 different furan congeners. IARC classifies one congener of dioxin as group 1 carcinogen (human carcinogen). All others are carcinogenic in animals.

Dioxins and furans are generated as unwanted by-products in a variety of combustion and chemical process. The major sources include waste incinerators combusting municipal waste, hazardous waste, medical waste, sewage sludge etc. Incineration of medical wastes in small and poorly controlled incinerators was found to be a major source of dioxins and furans. Kilns firing of cement industries and open air burning of wastes may also generate dioxins and furans. Other dioxins and furan sources are: pulp and paper mills using chlorine bleach processes, certain thermal processes in metallurgic industry and chemical production process.

Dioxins and furans are formed as byproducts in a wide range of processes. They are directly dispersed to the environment and may also be present in manufacturing processes such as extracting raw materials or preparing primary products.

Dioxins and furans are persistent in the environment and transfers can occur between media, e.g. from air to water through rain water and by run off from soil to water reservoir. This type of transfer may also make an important contribution to human exposure to these organic compounds.

### ***1.3. The Compilation Process of NIP in Yemen***

The development of the National Implementation Plan (NIP) to manage and phase-out persistent organic pollutants was initiated in early 2004 by establishing the General Authority for Environmental Protection (GEPA) as the responsible implementing agency within the Government. UNDP has been the executing agency. The main funding source has been (GEF). The practical work started in mid-2004.

The specific inputs, duly reported, in the process are as follows:

**1. Initial capacity assessment, identification of national and international experts, detailed work plan, in June-August 2004** by the project director and international consultant.

**2. Pilot inventory (guided methodology wise by an international expert) and initial inventory (covering the whole country) of pesticides stocks, stores and contaminated soils:** Initiated in late 2004, revised in 2005-2006 by national experts.



**3. Review of the sources of the dioxin and furans (unintentional**

POPs) releases. Initiated in 2004, revised in 2006, by national experts supported methodology wise by an international consultant. Training of two people in Germany

**4. Report on BAT/BEP considerations for reduction of unintentionally formed Persistent Organic Pollutants (UPOPs) releases in Yemen, by an international consultant, 2005.**

**5. Review of the DDT use in vector control, by national expert, from the Malaria Administration, 2004.**

**6. Inventory (sample based) of the PCBs containing equipment in the operational areas of the National Electricity Corporation, initiated in 2005 and further elaborated in 2007.**

**7. Assessment of the socio-economic impact of POPs prepared by an international reviewed by the GEPA in 2005.**

**8. Setting of national priorities, reported in 2005 reviewed by the MNCC and the international expert.**

**9. Report on The National Legislative and Institutional Framework: An Evaluation in Light of the Stockholm Convention, 2005.**

**10. Assessment of National POPs Monitoring, Research and Development capacity for POPs in Yemen, 2005.**

**11. Report on the awareness raising programs, 2006.**

**12. Report on the Level of POPs chemicals in the Environment and Humans, 2006.**

**14. Training workshop on action plan development, supported by UNITAR, held May 2005. راجع القضايا الأخرى وتؤكد من البرامج مع سالم**

**Focus of Yemen NIP (REVISE AT THE FINAL STAGE OF DOCUMENT)**

The focus of the Yemen NIP may be summarized as follows:

- Completing the elimination from products and equipment in use of POPs or POPs-containing materials according to Annex A of the SC.
- Contributing to the mitigation of the use and worldwide distribution of POPs according to Annex B of the SC.
- Perfecting the suppression of the unintentional production of POPs according to Annex C of the SC.
- Ensuring sustainability of the POPs-related measures taken and to be taken, respectively.
- Fostering and ensuring continuity of awareness of the POPs issue.
- Enhancing the transparency of the measures taken or to be taken, respectively.
- Corroborating the efficacy of these measures.



#### **1.4. National Priorities**

The priority fields for Yemen with regard to POPs management are the following:  
(REVISE

- Updating the national legislation in order to take Stockholm Convention obligations into account;
- Development of a strategy for identification and destruction of non-identifiable pesticides stocks, obsolete or subject to contain POPs;
- Development of an integrated strategy for management of chemicals used in the fight against disease vectors, including DDT;
- Elaboration of a strategy to eliminate PCB equipment from the national environment, and destroy PCB contaminated oils ecologically;
- Promote implementation of best available techniques in industry units that are subject to release unintentional POPs, and help the local communities better manage their rubbish dumps;
- Develop a strategy for sensitization and communication with the public, in view to reduce POPs generation practices;
- Develop national technical capacities regarding POPs management.

#### **1.5. Actions (REVISE AT THE FINAL STAGE OF DOCUMENT)**

The actions foreseen by the NIP were identified and classified taking into account the following criteria:

- requirement with regard to Stockholm Convention,
- benefits for public health and environment,
- technical and economic feasibility,
- perception of the problem by stakeholders and the public.

Because of limited economic resources in the country, the implementation strategy takes the financial constraints into consideration and gives priority to actions that allow reduction of POPs' direct negative impacts on health and environment. In particular, the NIP insists on less costly actions that are achieved at short term and which are likely to benefit from the support of national economic operators and NGOs.

#### **1.6. Monitoring and Evaluation (REVISE AT THE FINAL STAGE OF DOCUMENT)**

The implementation of the NIP will be subject of regular evaluations by the National Commission for POPs (NCP), services of the Ministry of Water and Environment (MOWE), and once every three years, by an independent expert known at international scale. The results of different evaluations will lead to adjustments of the NIP components in terms of real impacts of each action and changes intervened during the implementation. Programs of action by sector will be established, when needed, and implemented according to the objectives and strategy of the NIP.

#### **1.7. REPORTS TO THE CONFERENCE OF PARTIES (REVISE AT THE FINAL**

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Within the framework of the Conference of Parties (COP), each country has to inform other nations about arrangements in place, efforts made and results obtained. In particular, each Party has to submit the following reports:

- a- A Plan of Action for the identification, characterization and management of release of chemicals listed in Annex C of the Convention. This plan is to be reviewed every five years (see Article 5).
- b- A National Implementation Plan (NIP), two years after ratification of the Convention, including the first national plan of action for the reduction of unintentional releases. The factors due to start an assessment and updating of the NIP could be internal or external to the Party (According to Article 7 and decision SC-1/12 of COP).
- c- A report on measures taken to apply Stockholm Convention and on efficiency in achieving objectives (Article 15) established according to the format adopted by COP, this report will comprise statistical data regarding production, use, import and export of each of the products listed in Annexes A and B of the Convention, as well as a list of countries from which it has imported or to which it has exported POPs. The initial report will be submitted to the Secretariat of the Convention before 31 December 2006, in view of its assessment during COP3 in 2007, then every four years later (Decision SC-1/22 of COP1).
- d- A report on monitoring activities results led by countries or regional bodies four years after the entry into force of the Convention, and periodically afterwards according to an agenda to be defined by COP2 (Article 16, §2).
- e- A report on progress achieved in PCBs elimination every five years (aline a g – second part of Annex A).
- f- Every party that uses DDT should also provide, every three years, a report on quantities utilized, conditions of this use and its interest for prophylactic strategy (§ 4 – second part of Annex B).



## **2. General Profile of the Republic of Yemen**

Yemen was given different names in the history books. The former geographers called it "Arabia Felix". The Old Testament "Torah" recalls Yemen as a derivative of south and Queen South (Queen Tymna). Formerly, Yemen was named after Ayman bin Ya'rub bin Qahtan. In the Arab tradition, Arabic literature, language and the people of Yemen themselves, the word "Yemen" is derived from "Yumen" which means blessings, consistent with the old name "Arabia Felix".

Others said Yemen is called "Yemen" because it is to the right of Kaba in Mecca. Arabs like the right and consider it the symbol of good hope. Still some people of Yemen use the word "sham" meaning north and "Yemen" to mean south. Yemen is called today "the Republic of Yemen".

### **2.1. Natural and Demographic Structure of Yemen**

Yemen is situated in south-west Asia, in the south of the Arabian Peninsula and is bordered to the north by Saudi Arabia, to the south by the Arabian Sea and the Gulf of Aden, to the east by the Sultanate of Oman and by the Red Sea to the west. There are a number of Yemeni islands spread across the coastline along the Red Sea and the Arabian Sea. The largest of the islands is Socotra, which lies 150 kilometers from the coast of Yemen, in the Arabian Sea.

The State's official religion is Islam and Arabic is the official language. The system of the government is republican and democratic, where people exercise their rights directly through referendums and general elections, as well as engage indirectly through the legislative, executive and judicial bodies and through the elected local councils. The political system in the Republic of Yemen is based on political and party pluralism. The devolution of power and participation is done peacefully through general elections.

The capital of Yemen is Sana'a city, called "the Capital" in this document. Aden is the commercial and economic capital of the Republic of Yemen. The administrative division of the Republic contains (21) governorates (Figure-1) in addition to the Capital Sana'a. The most important ports of Yemen are Aden, Hodaida, Mukalla, and Al-Makha.

### **2.2. Population**

Data population projections indicate that the resident population in 2004 reached approximately 19.685 million compared to 14.588 million, according to the General Population Census of 1994. The annual population growth rate is approximately (3%) and the population density nationwide is generally (3.3) persons per square kilometer. The demographic composition of the population of the Republic of Yemen is divided almost as follows:

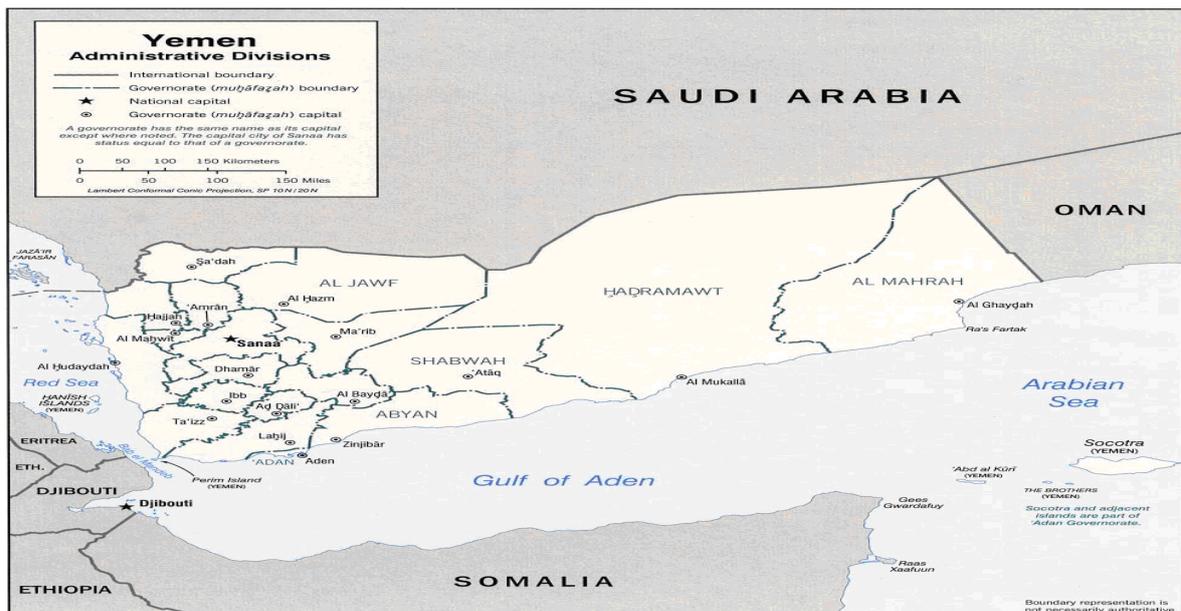
- The male population is 10.036 million, representing 51% of the total population.
- The female population is 9.648 million, representing 49% of the total population.

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- The population between the ages (0-14 years) is representing 45% of the total population.
- The population between the ages (15-64 years) is representing 52% of the total population.
- The population over the age of 65 years is representing 3% of the total population.

**Figure 1: The map of Yemen.**



**2.2.1. Fertility and Mortality**

The observed total fertility rate is 4.93 births per woman while the rate of infant mortality is 82.4 children per 1,000 children according to the Yemeni Family Health Survey of 2004. The average life expectancy at birth is 61.08 years for both sexes. Mean age at first marriage of both sexes is 23.81.

The average size of the Yemeni family is 7.4 members while the average number of individuals per room is 3.1. Total registered births (males + females) are 152792 in 2005 and total registered deaths of both sexes are 19653.

**2.3. Education**

Indicators of 2005 Census show that the proportion of school children in the ages (6-15 years) enrolled in schools is up to (84%). The number of secondary school students is 12 % of total students in Yemen. The university students are less than 3 % of the grand total. In general, the proportion of illiteracy among the adult population is up to (59%). In the face of this illiteracy, increasing annual expenditure on education in the establishment and expansion of educational facilities at various levels are noted. The latest statistics according to the Yemeni Family Health Survey show the following:

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The illiteracy rate is still high generally hitting (47%) of the total population according to 1994 census. It is high among females up to (67%), but amounting to approximately (27%) among males and is concentrated in the countryside (53%) whereas in urban areas it is (28%). It also increases among females in rural areas, where it reached up to (76%) while it is (31%) among males. In urban areas it amounts to (41%) among females and (15 %) among males. Yemen passed a literacy and adult education law in 1998. It also endorsed the national strategy for literacy and adult education, as well as set up a special literacy system.

- The number of private kindergartens mounted 198 with the number of pupils 8810, where there are 63 governmental kindergartens holding 9183 children according to statistics of 2004/2005.
- The number of basic education schools is (10879), while the number of students at the primary stage is around four million in 2005. There are also 166 private schools holding around one hundred students.
- The number of governmental secondary schools is 297, while the number of students at the secondary level is (593243) in 2005. There are also 10 private schools holding 11871 students.
- The number of professional and technical institutes is (78), and the total number of vocational education students is (3486) in 2005.
- The number of public universities is (7), while the number of students studying at the university governmental organizations is (164208). The number of private universities is (9), while the number of students studying at these universities is (23916) as shown in Table-1.

**Table 1: Numbers and percentages of students in the different education stages in Yemen.**

	<b>Governmental</b>	<b>Private</b>	<b>Total</b>	<b>%</b>
<b>Primary</b>	3977443	94851	4072294	٨٣,٨
<b>Secondary</b>	583243	11871	595114	١٢,٣
<b>University</b>	164208	23916	188124	٣,٩
<b>Grand total</b>	4724894	130638	4855532	١٠٠
<b>%</b>	<b>97.3</b>	<b>2.7</b>	<b>100</b>	

#### **2.4. Geographical Structure of Yemen**

Yemen (Figure-2) is characterized by the diversity of surface features and accordingly has been divided into five major geographic regions:

##### **2.4.1. The Coastal Plain Territory**

This territory extends sporadically along the coasts of Yemen; where the mountains and hills go up directly to the sea in more than one place, hence, the territory of the coastal plain of Yemen include the following plains:

- The Tehama Plain
- The plain of Tuban-Abyan

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- The Plain of Mayfaa-Ahwar
- The Coastal Plain of Al-Mahra.

The territory of the coastal plain is characterized by a warm climate throughout the year with little rain ranging between 50-100 mm per annum. It is an agriculturally important territory, especially Tehama Plain, due to the large valleys that cut across the province and into the plain which is flooded by the precipitation on the mountain slopes.

### **2.4.2. The Mountainous Heights Territory**

This region extends from the northern limits of Yemen to the far south. This territory has been subjected to tectonic plate movements resulting in major and minor faults, some of which are parallel to the Red Sea and some others are parallel to the Gulf of Aden, which resulted in jumping plateaus, kept among pools of mountains called Qiaan or fields.

The territory is rich in surface valleys that divide it into blocks with very steep slopes which continue as mountainous walls that overlook the Tehama Plain. The mountains of this region are the highest in the Arabian Peninsula and their average height is more than 2000 meters and their peaks ascend to more than 3500 meters. The highest mountain is Mt Prophet Shuaib which is 3666 meters high.

The line of water divides these mountains and lies where water stoops across a number of valleys eastward, westward, and southward. The most important of these valleys are Moore, Haradh, Zabeed, Siham and Rasian. All these valleys flow into the Red Sea. The valleys flowing into the Gulf of Aden and the Arabian Sea are Bana, Tuban, and Hadramaut.

**Figure 2: The geographical map of Yemen.**



### **2.4.3. Territory of Mountainous Basins**

This territory consists of the basins and mountainous plains located in the mountainous heights, mostly located in the eastern section of the water dividing line that extends from



the far north to the extreme south. The most important are mainly Yareem Field, Dhamar, Maabar, Sana'a basin, Amran and Sa'dah.

#### **2.4.4. Territory of Plateau Basins**

This territory is located to the east and north of the mountainous heights territory and parallel to it, however, it expands over the direction of the Empty Quarter and starts to decline gradually with surface sliding to the north and east sides slowly. Most of the surface of the territory is made of rocky desert with some valleys passing through it particularly Hadramaut and Hareeb valleys.

#### **2.4.5. Territory of the Sahara**

It is a sand territory almost devoid of vegetation except in the areas of streams of rainwater, which shed some fall in the mountainous areas adjacent to the territory ranges. The height of surface is between 500 and 1000 meters above sea level and descends without interruption markedly towards the northeast to the heart of the Empty Quarter. The climate here is harsh with the advantage of being warm and with a high heat range and scarce rainfall and low humidity.

### **2.5. The Yemeni Islands**

The many islands of Yemen are scattered in the territorial waters and have their own special terrain, climate and environment. Most of these islands are located in the Red Sea. The most significant of which is Kamaran Island which is the largest inhabited island in the Red Sea. Islands of Hunaish Archipelago and the island of Mioon are of strategic location in the Strait of Bab Al-Mandab, the southern gate of the Red Sea.

Among the most important of the Islands in the Arabian Sea is Socotra Archipelago. Socotra is the largest island of the archipelago, which includes in addition to Socotra three islands: Samhah, Darsah and Abdel Kory. Socotra Archipelago is characterized by huge biodiversity, where the estimated Socotra rare and medical plants on land to be about 680.

### **2.6. Climate**

Yemen oversees the Red Sea and the Arabian Sea. However, the climate of Yemen has not benefited much from the marine characteristics except in the high humidity in the air of the coasts. The impact of these marine characteristics of the two seas to modify the climate of the Republic is very limited and confined to the high humidity and modification of some of the characteristics of wind, while their role in the case of climate instability is limited.

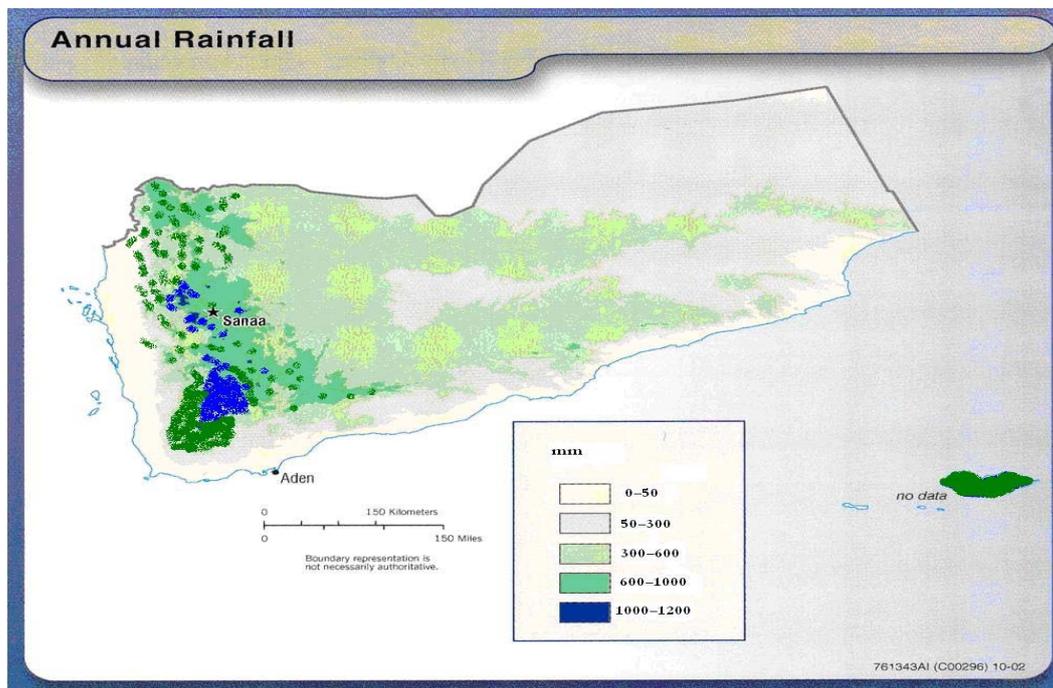
The rain falls in Yemen in two seasons; the first season is the spring (March-April) and the second is the summer (July-August) which is the season where more rain falls than in the spring. The amount of rainfall in Yemen varies widely by location. The highest amount of annual rainfall is in the southern highlands and western regions: Ibb, Taiz, Al-Dhalea and Yareem. The amount of rainfall is between 600-1500 mm annually. The amount of rainfall is less in the western coastal plain such as Hodaida and Almakha, despite being in the way of the monsoon coming from the south-western Indian Ocean crossing the Red Sea because of the absence of the moist winds lifting factor. However, the average annual rainfall



increases with the altitude from 50 mm on the coast to about 1000 mm in the highlands confronting the Red Sea.

The rainfall is not different in the southern and eastern coasts from the western shores of the country in amounting to about 50 mm per year in Aden, Al-Fioosh, Al-kode and Al-Rayyan. This is due to several factors; the most important of which is the direction of the moist wind along the coast without penetrating to the interior. Therefore, the impact would be very small and hence the rainfall was not of any economic significance (Figure-3).

**Figure 3: The distribution of rain fall in Yemen.**



In terms of temperatures, the plains of East and West are characterized by high degrees of temperature where they go up to 42 °C in the summer and down to 25 °C in the winter. The temperatures become lower at higher elevations gradually with height to reach a maximum of 33 °C and a minimum of 20 °C in the summer. In winter the lower temperatures at the heights approach zero degrees. The winter of 1986 recorded a low temperature of -12 °C in Dhamar.

The humidity is high in the coastal plains; up to more than 80%, while goes down at the interior and reaches the lowest percentage in the desert areas, which accounts for a humidity of 15%.

## **2.7. Health**

According to the data of 200<sup>o</sup>, the number of physicians in the Republic in general is (٥٩٢٠), which represents a physician for each (٣٤٣٠) persons of the population. The total number of nurses is (١٥١٢١), which represents an average of (3) nurses per physician. The

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total number of beds in hospitals is (13841), which represents an average ratio of one bed for every (1467) individuals of the population.

Health indicators in Yemen remain less than the average in comparable low-income countries. Those who get health services are only 50% of the population in general; 25% are in rural areas where the majority of the population lives, with the continuous spread of infectious diseases such as malaria, bilharzias, diarrhea, and typhoid. This is due to the relative low level of public health in Yemen attributed to the low spending on health care, which did not exceed 4% of the expenditures per year during the first five-year plan because of limited financial resources.

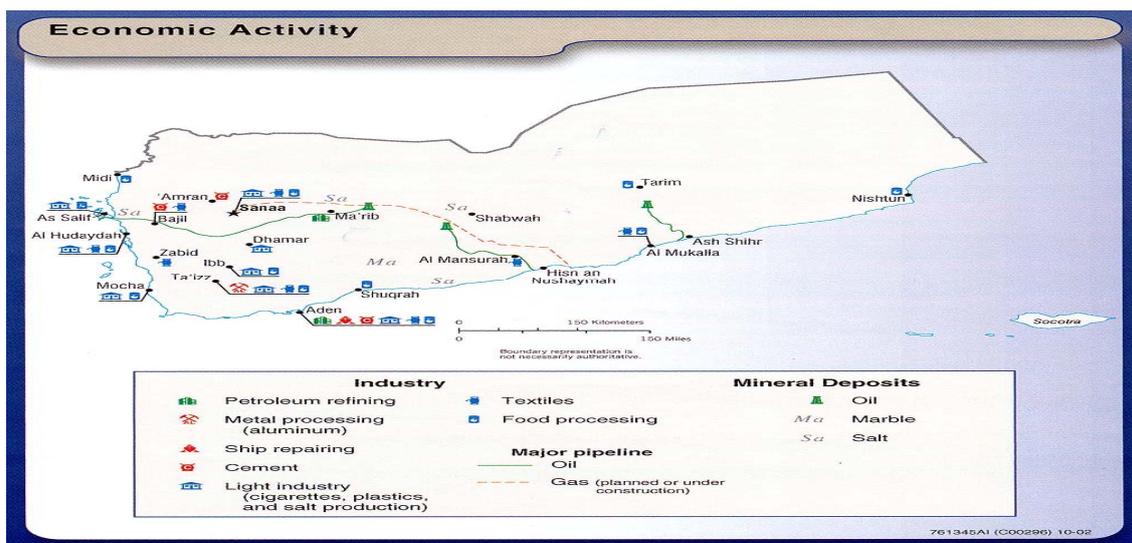
**2.8. Industry and Agriculture**

Yemen is classified among the least developed countries; however, it is viewed as a country of promised blessings and important economic resources. There are resources that have not so far been exploited economically, particularly in the field of oil, gas, fish, and different mineral wealth. In fact, most Yemeni economy indicators show currently the following:

Agriculture and fisheries constitute a ratio ranging between (11) % of the gross domestic product, where the area of arable land is (3%) of the total area of the Republic and the area already planted is (1,076,771 hectares) of the total area of arable land which is (1,668,858 hectares).

Extractive and manufacturing industries constitute between (43) percent of the GDP. In the framework of this ratio, the extraction and refining of oil represent the major part, where the contribution of the oil sector to GDP varies between (13) percent. Table 2 shows the gross value of output for industrial installations in 2003–2005 (Million Rials). Figure 4 illustrates the economic activities in Yemen, 2005.

**Figure 5: The economic activities in Yemen, 2005.**



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**Table 2: Gross value of industrial output for 2003–2005 (Million Rials).**

Economic Activity	Gross value output		
	2005	2004	2003
Mining and quarrying	5116	3654	2186
Food stuffs and beverages	287176	205126	139668
Tobacco products	13096	9354	30882
Manufacture of textiles	5827	4162	5520
Dressmaking and dyeing of fur	19639	14028	6500
Bags shoes & tanning of hides	7356	5254	3237
Wood products, excluding furniture	16869	12049	6424
Paper and paper products	19368	13834	2164
Printing, publishing & photocopying	2334	1667	8692
Refined petroleum products	8537	6098	296790
Chemicals and chemical products	13604	9717	5324
Plastic products	36607	26148	9595
Structural non-metallic products	49966	35690	33447
Worked Metal products	40466	28904	22383
Machinery and equipment	445	318	311
Electrical equipment and apparatus	248	177	103
Vehicles with engines	8	6	0
Other transport equipment	381	272	205
Furniture	11950	8536	5966
Electrical supplies	3002	2144	48505
Accumulation, purification & distribution of water	6257	4469	10582
<b>Total</b>	<b>548252</b>	<b>391607</b>	<b>638484</b>

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**Table 3: The most important agricultural crops production (ton) (2003-2005).**

Year Crop	2005	2004	2003
<b>Cereal Total production</b>	<b>555422</b>	<b>552891</b>	<b>477419</b>
Wheat	112963	103265	103794
Maize	31108	32410	32841
Sorghum	263691	263428	212780
Millet	66640	66383	40587
Barley	21189	24791	27935
Legumes	59831	62614	59482
<b>Vegetables Total production</b>	<b>882053</b>	<b>833416</b>	<b>833349</b>
Tomatoes	204446	200438	272696
Onions	173112	154140	82025
Potatoes	217759	197958	213324
Sweet-melons	27502	28586	38129
Water-melons	144212	141339	86554
Other Vegetables.	115022	110955	140621
<b>Fodder Total production</b>	<b>1541288</b>	<b>1505204</b>	<b>1432310</b>
Alfafa	223038	255848	241592
Other Fodders	1318250	1249356	1190718
<b>Cash Crops Total production</b>	<b>68961</b>	<b>65978</b>	<b>71289</b>
Cotton	20573	19536	29091
Sesame	19363	19181	18729
Tobacco	17694	17001	11861
Coffee	11331	10260	11608
<b>Total production of Fruits</b>	<b>764790</b>	<b>742408</b>	<b>736216</b>
Dates	29990	28576	33312
Bananas	89905	85555	99010
Grapes	107753	104062	168824
Oranges(Including Mandarine)	97237	82359	191420
Papayas	20588	20735	73751
Mangose	341838	348651	116346
Other Fruits	77479	72470	53553
<b>Qat Total production</b>	<b>121399</b>	<b>118207</b>	<b>103610</b>

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The Yemeni economy is growing steadily, with an average annual rate of growth of the ratio between (3-5) percent at current prices. While the rate calculated with the fixed prices is (2-4) % annually. The average per capita income of GNP in 2005 is (760) dollars.

Yemen's main exports are concentrated in the area of intermediate goods, which represents (95-98) % of the total exports, while the direct consumer goods represent (1-3) %. In contrast, intermediate goods imports accounted for (55-60) % of the total imports. Direct consumer goods are (15-20) %, while capital goods are (20-25) percent.

Yemen imports from Arab countries are (30-40) % of the total imports, while exports to the Arab countries are only (2-6) % of the total exports abroad. The non-Arab Asian countries are the largest market for exports in Yemen which ranged between (80-90) percent of the total exports.

Table (3) summarizes the most important agricultural crops production (ton) (2003-2005). Table (4) summarizes the livestock count for the years 2003-2005 (000). Table (5) summarizes production value and quantity of fish and other aquatic catch (ordinary and industrial fish) by type for 2003 – 2005. Figure (5) illustrates the area of agricultural crops.

**Table 4: Livestock count for the years 2003-2005 (000).**

Years/Item	2005	2004	2003
Sheep	7980	7899	7819
Goats	7864	7785	7707
Cattle(Cows)	1447	1433	1418
Camels	357	353	350

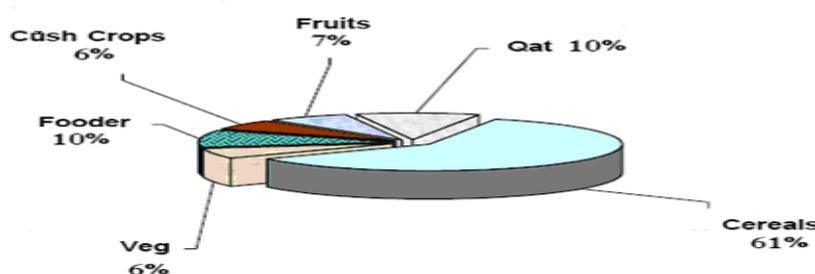
Source: DAS of Ministry of Agr. and Irrigation.

**Table 5: Production value and quantity of fish and other aquatic catch (ordinary and industrial fish) by type for 2003-2005.**

Sector Years	2005		2004		2003	
	Value	Quantity	Value	Quantity	Value	Quantity
Surface Fish	44117.7	216263	36747.6	228246	27777.8	202758
Deep Water Fish	178.7	1547	276.1	2447	1146	10911
Other Aquatic Catch	6654.2	21035	7527.7	25673	9582.8	14447
<b>Total</b>	<b>50950.6</b>	<b>238845.0</b>	<b>44551.4</b>	<b>256366.0</b>	<b>38506.6</b>	<b>228116.0</b>

Quantity (Tons) - Value (million rials)

**Figure 6: The percentage of area of agricultural crops, 2005.**





### **3. Assessment of POPs issues in Yemen**

#### **3.1. Legal Tools Of Chemicals Management**

Yemen is one of the poorest countries on earth although it has so many resources. It has more than 2000 km of sea shore from which fish and other sea wealth can be cropped. It has some oil and natural gas. It has many mineral resources. The sun is shining on Yemen almost all year round. Although in some areas, especially the Capital Sana'a, water is scarce many arable land valleys and broad fields are scattered all around Yemen and that is why Yemen is called Arabia Felix. The population is around 20 million and is increasing rapidly and is expected to double in 23 years. This is creating a burden on the available natural resources. In the absence of strict environmental legislation, development and economic growth will cause adverse impacts on the local environment with respect to water, land and air-pollution and consequentially the health and wellbeing of the citizens. The same is true with regard to lack of proper planning, absence of comprehensive environmental regulations, monitoring and management systems.

In reviewing the existing laws, regulations and acts in Yemen it can be concluded that the concept of POPs has not been incorporated directly. However, some regulations that have indirect effects are presented.

More sustainable developments could be achieved in Yemen, if the natural wealth of the country is administered wisely. Moreover, the following points should be taken seriously:

- Harnessing renewable sources when their economics are attractive and increasing efficiency of resource use. This requires raising public-awareness and encouraging-public participation in decision-making.
- Adopting more efficient energy-thrift and environmental-protection policies by integrating environmental, social, and economic goals in the development, planning and implementation stages of all state and private projects.
- Most important is that the government should make sure that subsidies reach those truly most in need, or where they are most desirable, for achieving a sustainable economy.

##### **3.1.1. Laws Concerning pesticides**

Yemen has issued a number of legislations in the area of regulation of pesticides. These bylaws are summarized below:

- 1) Law No. (25) for the year 1999 on the regulation of plant pesticides:

The law consists of seven chapters and the objectives of the Act aims at the following:

- Establish the organization of the circulation of plant pesticides.
- Establish procedures for the registration and regulation, oversight and inspection of plant pesticides.
- Avoid the risks of pesticides and their toxic effects on human and animal health, the environment and protection of natural enemies and beneficial economic insects.

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- 2) Ministerial Resolution No. (73) for the year 2001 to set up a committee to register plant pesticides.
- 3) Ministerial Resolution No. (8) for the year 2002 for adding two members to the plant pesticides registration committee: the first from the Yemen Society for Consumer Protection and the other from the Yemeni Society of Agricultural Traders Inputs.
- 4) Ministerial Resolution No. (10) for the year 2002 Regulation Executive Law 16/2002.
- 5) The procedures manual for registration and circulation of plant pesticides in August 2002.
- 6) Ministerial Resolution No. (18) 2002 of 30 April 2002 delegating the offices of agriculture and irrigation departments to supervise, control and inspection of all those who operate in the circulation of pesticides; each in his governorate.

### **3.1.2. Laws Concerning the Management of Chemicals**

Table No. 6 summarizes a list of the laws and stakeholders responsible for applying the provisions of those laws and the type of chemical concerning each of them. This table contains the individual laws of articles and legal texts relating to the departments of chemical items of the relevant bodies.

It can be recalled here that the Yemeni legislations focused on the preservation of the environment from the risks of chemicals. It is a proof that the amended Yemeni Constitution, which is the highest echelon of the legislation, has given the environment special texts. It is a characteristic of Yemeni legislation compared to other States.

The legislative framework for the management of chemical residues in Yemen includes:

- The national legislations.
- The international treaties and conventions signed by the Yemeni government.

### **3.1.3. Basic National Legislative Tools Concerning Chemicals**

The national legislations that touched the management of chemicals and environment include the following:

- 1) The Constitution of the Republic of Yemen Amended Articles (No. 32 and 35) considered the preservation of the safety and health of the environment and making it safe is the responsibility of the State and society since what affects the environment is a threat to everyone.
- 2) Environmental Protection Act No. 26 of 1995 and its implementing regulations covers almost all the elements required for the management of chemicals. The executive regulations contained a list of the hazardous wastes in light of the law: materials (No. 3, 10, 19, 44, 56, 62, 63 and 65).

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- 3) Law of the offences and penalties No. 12 of 1994 considered dealing with the chemicals illegally an offence punishable by law (Article No. 140) and entrusted the implementation to the Attorney General through the provision of public prosecutions.
- 4) Act No. 5 of 1995 as amended by Act No. 25 of 1997, articles (No. 113, 114, 115, 116, 117 and 118) gave the right to the Ministry of Labor, Inspection Department, to conduct surveillance and inspection of industrial and service installations where workers exist, to ensure the installations commitment to occupational health and safety and to ensure that the workers are safe from injury with hazardous materials.
- 5) Health Professions Practitioner Act, articles No. 32 of 1992, singled out in the articles (No. 12, 16 and 17) restrictions and special requirements for practitioners of health and the prohibition of the sale of any expired medicines or preparations and entrusted the responsibility of implementation to the Ministry of Public Health.
- 6) Shipping Act No. 15 of 1994 singled out in the articles (No. 224 / 2, 226 / 2, 228 / 1 and 425) the prevention of the shipment of prohibited goods unless permitted circulation in the framework of the laws in force in Yemen. The law did not require chemicals only, even allowed goods as long as they are contaminated and gave examples such as cars, and entrusted the implementation to the Ministry of Transport.
- 7) Act No. 37 of the customs tariff of 1997 to be applied by the Ministry of Finance, Customs Department. In chapters twenty-ninth, thirty-first and thirty: inventory of chemicals permitted circulation in Yemen in the light of the laws governing the importation.
- 8) Act No. 42 of 1991 on the regulation of fishing and the exploitation and protection of aquatic life. Materials (22 and 23) have touched the prevention of the use of offshore as dumping grounds for residues of toxins and chemicals in order to preserve the integrity of the marine environment, and entrusted the implementation to the Ministry of Fisheries.
- 9) Act No. 50 of 1990 on the mines and quarries. The Yemeni legislator was keen to find constraints of the disclosure and prospecting, as well as investors or exploiters of quarries raw materials. Among such restrictions that they must obtain a permit and prior approval from the competent authority for those who want to work in mines or quarries, as well as contracting with the competent authority. The conditions included in articles (50, 52 and 53) to empower staff of the commissioners in writing of the right of inspection and monitoring to ensure application of regulations of occupational health and safety and other means of surveillance, other investigative processes, the places of detection and the search for minerals and quarry raw materials.
- 10) Act No. 24 of 1993 on the free zones with the privileges and guarantees granted to the goods imported to the free zone and to all projects operating in the free zone. However, the health and safety of human beings is the fulcrum of development as well as to preserve the integrity of the environment and the protection of society from polluting substances, banned chemicals and damaged goods. Therefore, articles (No. 9 and 10) stressed, as well as Article No. (27) of the Act, the prevention of the importation and circulation of damaged, stench and corrupt goods and waste materials harmful to the

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environment and not suitable to human and livestock consumption, as well as any actions or activities in contrary to the instructions on the protection of the environment.

- 11) Act No. 39 of 1999 on the law of public hygiene. A number of articles were included that would ensure the protection of the environment, the health of the community and the disposal of residues, wastes, toxic substances and chemicals. Penalties were imposed in case of breaking the law; those articles are (3, 4, 5, 8, 9, 10, 11, 12, 18, 19 and 31) of the code of hygiene.
- 12) Act No. 1 of 1992 on foreign trade, as amended by Act No. 16 of 1996, ban on the importation of foodstuffs that are contrary to the approved specifications by articles (3, 5 and 6), entrusted to the Ministry of Industry and Trade.
- 13) Act No. 38 of 1992 on the control and regulation of food circulation, authorized jurisdiction of the Ministry of Housing and Urban Planning the right to take the necessary action to punish those found violating the acquisition of foodstuffs detected through laboratory testing that they harm the health of human being. The law grants the inspectors of the ministry right of the justice and the power of seizure in Articles (7, 8, 12, 19 and 20).
- 14) Act No. 33 of 2003 on road transport, authorized the Ministry of Transport and Maritime Affairs the right to prohibit the transfer of any property or goods that can cause environmental damage, affect the safety of passengers or the environment in general, whether chemicals or toxic substances in the articles (8, 27 and 31).
- 15) Act No. 20 of 1999 on the establishment of cleanliness funds and improve the shapes of the cities, authorized the Department of Housing and Urban Planning and its offices in the capitals of provinces and cities and the Capital to prevent whatever can effect the environment of remnants of any sort, in the articles (3 and 5).
- 16) Act No. 24 of 1990 as amended by Act No. 35 of 1997 on supply, authorized the Ministry of Industry and Trade the right to control and confiscate corrupt goods and materials containing conservative chemicals that have an impact on human health, in the articles (4, 15, 16 and 21).
- 17) Act No. 3 of 1993 on combating trafficking and illicit use of narcotic drugs and psychotropic substances authorized the Ministry of Industry and the Ministry of Agriculture the right to protect the community from harms and the risks of chemicals, drugs and all psychotropic substances, through the organization of entry of materials allowed to the country and to prevent and to punish violators. The law included six tables that organized the materials to be allowed entry and circulation in the country, according to the requirements and licensing authorized to the two ministries in the articles (No. 8, 9, 10, 11, 12, 13, 27, 33 and 34).
- 18) Law No. 25 of 1999 on the regulation of plant pesticides; the competent authority is the Ministry of Agriculture and Irrigation and tasked beside customs outlets, the Ministry of Industry and Commerce and members of the security, armed forces and mail, each in his place of work, on the country's border inlets, in order to prevent any scourge of plants, eliminating control or eradicated through expulsion or through the organization

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of the circulation and trafficking of pesticides, and how to import and export in a known and organized way because of the risk to human, animal and environmental health and safety and all the implications of articles (3, 4, 5, 6, 7, 8, 11, 12, 14, 15, 16, 21, 22, 24, 25, 27 and 28).

- 19) Regulation Law No. 25 of 1999 on the regulation of pesticides circulation, traffic and trade, entrusted to the Ministry of Agriculture and Irrigation, to organize the legitimate trafficking and trade of pesticides for allowing entry to the impermissibility of any person trafficking unless holds a license from the Ministry of Agriculture. This is not only necessary but required informed consent of the ministry, the type and quantity of insecticide and to be registered in the records of the Ministry. It stressed the application of the sanctions specified in the law about dissent, and earmarked specifically not allow entry of any pesticides through Sana'a International Airport; articles (3, 4, 5, 6, 7, 8, 9, 10, 13, 14, 15, 16, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 32, 33, 34 and 35).
- 20) Decree No. 12 of 1995 on the Regulation of the Ministry of Housing, Construction and Urban Planning. The competent authority is the Ministry of Housing, Construction and Urban Planning. The regulations texts included the responsibility of the Ministry to preserve the environmental integrity from any influences whether resulting from the remnants of human, animal or the product of the construction of industries, reconstruction or infrastructure. The articles of the regulation (2, 9, 21 and 22) outlined the responsibility of the Ministry in the reduction, the preparation of studies and planning of potential sites for reconstruction of urban areas.
- 21) Act No. 4 of 2000, articles (2, 4, 61 and 16) on the local authority, the jurisdiction of the Ministry of Local Administration, mandated by law the right to supervise the implementation of environmental legislations, by local authorities throughout the administrative units in the Republic of Yemen, which would surround the danger and eliminate it upon inception in any administrative unit.
- 22) Decree No. 269 of 2000; articles (7 / 11, 12, 18, 20, 6-8, 9 and 10) on the executive statute of the local authority. The competent authority is the Ministry of Local Administration and the administrative units in the governorates and districts. The texts of the Regulation conveyed wide powers to the local authority to take all necessary measures to preserve the integrity of the environment and the proper control of utilization of fisheries and watersheds. It should discuss and prepare the environmental plans at the level of Boards of the Provinces and bring it to the power centers.
- 23) Act No. 33 of 2002 (Articles 2, 3, 7, 8, 10, 11, 12, 17, 21, 22, 27, 35 and 38) on the water. The competence authorities are the General Authority for Water Resources and other entities, such as The Ministry of Agriculture and the General Authority for Environment Protection. It aims to regulate the development and rational use of water resources and protection from depletion, pollution and upgrading the transfer, distribution and use, in addition to good maintenance and operation of facilities and planning of water resources, and the dividing the Republic into the water basins, as well as the granting of licenses to dig wells, determine their depth and provide support and facilities to farmers, the construction of dams and water barriers, the fight against

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desertification, the protection from flooding, carry out research and coordination with other relevant agencies. The law also gives the authority officials acknowledged the right of judicial seizure, penalties to violators and the users of water for other unspecified purposes.

***3.1.4. International Treaties and Conventions Signed by the Government of Yemen***

- 1) Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and their Disposal as ratified by Act No. 32 of 1995.
- 2) Vienna Convention for 85 for the Protection of the Ozone Layer and the Montreal Protocol on Substances of 87 concerning the chlorofluorocarbon pollutants that deplete the ozone layer.
- 3) Convention on Climate Change ratified by Act No. 30 of 1995.
- 4) Convention on Biological Diversity ratified by Act No. 31 of 1995.
- 5) Convention on Psychotropic Substances of 1971, ratified by Act No. 176 of 1995.
- 6) United Nations Convention against Illicit Traffic in Narcotic Drugs and Psychotropic Substances, ratified by Act No. 177 of 1995.
- 7) Single Convention on Narcotic Drugs of 1961 as amended by the Protocol signed in 1972, and ratified by Act No. 178.
- 8) Stockholm Convention on POPs ratified on 5 / 12 / 2001.
- 9) Rotterdam Convention on the Application of the Prior Informed Procedure Consent for Chemicals and Certain Hazardous Pesticides Circulating in International Trade. Ratification is under process. SALIM?????

***3.1.5. POPs Legal and regulatory bylaws in Yemen***

Although there are various legislations that are linked or related to chemical materials these legislation handled chemical material generally and without specifying the POPs. In addition these legislation do not cover all the stages of the handling of chemical materials, according to POPs which ban the handling of most of POPs mentioned according to Stockholm Convention.

Lack of existence of legislation and lack of their effectiveness to the required form could be attributed to many reasons, including the following:

1. Lack of a unique legislation which cover chemical materials; specifically the inexistence of a bylaw special to persistent organic material.
2. Shortage of professional staff to conduct tasks given to them which has relation to POPs.
3. Lack of coordination between a variety of parties that do the monitoring which resulted in wasted efforts without achieving the purpose of the targeted aim.
4. Involve concerned effective parties working on monitoring and execution of legislations.
5. Allow the required flexibility in the analysis instead of following the script strictly.

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**Table 6: A list of the laws responsible for applying the provisions of chemicals.**

	<b>Legislative instrument (Type, Ref., Year)</b>	<b>Ministries or agencies responsible</b>	<b>Chemical use, items covered</b>	<b>The aim of legislation</b>	<b>Related Materials/ Provisions</b>
1	<b>Constitution of the Republic of Yemen 2001</b>	State and society		To protect the society from all that harms the health and pollutes the environment by cooperation between the State and society	Articles (32) and (35) of the Constitution
2	<b>Crimes and penalties Act No. 12 of 1994</b>	Attorney General	Toxic materials, or putting people in poisonous jeopardy or harmful Status in the territorial waters or ports, or a tank of water or anything else	To protect the lives of people and preserve the public health, which may endanger their lives, injury or death by deterring any obstacle that may endanger people's lives, safety and simply danger by imprisonment for a term not exceeding ten years,	Article (140) of the Crimes and Penalties Act
3	<b>Labor Act No. 25 of 1997 as amended by Act No. 5 of 1995</b>	Ministry of Labor	Department of Public Health and Occupational Safety	In the workplace and all pollutants to ensure the health and safety of workers during work, as well as to ensure public health and safety	Materials (113, 114, 115, 116, 117 and 118) of the Labor Act
4	<b>Law on health professions practitioner No. 32 of 1992</b>	Ministry of Public Health and Population	Restrictions on engaging of the health professions practitioner in the use of materials, equipment and medical supplies except in accordance with the conditions set forth by the regulation issued, as well as deprive the sale of medicines or medical preparations after the expiry of the use	Concern for the safety and health of patients, as well as health professionals and through the requirements established in the building of health and patient rooms, as well as quality supplies, medical supplies and outlaw the sale of expired medicines	Materials (12, 16 and 17) of the Code of engaging in the health professions
5	<b>Maritime Law No. 15 of 1994</b>	Ministry of Transport	Not ship prohibited cargo in accordance with the laws in force	To protect the environment and the share of the individuals of the community of any contaminated goods whether baggage, machines, cars or others	Materials (No. 224 / 2, 226 / 2, 228 / 2, 425) of the Maritime Law
6	<b>Harmonized customs tariff law No. 37 of 1997</b>	Ministry of Finance (Customs)	The twenty-ninth chapter of the Law No. 37 of 1997 on customs tariff addressed the Standards and items which may be used and set the quality of organic chemical materials imported. Chapter thirty dealt with the pharmaceutical products and chapter thirty one dealt with all fertilizers as explained in the attached tables	The legislator has two aims from the many qualities and quantities mentioned; the first objective is the qualities that may be imported organized according to their special legislations and the second aim is the custom tariff for each type.	Chapters 29, 30 and 31 of the customs tariff law
7	<b>Act No. 42 of 1991 Regulation of Fishing, Exploitation and Protection of Aquatic Life</b>	Ministry of Fisheries	Protection of aquatic life from disposal of pollutants, poisons and chemicals	To protect aquatic life from any harm, cause of destruction or killing due to waste disposal, toxic substances or chemical materials in the sea or ocean water	Materials (22 and 23) of Act No. 42 of 1991. Regulation of Fishing, Exploitation and Protection of

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	<b>Legislative instrument (Type, Ref., Year)</b>	<b>Ministries or agencies responsible</b>	<b>Chemical use, items covered</b>	<b>The aim of legislation</b>	<b>Related Materials/ Provisions</b>
					Aquatic Life
8	<b>Act No. 50 of 1991 on the mines and quarries</b>	Ministry of Oil and Mineral Resources	It did not indicate the materials allowable use and exploration, however, in summary, decided to ban the use of any material harmful to health and public safety, particularly to ensure the health and safety of workers in mines	Maintain the health and safety of workers at the mines and quarries as well as ensure the protection of the environment and society from any risks that arise from the exploration and manufacturing.	Materials (50, 52 and 53) of the Law of Mines and Quarries
9	<b>Act No. 4 of 1993 on the Free Zones</b>	General Authority for Free Zones	Prohibit the introduction and circulation of corrupt goods, rotten, radioactive substances, drugs, waste and material harmful to environment and not suitable for the human and animal consumption	The free zones are considered the world product market, hence the Yemeni legislator has created restrictions to protect the environment and human beings in the free zones and the outside from all harmful compounds and products	Materials (9, 10 / d, 27) of the Act of Free Zones
10	<b>Law No. 1 of 1992 on Foreign Trade, as amended by Act No. 16 of 1996</b>	Ministry of Supply and Trade	Ban on the importation of foodstuffs that are contrary to the approved specifications and all exports and imports are subject to the supervision of the Ministry	Ban damaged foodstuffs exported from foreign countries, as well as ensure the safety of the exported goods to maintain the reputation of the Yemeni national product	Materials (3, 5 and 7) of the Foreign Trade Law
11	<b>Law No. 26 of 1995 on Environmental Protection</b>	General Authority for Environmental Protection (previously Environmental Protection Council)	Non-use of any pesticides without a license. The stores and shops selling pesticides should be away from the residential areas as well as the ban on the circulation of toxic materials and hazardous wastes without a license.	Protection of environmental components; cosmic and human; from contaminating materials and toxic chemicals that may cause risk or harm to living organisms and human beings in the geographical surroundings	Articles (3, 15, 19, 44, 56, 62, 63 and 65) of Environmental Protection Act
12	<b>Law No. 38 Year 1992 on the Control of Food Circulation and Handling</b>	Ministry of Housing and Urban Planning	The procuring competent have the right to take action according to law against any food or diet proves harmful to human consumption through laboratory screening	The ministry is entrusted the right of inspection and control of all goods and items used in the consumption of food and the right to undergo laboratory tests and take the necessary legal actions	Materials (7, 8, 12, 19 and 20) of the Act on the Control of Food Circulation and Handling
13	<b>Law No. 33 Year 2003 on Road Transport</b>	Ministry of Transport and Maritime Affairs	May not transfer baggage or unlicensed cargo, bears responsibility for any damage to the carrier in inflicted psychology or health and also what cause the contamination of the environment and harm to public health	To protect traveling passengers from any damage caused by the carrier such as having a quantity of poisons or chemicals, leaking and affecting the health of passengers or that contravenes Article No. (8) of the Code of Road Transport, which requires compliance with traffic law and the law of weights and the technical specifications of means of transportation. This help protect the environment and the public from pollutants resulting from the fuel used such as diesel etc.	Articles (8, 27 and 31) of the Road Transport Act

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	<b>Legislative instrument (Type, Ref., Year)</b>	<b>Ministries or agencies responsible</b>	<b>Chemical use, items covered</b>	<b>The aim of legislation</b>	<b>Related Materials/ Provisions</b>
14	<b>Law No. 39 of 1999 on the Law of the Hygiene</b>		Disposal of waste in cities as well as the work necessary to get rid of the waste, which is believed poisonous or chemical such as remnants of hospitals, laboratories, pharmacies and factories	Protect the environment and health of the community and not damage them and the realization of the principle of decentralization in hygiene in order to organize jurisdiction and thereby eliminate polluting and harmful substances and to take all necessary measures to avoid what may be detrimental to the environment and health of the community such as disposal of residues and the planting of trees and to oblige the owners of the chemical, therapeutic and industrial residues to do the required work in their transmission, burial and disposal.	Materials (3, 4, 5, 8, 9, 10, 11, 12, 18, 19 and 31) of the Code of Hygiene
15	<b>Law No. 20 of 1999 on the Establishment of Funds Cleaner and Better Cities</b>	Ministry of Construction and Urban Planning, and the Capital	All that may cause pollution of the environment from types of waste	financing cleaner and improved urban beautification	Materials (3 and 5) of the Fund Act to Improve Cleanliness and Cities
16	<b>Law No. 24 of 1990 as amended by Law No. 35 Year 1997 on Supply</b>	Ministry of Supply and Trade	Each damaged or corrupt commodity and unfit for human consumption	To protect consumers from bad food, harmful to health, especially obsolete, because of the interaction of preserving chemicals with materials and its impact on human health	Materials (4, 15, 16 and 21) of the Supply Law
17	<b>Law No. 3 of 1993 on Combating Trafficking and Illicit Use of Narcotic Drugs and Psychotropic Substances</b>	Ministry of Public Health, Yemen Company for Manufacturing and Trade of Medicines, National Foundation of Medicines, Ministry of Agriculture	The items seen in the six tables according to the law	To protect society from harm and risks of chemicals, drugs and all psychotropic substances	Tables (1, 2, 3, 4, 5 and 6) Materials (8, 9, 10, 11, 12, 13, 27, 33 and 34) of the Law on Fight Against Drugs
18	<b>Law No. 25 Year 1999 on the Regulation of plant pesticide</b>	Ministry of Agriculture and Irrigation	Prevention of plant pests, elimination or control through the destruction or expulsion	Organization of the circulation of plant pesticides. Arranging registration, control and inspection of plant pesticide, as well as the risks of pesticides to plant and toxic effects on human and animal health, the environment and nature, and protection of economic beneficial insects. The law assigned to all the competent authorities, such as customs, security and the armed forces cooperation in law enforcement each in his respect	Articles (3, 4, 5, 6, 7, 8, 11, 12, 14, 15, 16, 21, 22, 14, 25, 27 and 28) Regulation of plant pesticides
19	<b>Act No. 25 of 1999 on the Handling of Pesticides</b>	Ministry of Agriculture and Irrigation	Prevention of plant pests, elimination or control through the destruction or expulsion	Organization of the circulation of plant pesticide. Arranging registration, control and inspection of plant pesticide, as well as the risks of pesticides to plant and toxic effects on human and	Articles (3, 4, 5, 6, 7, 8, 9, 10, 13, 14, 15, 16, 21, 22, 13,

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	<b>Legislative instrument (Type, Ref., Year)</b>	<b>Ministries or agencies responsible</b>	<b>Chemical use, items covered</b>	<b>The aim of legislation</b>	<b>Related Materials/ Provisions</b>
				animal health, the environment and nature, protection of economic beneficial insects. The law assigned to all the competent authorities, such as customs, security and the armed forces cooperation in law enforcement each in his respect	14, 15, 16, 17, 28, 29, 30, 32, 33, 24 and 35)
20	<b>Decree No. 12 of 95 on the Regulation of Construction, Housing and Urban Planning</b>	Ministry of Construction, Housing, Urban Planning and Development	Designs to maintain the environment of all kinds	To maintain the environmental integrity of any flew that would affect it, whether the result of the industry or the remnants of human and animal. Preparation of studies and research in this aspect, especially in the area of reconstruction, city planning and the creation of infrastructure.	Articles (2, 9, 21 and 22)
21	<b>Law No. 4 of 2000 on Local Authority</b>	Ministry of Local Administration	All types of chemicals with environmental impact and all that have impact on the environment	To maintain the integrity of the normal environmental situation through the local authority throughout the republic so as to eliminate the danger level at the administrative unit and directorate	Articles (2, 4, 6 and 16)
22	<b>Decree No. 269 of 2000 on the Execution of the Local Authority</b>	Ministry of Local Administration and administrative units in governorates and districts	To supervise the implementation of policies and environmental legislations	To oversee the implementation of environmental legislations and to take measures to preserve sound environment, as well as good control of the exploitation of fish stocks and protection of watersheds, discuss and approve plans on the level of environmental preservation and informing the central authority	Articles (6, 7,8, 9, 10, 11, 12, 18 and 20)
23	<b>of Law No. 33 of 2002 on the Waters</b>	General Authority for Water Resources and other relevant agencies	Aimed at regulating the management of water	Development and rational use of water, natural resource must be preserved and prevent tampering by the use of optimum utilization through installations, organization and working, to support farmers	Articles (2 3, 7, 8, 10, 11, 12, 21, 22, 24, 25 and 38)



In conclusion, researcher must be aware of the Yemeni legislations' richness in legal texts. However, the problem lies in the enforcement of these bylaws.

Through the number of 23 legislations; bylaws and regulations, all designed to create a clean environment, to enjoy a balanced safe life, for every living creature existing on the ground. There is no doubt; there have been some shortcomings as a modern institution is caring for the environment represented in the General Authority for Environmental Protection.

The date of the adoption of the Republic of Yemen and its concerns in these areas started since 1995, while the world has made great strides, and others almost reached perfection in this area, through monitoring data and statistics of residues of human positive and negative interaction with the surroundings. This is in addition to evaluating the policy of the responsible departments that deal mostly with the environmental effects: Ministries of Industry, Trade, Planning and International Cooperation, Public Works and Roads, Health and Population, Agriculture and Irrigation, etc. of the relevant authorities.

These actors are in need from time to time to assess the extent of the application of the provisions of legislations, their usefulness, and the obstacles which transmit application, the deficiencies and modernize the legislations to prevent duplication. The practice and conduct of the authorities and their functions to provide services to the public is another problem that needs to be addressed.

Legislation provides for the need to maintain the birds, air, tree and all natural resources in sea and land, particularly endangered species.



### 3.2. POPs Management, monitoring and control in Yemen

Ministries, Authorities and Institutions Concerned with the Management of Chemicals are:

a) Ministry of Water and Environment and its Organizations

The following authorities are affiliated to the Ministry of Water and Environment:

- General Authority for Environmental Protection
- General Authority for Water Resources
- General Authority for Water and Sewerage
- General Authority for Rural Water Projects
- Local Authorities for Water and Sanitation.

b) Ministry of Finance (Customs Directorate)

All chemical materials enter to major outlets across the country under the supervision of customs, which possesses a technical team in all outlets using the classification of international trade.

c) Ministry of Social Affairs and Labor

General Directorate for Occupational Health and Safety is practicing the management of chemicals through labor law and legislations of occupational health and safety.

Functions and terms of reference were mentioned in the interior regulations of the Ministry of Labor and Vocational Training (No. 82) for 1999. Chapters III and IV included the special part for the work of juvenile and women in paragraphs related to chemicals.

d) Ministry of Public Works and Roads

Proceeding from the role of the Ministry of Public Works and Roads in the functions of environmental sanitation, and what health and environmental mean in disease and environmental pollution control, the Ministry has been keen to provide all distinguished services in the area of environmental sanitation at the level of the Capital and all governorates of the Republic.

e) Ministry of Agriculture and Irrigation

Ministry of Agriculture and Irrigation controls the imported plant pesticides, agricultural fertilizers and veterinary medicines. Agricultural plant pesticides are subject to the conditions outlined in the executive Law No. 25 of 1999 on the regulations of circulation of plant pesticides.

Table (5-11) summarizes the responsibilities of government ministries, agencies and institutions dealing with the different POPs materials.

**Table 7: Responsibilities of government ministries, agencies and institutions dealing with the different POPs materials.**

	Import	Production	Storage	Transport	Distribution	Use	Disposal	Control
General Authority for Environmental Protection							*	*
Ministry of Public Health and Population	*		*	*		*	*	
Ministry of Agriculture and Irrigation	*		*	*		*	*	*



Ministry of Labor								*
Customs							*	*
Ministry of Trade and Industry			*	*	*	*		
Ministry of Electricity	*		*	*	*	*	*	
Ministry of Interior (Civil Defense)								*

The following points have to be considered:

- There is a lot of overlap in the work of the relevant bodies with respect to the management of chemicals other than pesticides, where there is a clear mechanism, list and cooperation between the governmental authorities concerned in the importation and disposal of damaged pesticides.
- There is no clear mechanism for public health pesticides, which raises many problems between importers and stakeholders.
- Role of the Ministry of Health includes the registration, import, licensing and use of medicines and some chemicals (such as some acids and artificial flavors, in a limited number).
- Environmental health and occupational health are non-existent in the Ministry of Health but affiliated to other ministries and thereby their functions overlap with the functions of the Ministry of Health and Population.
- Regulations and penalties for laws abusers of chemicals are not clear except for pesticides.
- Bylaws and regulations on chemicals need to be adjusted and given more attention according to the local and international State's commitments, through the admission of the State in many international conventions.
- Weak rehabilitation and training for workers in all quarters concerned in this area.
- Awareness programs are not clear in this area.
- There are no contingency plans for hazardous materials incidents.

### ***3.2.3. The Activities of Non-Governmental Actors in the Management of Chemicals***

The non-governmental actors in the field of management of chemicals are:

#### a) The Yemeni Consumer Protection Society

Main activities relating to management of chemicals of the Society is follow-up and monitoring of cases of environmental pollution or damage arising from the misuse of chemicals, whether these chemicals are used directly or added to food, medicines or food crops.

#### b) National Society to Combat the Damage of Qat

In terms of activities related to the management of chemicals, they are confined to the compilation of information on the chemistry of qat and the chemistry of pesticides used in its treatment, for the purpose of dissemination and use in raising awareness and facilitating its delivery to researchers. The main interest of the Society is awareness of the general public to the dangers of pesticides used in qat through awareness campaigns and national programs to raise awareness of damage caused by qat conducted by the Society.



c) Commercial and Industrial Chamber (the Capital Sana'a)

In terms of activities related to the management of chemicals, it has been spreading awareness in the commercial center about the risks of industrial chemicals to the individual and the society in general, as well as the search for specialized industrial zones in order to curb the waste and industrial hazards to the environment so as to make it easier to control.

d) Yemeni Industrialists Society

The most important activities related to chemicals management is the management of food safety, plastic materials and their role in the pollution of the environment, finding solutions and alternatives in addition to the environmental awareness about the appropriate methods of dealing with these substances.

**Table 8: The activity and the experiences of organizations and their relationship to the management of chemicals.**

Organization and the area of expertise	Universities	Environmental associations and consumers	Chambers industrial	Specialized associations	Unions
Compile data	Yes a	Yes b	Yes c	Yes d	
Test chemicals	Yes a	No	no	no	
Risk assessment	Yes a	Yes b	No	Yes d	
Analysis of strategic policy	No	No	No	No	
Training and education	Yes a	Yes b	No	Yes d	
Search for alternatives	Yes a	Yes b	No	Yes d	
Control	Yes a	Yes b	Yes c	Yes d	
Implementation and application	Yes a	Yes b	No	Yes d	
Educate workers	Yes a	Yes b	No	Yes d	
Public awareness	Yes a	Yes b	Yes c	Yes d	
Other					

Notes:

- (<sup>a</sup>) Related to the management of chemicals within the interests of the organization, scientific and awareness goals.
- (<sup>b</sup>) Related to the management of chemicals through guidance and awareness.
- (<sup>c</sup>) Related to the management of chemicals through the actions and projects, which serve the interests of members?
- (<sup>d</sup>) Related to the management of chemicals through the work and projects that serve the management of chemicals.

The following points are to be considered in this issue:

- Role of the government in raising awareness of citizens is very limited, especially in the area of chemicals.
- There are no clear mechanisms and cooperation among peoples, government and the few existing research centers in the State in the field of chemicals.
- There are clear gaps with regard to references containing information and the problem of its availability in a permanent and non-arrival of most of organizations to them.



- Weak coordination between governmental authorities and non-governmental organizations with respect to chemicals.
- There is no real impact assessment of the effects of chemicals.
- There are no databases in the various government and popular bodies and if available are very limited and within the same institution or ministry.

### ***3.2.6. The Infrastructure of the Central Laboratory for Analysis and Registration of Pesticides (Ministry of Agriculture and Irrigation)***

Establishment and operation of the Central Laboratory for Analysis and Registration of Pesticides, which is responsible for the quality control and conformity to standard specifications adopted by the FAO and WHO. It started the implementation of its work in October 1993 in cooperation with the German GTZ Organization with a cost of 650.000 dollars. It became easy to control the movement of pesticides that are entering the country through official import, so as not to release any shipment from the port of entry before the analysis of random samples taken from the port of entry and the certificate of analysis granted to demonstrate compliance with the specifications. In the case of non-compliance with specifications the pesticides will be returned to the country of origin

This laboratory is one of the international laboratories which are subject to periodic control, every two years, to assess the performance of professionals and the commitment to the methods of analysis commonly referred to. The laboratory has acquired the ranks 11 and 9 in 1996 and 1998, respectively among 45 global laboratories that participated in the Analytical Quality Assurance (AQA).

Number of samples analyzed since the laboratory started operation until 13 / 6 / 2003 amounted to (2300) samples. Table (9-2) lists the major equipment available in the Central Laboratory for Analysis and Registration of Pesticides (Ministry of Agriculture).

**Table 9: The major equipment available in the Central Laboratory for Analysis and Registration of Pesticides (Ministry of Agriculture).**

<b>Laboratory and location</b>	<b>Equipment available</b>	<b>Aim of lab</b>	<b>Number of workers</b>	<b>How to obtain information</b>	<b>Cooperation and coordination</b>
<b>Ministry of Agriculture and Irrigation, Public Administration for Plant Protection (Sana'a)</b>	1. Gas Chromatography	To ensure conformity to specifications of pesticides	8	Reference approved by the scientific and progress of the companies files for analysis	Governmental and non-governmental sectors
	2. HPLC (1)				
	3. Spectrophotometer (1)				
	4. Viscosity meter				
	5. Flash Point (1)				
	6. Oven (3)				
	7. PH-meter (1)				
	8. Fume hood (2)				
	9. Analytical balance (3)				
	10. Centrifuge (3)				
	11. Refrigerator 1				

There are several problems that need to be noted:

1. There are a lot of laboratories that have the potential of devices capable of dealing with chemicals effectively; as seen in the laboratories of the Ministry of Agriculture and the Ministry of Health. Some laboratories are in need of



maintenance and rehabilitation of employees in addition to operating expenses and the provision of consumable items such as the different reagents and glassware according to their need.

2. The presence of lots of equipment that are not operating properly due poor maintenance. The maintenance engineers in laboratories must be highly trained and qualified.
3. The laboratories need confirmatory analysis between them in order to obtain certificates of recognition and the need for reference laboratories, for example, in the areas of water, environment and chemicals. They need to intensify the weak coordination between laboratories.

### 3.2.9. International Linkages

#### 3.2.9.1. International Linkages

Yemen is keen to join the international conventions on chemicals and to participate in the international forums for chemical materials. The following tables illustrate that. Table 10-1 shows the membership in the programs and the international organizations. The 10-2 summarizes the participation in international conventions and the procedures for the management of chemicals.

**Table 10: The membership in the programs and the international organizations.**

<b>International Organization / procuring Activity</b>	<b>Joint National Contact Point (Ministry / body)</b>	<b>Relevant national and other ministries / bodies</b>	<b>Relevant national activities</b>
<b>International Forum on Chemical Safety IFCS</b>	The General Authority for Environmental Protection Brother / Salim Abdullah Baguhaizel)	Relevant bodies	
<b>UNEP, Cleaner production</b>	General Authority for Environmental Protection Brother / Mohammed Ahmed Ali	General Authority for Environmental Protection	A national preparatory committee for the establishment of the center has held several meetings to draw up the statute of the center.
<b>WHO, World Health Organization, Dr. Hashim Ali Al-Zain</b>	General Authority for Environmental Protection Brother / Ahmed Salim Melgat	Other relevant agencies	Support and training in the area of laboratory
<b>UNIDO</b>	Ministry of Trade and Supply		
<b>World Bank (regional bank for development)</b>			
<b>FAO, Food and Agriculture Organization, Mr. Hashim Al-Shami</b>	The Ministry of Agriculture and Irrigation, Mr. Mohammed Al-Ansi, Director of Projects		

The following points have to be considered:

1. Yemen is keen to join the international conventions on chemicals and participate in international forums for chemicals.



2. There is no effective coordination at the national level between local government institutions, donors and international organizations with regard to chemicals.
3. Weak coordination between local institutions and international organizations with regard to the importation of chemicals required in the analysis and examination, assistance in the disposal of obsolete chemicals and the isolation of agreements items in limited programs.
4. Lack of good links between local institutions associated with the environmental aspects, due to the lack of qualified personnel in this area.



**Table 11: Participation in international conventions and the procedures for the management of chemicals.**

International conventions	Relevant national body in charge	National relevant activities
<b>Agenda 21 of the Commission on Sustainable Development.</b>	General Authority for Environmental Protection (the Socotra project). Brother / Ahmad Wazzani General Authority for Water Resources Dr. Khalid Riyadh. UNDP Brother / Fuad al-Qadasi and Brother / Wahib Al-Iryani.	Support in the area of laboratory quantities with small quantities. The Socotra project. The General Authority for Water resources.
<b>Rotterdam Convention</b>	General Authority for Environmental Protection	
<b>Montreal Protocol</b>	General Authority for Environmental Protection (Ozone Unit), Engineer / Faisal Nasir	Many awareness issues. Ending the use of ozone-depleting substances in the foam sector. Ending 80% of the use of the ozone-depleting substances in the direction and work under way to terminate the remaining 20%. Working to end the use of nearly 14 tons of ozone-depleting substances in the commercial sector (Refrigeration). Action underway to reduce dependence on ozone-depleting substances in the maintenance of refrigerators.
<b>ILO Convention 170</b>	Ministry of Social Affairs and Labor	
<b>Recommendation of United Nations on Special Transport of Dangerous Goods</b>		
<b>Basel Convention</b>	The General Authority for Environmental Protection (Poisons and hazardous waste unit - Engineer / Ali Abdullah Al-Thobhani)	A 1990 inventory of hazardous waste (industrial waste water, plastics, photography factories, medical and health pesticides, expired pesticides, expired medicines and waste oils). A 1997 inventory of hazardous medical waste, plastic bags and sheets. March 2002 survey of three types of hazardous waste. Coordination with UNEP-ROWA) and the secretariat of the Convention on the financing of the preparation of a draft national strategy in 2002. A workshop to introduce the discussion of the draft Convention, the National Strategy 17-18 July 2003 - Taiz. Completing the preparation of a draft national strategy for the integrated management of hazardous residues 2003. Action is underway to submit it to the Cabinet for approval.
<b>Stockholm Convention for POPs</b>	The General Authority for Environmental Protection (Dr. Jamal Al-Lawzi)	Implementation of the inventory of PCBs, dioxins and furans / preparation of the Implementation Plan of the National Convention (under progress)

### 3.3. POPs Pesticides in Yemen

#### 3.3.1. Introduction:

Organic pesticides played when discovered a key role in minimizing the damage of insect vectors of human and animal like flies and mosquitoes. They resist pests that destroy crops like locusts and white ants. However, these pros had hidden underneath,



as shown by the studies and scientific research, the risk of collateral damage to human and animal health, environment and safety. This is due to their impact and longevity in the environment. Hence, the desire to stop their use emerged.

Since the 1960s, many nations have worked to stop the production and use of most pesticides in their countries. However, regrettably they continued export and deportation of the production of such material to many countries of the developing world. They still produce large quantities and many quantities of damaged and obsolete stock are stored until today. We have therefore sought relevant international organizations to work for the consolidation of international efforts through global conventions that emerged from the Stockholm Convention, which aims to limit and eventually eliminate the use of the POPs.

The first phase of the Convention is the elimination of nine pesticides that belong to the POPs. Since Yemen signatory to the Convention requested the elimination of its stock; to achieve this, a comprehensive inventory of these materials is implemented and then appropriate actions were taken for safe disposal.

### *3.3. 2. Stages of the development and use of pesticides:*

A pesticide is defined as a substance or a mixture of substances (chemicals) for the purpose of preventing any scourge, elimination or control, including disease vectors of human, animal and plant.

The use of pesticides dates back to the beginning of the Islamic civilization, and possibly earlier, in which agriculture flourished. Their historical records have confirmed that Muslims used many innovative pesticides. The knowledge of pesticides moved through Islamic Spain and Sicily and the contact with Muslims during the Crusades to the European nations and America. Only in 1867, the use of sulfur and tobacco powder began in California as pesticides. It has been called the first generation of pesticides.

The second generation of pesticides may represent the organic substances manufactured during the period from 1939 until the mid-1960s, including chlorinated hydrocarbons, phosphoric substances, carbamates, herbicides, and others. Since the mid-1960s until now, scientists assessed the results of the use of pesticides and the search for procedures and modern methods of rehabilitation and reintegration of those compounds caused by environmental pollution, the breach of the balance of nature, and their relationship to living organisms, and damage to human health, including returning to the natural plant origin, and low toxicity for warm blood creatures. It enabled scientists to manufacture and produce industrial analogues, where compounds like parathions have taken important sites in the area of pest control, health and veterinary. Thus, insecticides were subjected to a considerable depth study in many branches of knowledge, starting from the preparation until industrialization, and through use and application.

What could be called third generation is the use of pesticides for specific programs within the control of a future integrated strategy. This enabled scientists recently to produce special chemical substances that will attack certain pests but not others, such as hormones, pheromones, anti-disengagement, nutrition, hatching ...etc.



### 3.3.3. *The use of pesticides in Yemen*

Yemen knew the use of pesticides for many years as other countries in the world. The modern historic statistics refer to 1935, when the agricultural expert Ahmed Wasfy Zakaria asked Saif al-Islam Abdullah to import Black Soap to deal with the diseased apples and bring sulfur medical treatment of Chagas's disease in the village of Alrodh, known recently as Algabil village.

The use of pesticides in the homeland, in the southern provinces, has been confirmed in the second half of the 1800s after the advent of the British colonialism, where it was used to combat the scourges of public health like the vectors: bugs, flies and mosquitoes, in order to preserve the health of soldiers. That has been emphasized by the botanist Belford who studied the plant environment of Socotra in that period.

In the forties of the twentieth century, the chlorinated hydrocarbons emerged such as D. D. T., Jamaxan, and their use expanded in the 1950s to combat locusts, cotton and palm pests, in addition to the scourges of public health.

In the 1960s, expansion in the use of pesticides increased through bilateral projects, where compounds like carbamates, organic phosphoric substances among others. The demand for pesticides increased together with the number of farms and farmers. In the early 1980s, the synthesized parathion compounds appeared. The activity marked the emergence of the private sector in Yemen in the field of importing types of pesticides, however in a limited manner.

During the last two decades of the twentieth century, the use of pesticides increased in the Yemen as a result of intensive agricultural progress, and the introduction of new crops and items of high quality and production to meet the increasing need of food, and the diversity of consumption patterns. The new species often showed less resistance to pests and diseases, which lead farmers to rely on the use of pesticides, in addition to other agricultural inputs, including fertilizers to protect their crops, and increase their productivity.

The high demands of farmers on pesticides encouraged the private sector to import different types of pesticides from many countries. When its importance was recognized by the Ministry of Agriculture and Irrigation, in the early 1980s, it organized the control of pesticides, and circulation, addressed the problems arising there from and the establishment of the General Department of Plant Protection. The Ministry worked in collaboration with the Federal Republic of Germany to set up a large part of the infrastructure needed to protect the plant, including provision and maintenance of machinery and workshop equipment, besides establishment of the following:-

- Laboratory for testing and diagnosis of plant pests and diseases.
- Laboratory to produce audio-visual media and print.
- Laboratory for raising and propagation of certain enemies of natural economic ills.
- Laboratory for analysis and quality control of pesticides.
- Laboratory to detect viral plant diseases.
- Laboratory to test the validity of seeds.



- Library specializing in the field of plant protection.
- Training hall.

At the beginning of 2001, the building of the laboratory of remaining from the impact of pesticides on vegetable and animal materials, water and soil, has been completed according to the international specifications. During the year 2004, the laboratory was furnished and supplied with processing equipment and some tools.

Yemen, too, claimed a bouquet of bylaws and legislations on protection of plant Quarantine e. g. Act No. 40 of 1981, No. 7 of 1985, and the issuance of the regulation of pesticides circulating decision of the Council of Ministers (No. 68) for year 1989.

Attempts were begun to establish and implement a system of registration and circulation of pesticides through monitoring and analysis of pesticides imported before allowing circulation in the market, in addition to a list of pesticides permitted for handling in Yemen, and implementation of laboratory and field experiments, to test the efficiency of pesticides on the target pest and the extent of their impact on the environment.

Ministry had, earlier in 1988, prepared a list of pesticides banned from circulation in Yemen, according to the degree of high toxicity and the high degree of constancy in the soil and the environment. The list included the nine POPs. In addition, many refresher courses were established for pesticides retailers, guides, agricultural cooperatives, and farmers in the various governorates, as these groups work to provide advice and guidance to farmers directly.

Table (12) represents the pesticides imported during the period 2000-2004 with an average of 1544 tons / year to cover approximately the requirement of two-thirds of the cultivated areas. Figure (6) illustrates the increase in demand between 2001 and 2004.

**Table 12: Pesticides imported during the period 2000-2004.**

Types of Pesticides	٢٠٠٠	٢٠٠١	٢٠٠٢	٢٠٠٣	٢٠٠٤
<b>Insecticide</b>	٨٤٩	٨٤٩	١٢٥٠	٨٠٩	١٣٣٠
<b>Spidercide</b>	-	-	٣٨	٣١	٥١
<b>Fungicide</b>	٩٥٥	٩٥٥	٥٩٣	٧٥٨	547
<b>Herbicide</b>	٢	٢	٣	٤	٠
<b>Nematode</b>	٠	٠	٧	١٦	٢
<b>Other</b>	٠	٠	٤	٣	٠
<b>Total</b>	١٣١٠	١٣١٠	١٨٩٥	١٦٢١	١٩٣٠

Table (13) lists the countries of origin of imported pesticides and the number of companies and number of agents in Yemen.

Figure (7) shows the percentage of the types of pesticides imported during the period 99-2004, which are about 59% insecticides, 39% pesticides and 2% spidercides.

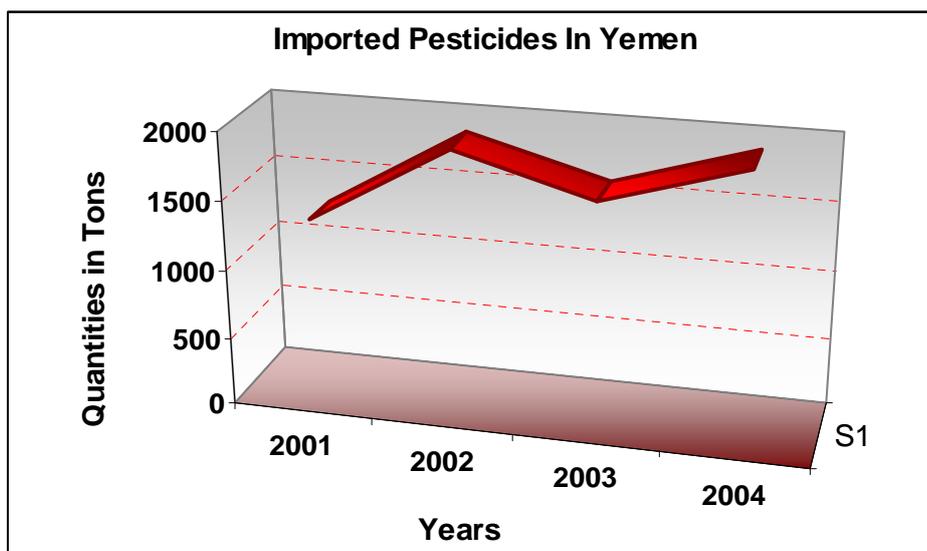


Figure 7: The increase in demand between 2001 and 2004.

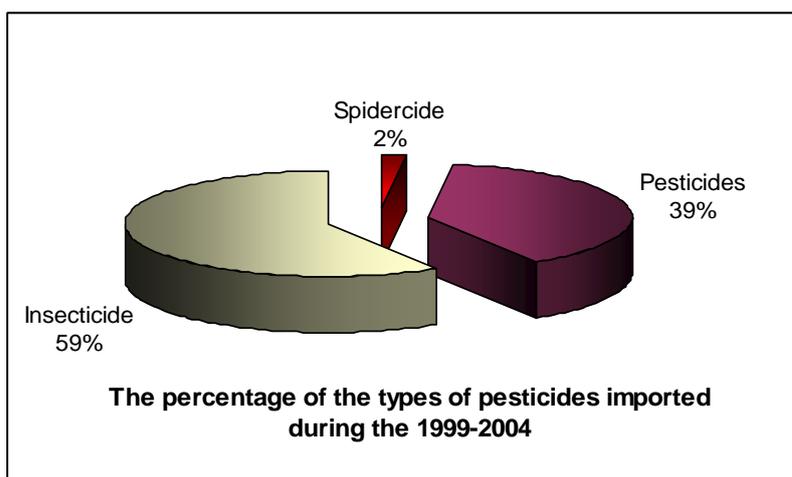


Figure 8: Percentage of types of pesticides imported during the 1999-2004.

Table 13: Countries of origin of pesticides imported, number of companies and number of agents in Yemen.

Country	Number of Companies	Number of Agents in Yemen
Belgium	1	1
China	13	12
Cyprus	3	1
Denmark	1	2
Egypt	5	5
Germany	2	6
Great Britain	7	4
France	5	3
Holland	2	2
India	11	8
Japan	1	1
Jordan	8	11
Malaysia	1	1
Saudi Arabia	6	8



Country	Number of Companies	Number of Agents in Yemen
Singapore	2	2
Spain	3	3
Switzerland	1	3
Turkey	1	1
USA	2	1

### 3.3.4. Availability of pesticides in Yemen

Pesticides are available in Yemen to whoever wants everywhere. It can be acquired more easily. Although this is a good advantage on the one hand, it is a big problem on the other hand. It makes fraud, smuggling, and possible misuse easy. Farmers could obtain pesticides from the following locations:

1. Guidance centers
2. Agricultural projects
3. Agricultural Cooperatives
4. Corporate agents
5. Retailers of pesticides and agricultural materials
6. Shops
7. Distributors
8. Roving vendors
9. Nomads
10. Vendors in the weekly markets
11. Farmers themselves
12. Pest fighting workers

### 3.3.5. Increasing numbers of farmers

Farmers using pesticides have been increasing in numbers year after year. At the same time, the farmers developed their knowledge, and understood how to deal with pesticides and their proper use. These results are according to studies carried out in 1988 and 1993, in different regions at Jehran valley, through groups of farmers. The number of each group is 100 farmers, in each region. Details are shown in table (3).

**Table 14: Increasing number of farmers using pesticides in Jehran valley, and increasing proportion of their knowledge, during the period 1988-1993.**

	Direction of Comparison	1988	1993
١	Farmers using pesticides %	٥٨	٩٠
٢	Farmers not using pesticides %	٤٠	١٠
٣	Farmers knowing the dangers of pesticides %	٥٦	٨١
٤	Farmers using the right dose %	٣٧	٨٠
٥	Farmers knowing the waiting period %	٣٠	٥٠
٦	Amount of pesticides used in the farm	٣.٥ Kg	٦.٨ Kg
٧	Remains of pesticides on the crops %	٧٠	٨٥



### 3.3.6. Chemical safety in pesticides

The chemical safety is so important. The Yemeni government was aware of this so early and worked on the following:

- 1) Activation of pesticides circulation control; hence many of the most important measures of legislative oversight were activated. Legislations concerning plant pesticides are divided into two parts: firstly: legislations on regulation of circulation, which aims at control and censorship of registration and circulation (import, sale... etc.) to protect investors, and users, and secondly: the safety of the environment.
- 2) Establishment of the central laboratory of analysis of pesticides, to ensure safety and to avoid the risk of damage and danger of pesticides and to put an end to fraud.
- 3) The protection of the environment and reduction of pesticide damage.

### 3.3.7. Central laboratory of analysis of pesticides

In order to guarantee safety, and to avoid the risks and harm of pesticides, and to put an end to fraud, the central laboratory of pesticides analysis has been established and operated. This means quality control and conformity to specifications of global standards, approved by the UN organizations (FAO and WHO). The operation of the laboratory began since October 1993. It is easy to control the movement of pesticides that are entering the country through official import, so as not to release any shipment of portal of entry, but after analyses of the samples, and a certificate of analysis is issued to demonstrate integrity. If the shipment is not according to international standards, it is returned to the country of origin.

This laboratory is one of the laboratories which are subject to universal international control every two years through participation in the competition to evaluate the performance, commitment and universally recognized analysis methods. The laboratory has achieved the rank laboratory No. 11 among 48 laboratories worldwide for the analyses of pesticides in the annual competition conducted by the German Aid (G.T.Z) in 1998. The lab was ranked 9 in 1996. Table (4) summarizes the results and the types of tests and analyses conducted in the central laboratory of analysis of pesticides, for the period 2000-2004.

**Table 15: Results and types of tests and analyses conducted in the central laboratory of pesticides analysis, for the period 2000-2004.**

Type of analysis	2000	2001	2002	2003	2004	Total
Quality control	343	475	513	446	417	2194
Physical and chemical tests	36	40	25	19	14	134
Evaluation of validity period	8	12	9	12	7	48
Observing the performance of lab	0	0	0	0	0	0
Fraud and smuggled samples	3	3	0	0	0	6
Samples for registration but off spec and refused	30	0	0	0	0	30
Off spec samples returned to country of origin	0	0	0	0	4	4
<b>Total</b>	<b>420</b>	<b>530</b>	<b>547</b>	<b>477</b>	<b>442</b>	<b>2416</b>



### **3.3.8. Protection of environment**

Ministry of Agriculture and Irrigation cooperated with FAO, in order to protect the environment, and reduce the damage caused by pesticides. The future strategy of pest control aimed at gradual transition to integrated control methods including rational use of pesticides, and revitalization of natural enemies and pathogens. In addition to that actions of mechanical, agricultural together with training of farmers, should be stressed to enable them to acquire the necessary knowledge to deal with such methods. The aim was increasing production, improving quality, at the lowest cost, without any pollution, or dangers to humans and the environment.

In areas of predicting side effects of pesticides on the ecosystem, a study has been carried out of agricultural indicators of natural pesticides in the Central Highlands in 1993. The results of the study showed the possibility of using the fauna insects of bugs for cultivating clover, as a suitable vital indicator. The diversity in the types of bug insects are negatively affected by using high quantities of pesticides in the ecosystem, and their numbers are lower. Thus, this index could be used to predict the negative consequences of the use of pesticides in different regions of the Central Highlands in Yemen. If these effects are detected early, it would be possible to take the necessary steps to reduce the use of pesticides, for the preservation of fixed insect fauna, or re-defect to the natural trend, and avoid damage arising from the intensive use of pesticides.

Many field surveys were carried out with the objective to know the magnitude of the content of the natural enemies of Yemen environment (predators, parasites and pathogens), and whether those natural enemies are able to create a balance with the natural harmful pest. This way the farmers will not rely totally on the use of pesticides to control the plant pest. The intensive use of pesticides could open the way to an endless evolution of the ability of pests to resist the pesticides, which may lead to reach the stage of a disaster; due to the lack of available and effective pesticides. The answer is positive. It was clear from the results of the first survey that the Yemeni environment is one of the richest global environments with natural enemies, as a result of the limited use of pesticides, compared to other countries. This calls for the need to protect these vital natural enemies, as a significant national wealth. A considerable number (73) of natural enemies were collected and classified as parasites and predators which revert to the original 16 important insect families.

### **3.3.9. Inventory of POPs**

Inventory of POPs is performed on the basis of the principles of Stockholm Convention on Persistent Organic Pollutants (POPs), which aims to protect human health and environment from persistent organic pollutants and according to Article No. 15 Paragraph 2 of the Convention, which stipulates that the Secretariat should provide each signatory to the treaty statistical data on total quantity and productivity of imports and exports of each of the chemicals listed in the Convention. Part of those pollutants is the nine POPs. The goal of the inventory is to know locations, amounts and types of the nine POPs

The locations and targeted sites are the public sector including Ministry of Agriculture and Irrigation, Ministry of Public Health and Population and Ministry of Public Works and Highways besides the private sector.



### ***3.3.10. Final results of the inventory***

Final results of the inventory of POPs in Yemen showed the lack of circulation of any of the nine organic persistent pollutants, whether damaged or usable. It has been clearly demonstrated through the process of inventory the status of the POPs in Yemen, as follows:

1. There is no any kind of manufacturing, re-packing or distribution of POPs in Yemen.
2. There are only two packing factories of household pesticides for pests like flies and cockroaches...etc. (aerosols). They import raw materials from abroad with the consent of the Ministry of Industry and Trade. These pesticides are not subject to supervision by the Ministry of Agriculture and Irrigation, both when they are imported or processed as long as they are concerning the fight against the scourges of public health.
3. Everything that exists in the market of pesticides of any kind are imported from abroad by the public, private and mixed sector, for pest control and public health pests.

### ***3.3.11. Classification of pesticides circulating in Yemen:***

Pesticides circulating in Yemen can be divided into three main groups:

- Plant pesticides; the competent authority is the Ministry of Agriculture and Irrigation as represented by the General Administration of Plant Protection.
- Pesticides of public health; the competent authorities is the Ministry of Public Works as represented by the General Administration of Environmental Health and the Ministry of Health and Population as represented by the Program to Combat Malaria.
- Pesticides of animal health; the competent authority is the Ministry of Agriculture and Irrigation as represented by the Public Administration of Livestock.

Groups of chemical pesticides in circulation:

The following groups of chemicals are found in circulation in Yemen:

- 1) Insecticides of spiders and insects:
  - Aliphatic hydrocarbons.
  - Organic phosphoric substances.
  - Organic carbamates.
  - Synthesized parathions.
  - Nitroquinidine.
  - Amedin.
- 2) Fungal pesticides:
  - Inorganic compounds
  - Organic compounds including the following groups: dithiocarbamates, benzimidazole, triazole, urea, piperazine, asilanin, pyrimidine.



- 3) Grubs pesticides.
- 4) Herbicides.

### **3.3.12. Problems facing circulation of pesticides in Yemen**

Perhaps the most important problems facing the circulation of pesticides in Yemen are the indiscriminate use and smuggling as explained below:

#### **3.3.12.1. Indiscriminate use of pesticides**

Yemen is suffering from indiscriminate use of pesticides. It is believed that this is due to lack of awareness, and the prevalence of illiteracy among farmers, in addition to a weak agricultural and health guidance. Dissemination of knowledge solves the problems of ignorance. Due to the importance of this matter, attention is required to agricultural, cooperative, and health guidance, and to develop awareness programs among farmers, across different media; visual, audio and print. In addition to following the appropriate methods of guidance during periodic and social meetings both in the days of seasonal farm or school, as well as build up public awareness campaigns in cooperation with agricultural and agricultural cooperative associations and private sector.

#### **3.3.12.2. Smuggling**

Smuggling operation of pesticides has become a serious social phenomenon, not only to deprive the State of the proceeds of customs duties, but the great danger lies in the fact that smuggled pesticides are not in conformity with world standards. The contents come from various information labels on the packs, or be damaged (expired) or already biodegraded, unusable as a result of the long period of storage, and thus may increase the intensity of danger, or be completely useless, besides that it is difficult to get rid of them. The smuggling process was due to the circumstances, the economic problems, policies to address price and the deterioration of the Yemeni currency (riyal) exchange rate against hard currencies, in addition to the difficulties faced by the body responsible for combating smuggling and border guards.

With respect to the current procedures for combating smuggling of pesticides within the city and ordered forfeiture consequent is doubling occurrence of problems of accumulation of waste pesticides in different regions of the country at a time when there were no means to get rid of them locally. In addition to that, the overseas disposal is extremely difficult and costly.

#### **3.3.13. Final results of the inventory of POPs in Yemen**

The final outcome of the inventory of POPs in Yemen can be summarized in the following table (16).

**Table 16: Final outcome of the POPs inventory.**

No.	Governorate	Number of Directorates	Govt'l establishment	Private sector	Notes
1	Capital Sana'a	10	6	72	None of 9 POPs available
2	Sana'a	15	2	10	None of 9 POPs available
3	Saadah	12	6	45	None of 9 POPs available
4	Thammar	11	2	60	None of 9 POPs available
5	Dhale'a	4	2	14	None of 9 POPs available
6	Amran	9	2	16	None of 9 POPs available
7	Hajjah	7	2	5	None of 9 POPs available



8	Hodeida	5	4	5	None of 9 POPs available
9	Taizz	5	4	15	None of 9 POPs available
10	Ibb	10	4	10	None of 9 POPs available
11	Beidha	5	2	5	None of 9 POPs available
12	Mareb	5	4	5	None of 9 POPs available
13	Mehweet	6	2	5	None of 9 POPs available
14	Hadramout valley	8	2	7	None of 9 POPs available
15	Mahra	5	2	6	None of 9 POPs available
16	Shabwa	8	2	7	None of 9 POPs available
17	Hadramout Coast	3	2	2	None of 9 POPs available
18	Jouf	5	2	16	None of 9 POPs available
19	Lahej	3	2	7	None of 9 POPs available
20	Abian	3	2	4	None of 9 POPs available
21	Aden	2	2	4	None of 9 POPs available

### **3.3.14. Factors affecting the accumulation of expired pesticides**

FAO outlined the factors that help to increase accumulation of expired pesticides as follows:-

1. Stop or prohibit sale of a pesticide.
2. Declining demand for the compound among farmers for any reason.
3. Contamination of a filled pesticide by another (especially if the other is herbicide).
4. Accumulation of a pesticide on farm for any reason.
5. Increasing resistance of pest to a pesticide or certain types of pesticides.
6. Stop planting the crop that pest got used to.
7. Expiration of validity of pesticide or clear decline in its effectiveness.
8. Destroying package containing the pesticide to the extent of breakage or destruction.
9. Damage to body of packaging so that its contents can not be emptied.
10. Not disposing of empty containers.

### **3.3.15. Risks and dangers of expired pesticides:**

Leaky packaging and shattered bags cause large occupational hazards. It also affects the health of staff working in storage sites, or others, who comes into contact with pesticides. The factors that determine the level of risk include the following:

- Quantity of pesticides, situation of packaging, containers and degree of leakage.
- Degree of toxicity of pesticides and other agricultural chemicals.
- Activity of materials in the environment (concentration, extent, movement in soil, degradation in water and degree of volatility).
- Storage location (inside or outside the warehouse), and terrestrial materials (degree of penetration).
- Extent of the storage site nearness from densely populated areas.
- Storage site nearness from water basins and level of groundwater.



### **3.3.16. Yemen's efforts to eliminate POPs:**

Through the information provided in Table (5), it is clear that there were none of the nine POPs in Yemen. This can be attributed to the fact that Yemen has done the following:

1. Most of POPs were included in the list of pesticides denied circulation in Yemen since 1988.
2. Yemen adopted projects of disposal of damaged or buried pesticides, during the years 1996, 2002 and 2004, especially that most of them are persistent organic pollutants.

### **3.3.17. Phases of the disposal of POPs in the Republic of Yemen:**

The following lines provide a concise review of the most important projects underwent to eliminate POPs in the Republic of Yemen:

#### **1) The old pesticides disposal project 1987-1996:**

The old pesticides are those pesticides that have not been in use for a long time, and those which are not expected to be used, and should be disposed of. The damaged and abandoned pesticides are those that are expired or suspended from use in Yemen, represented by the main pesticides in the fight against the desert locust, as Yemen was the regional store of pesticides, responsible for its distribution in the region since the 1950s. Thus, some quantities of those pesticides remained without use, as a result of the decline of the desert locust situation in the region and the world. This is in addition to other types of various pesticides entered the country through bilateral projects, assistance or as test samples, has not been used as a result of the termination of some of these projects at that time, and also as a consequence of the lack of adequate storage warehouses.

Due to the importance of the subject and high risk, the topic of pesticides was discussed and has taken a great deal of interventions and debates during the first national symposium in plant protection, held in Sana'a during the period 14-16/10/1985, which's recommendations stressed the importance and need for the speedy implementation of a comprehensive and full survey of such pesticides in the various governorates of the country together with safe and secure disposal.

#### **Stage I:**

Proceeding from the recommendations of the above-mentioned symposium, the Ministry of Agriculture represented by the Public Administration of Plant Protection started to pursue through correspondence and meetings with a number of donors, resulted in 1987 to implement a limited merely locusts pesticides, in some provinces, with the help of USAID. However, this has not been followed by any action to get rid of these pesticides.

#### **Stage II:**

For the completion of the survey and inventory in all governorates of Yemen, to reach a global picture of what is the storage sites content of various damaged pesticides; two agreements were signed with FAO, one in 1990 and another in 1991 with enough funding. Accordingly, a comprehensive survey was implemented, including sites which have been surveyed by USAID in order to know the quantities of pesticides, types and



situations, packs, their location and send samples abroad for identification. During the survey dealing with some cases of leakage, saw dust and soil were spread to absorb the leaked materials.

### *Stage III:*

The continued survival of waste pesticides in stores and sites constitutes a real risk and huge damage due to lots of leakages. This leads to saturation of the soil floors of the warehouses, and pollution of surface water and groundwater nearby, in addition to escalation of poisonous gases, bad odors and disturbing events, strangulation and poisoning humans and animals in the surrounding areas, as well as the anticipated fires and the fires in those locations, resulting in a catastrophic environmental consequences disadvantage.

Due to the difficulty and danger of getting rid of these pesticides through traditional channels, whether by burying in soil or burning in the open air and the unavailability of specialized incinerators in the country, and the inability to recruit exactly the kind of equipment, and the inefficiency of the fixed small incinerators to dispose of the chlorinated compounds. At the same time, process of destruction abroad is expensive. It requires many legal and political actions in many cases. After consultation with FAO, Ministry of Agriculture launched an appeal to the international organizations and specialized agencies and donor nations across the meetings called for by representatives of those bodies in the country. Over the representatives of Yemen in international organizations and forums, as well as through correspondence, a request for assistance to finance the disposal of pesticides and defeat the resulting pollution has been approved.

This has resulted in approval of the friendly Governments of the Netherlands and Germany financing a project to get rid of these pesticides. In light of this an agreement was signed by Ministry of Agriculture and FAO in March 1995 to dispose of the undesirable waste pesticides through collection, re-packaging, cleaning warehouses, and destroying outside Yemen. Accordingly, FAO stated a tender to get rid of these pesticides.

The Yemeni Government has ratified late 1995 to the Basel Convention concerning the control of the transfer of hazardous materials and their disposal across borders.

The government signed an agreement with UK in January 1996 provided for the approval and permitting the destruction of such material in Britain because such waste originated in Yemen, and resulted from the activities that were carried out within Yemen only on the basis that Yemen does not have, and it is not able to acquire the appropriate technical feasibility, or the necessary means to discharge waste in an appropriate environmental manner. UK is convinced that the resulting waste will be disposed of at the present time to deal with it in Yemen in a manner that ensures the safety of the environment, provided that ninety days have passed since the approval of Yemen to the Basel Convention.

#### **3.3.17.1. Implementation stage**

After the arrival of the company's technical team, and the preparation of the action programs, and discussion with Yemeni specialists, and the implementation of a training program for the assistant Yemeni team, and arrival of equipment and means of packaging from UK in the same period, liquidation process was carried out and cleaning stores and the re-positioning and mobilization of pesticides, toxic materials



and empty containers in special packages, with global specifications of such materials during the period from 11 March to 22 April 1996. This was followed by collection and transfer of such packages from various governorates to the compiler, near Hodaida port. All those containers were shipped to the UK during the period (19/5-1/6/1996).

The total weight of expired pesticides and contaminated materials and empty containers were 269 tons. Detailed findings are set out in Table 17 and 18. Figure 3 shows the persistent organic pollutants that have been disposed of and their percentages.

**Table 17: Names and the quantities of old, damaged, expired and abandoned pesticides, already disposed of in 1996, and their physical states.**

Common name	Quantity ton	State
Dieldrin	77.451	Liquid
Dieldrin	1.155	Solid
Indosilfan	1.198	Liquid
Bisicuron	1.598	Solid
Heptachlor	7.9	Solid
Depimethiot	61.678	Liquid
Fintrothion	44.1	Liquid
Fintrothion	0.45	Solid
D D T	10	Solid
B T C	30.689	Solid
Tetrachlorofinloss	1.26	Liquid
Tetrachlorofinloss	0.554	Solid
Propoxore	12	Solid
Melathion	6.848	Liquid
Mrthyl Mercaptofoss	2.465	Liquid
Aluminium fosfide	3	Solid
Nitrofin	2	Liquid
Carboxin	0.646	Solid
Dazomit	1	Solid
Oxokonox	0.48	Solid
Populite	0.42	Liquid
Dichlofoss	0.404	Liquid
Quintozin	0.3	Solid
Pentazan	0.256	Liquid
Finamifoss	0.202	Liquid
Methyl Premfoss	0.271	Solid
Diazinon	0.293	Liquid
B M A	0.203	Liquid
Thioremid	0.204	Liquid
coperfat Ammonilal	0.182	Liquid
Barkwat	0.123	Liquid
Dichloflonide	0.102	Solid
Total	269.372	

**Table 18: Quantities of waste solid and liquid pesticides and their percentages according to chemical groups.**

Serial #	Chemical group	Quantity liquid ton	Quantity solid ton	Total	%
1	Chlorinated organics	86.636	41.098	127.734	55.80
2	Organic Phosphorous	44.338	02.091	46.429	20.30
3	Carbamates	0	31.510	31.510	13.80
4	herbicides	05.593	00329	05.922	2.60



5	Fugicides	00.536	10.305	11.039	4.80
6	Others	02.193	04.007	06.200	2.70
<b>Total</b>		<b>139.296</b>	<b>89.538</b>	<b>228.834</b>	<b>100</b>

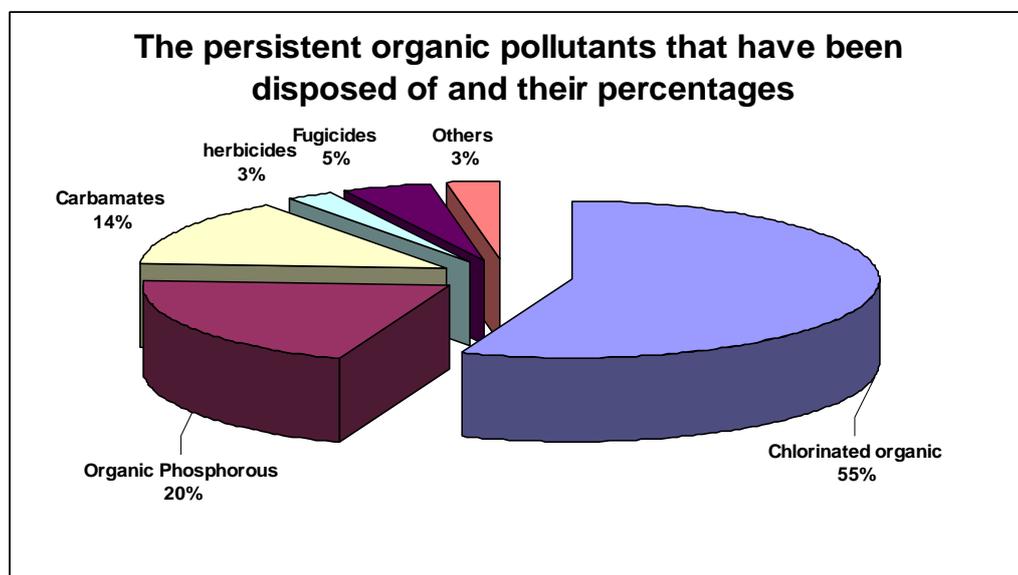


Figure 9: Persistent organic pollutants that have been disposed of and their percentages.

2) Project of getting rid of pesticides buried in Sordod productivity farm 1992-2004.

The first phase was completed in 2002 and the second phase in 2004. Tables (2-12) and table (2-13) show the results:

**Table 19: Waste pesticides found in the first phase.**

Serial #	Contents	No of containers	Net wt. Kg/Lit.	Gross wt.
1	Highly pesticide polluted soil classified (6.1) UN # (2588)	92 sacks 1 ton each	65734	74934
2	Pesticides	17 Drums (205 lit.) 10 Drums (310 lit.)	20219.5	21951.5
3	Empty containers	38 Drums (205 lit.) 3 sacks 1 ton each Steel container 1	1679	1992
4	<b>Total</b>	95 sacks 1 ton each 215 Drums (205 lit.) 10 Drums (310 lit.)	87632.5	98877.5

During a visit of the evaluation carried out by surveyors of the project, quantities of pesticides, fertilizers and other waste materials were discovered buried in the field (No. 27) in Sordod productivity farm in 1992. The problem has not been included to be solved in the project due to its high magnitude, lack of information in a timely manner, as well as the amount of money required. As a result, the State has requested FAO's assistance in disposing of these buried materials in safe and secure ways after site field studies, and knowledge of its dimensions, and depth of the pit, by the Dutch Tao Company, with funding from the World Bank. An agreement was signed between the Yemeni government and FAO, according to which the field work was carried out as follows:



*First Phase:*

The detailed findings are set out in table (20):

**Table 20: Waste pesticides found in the first phase.**

Ser. #	Contents	No of containers	Net wt. Kg/Lit.	Gross wt.
1	Highly pesticide polluted soil classified (6.1) UN # (2588)	92 sacks 1 ton each	65734	74934
2	Pesticides	17 Drums (205 lit.) 10 Drums (310 lit.)	20219.5	21951.5
3	Empty containers	38 Drums (205 lit.) 3 sacks 1 ton each Steel container 1	1679	1992
4	Total	95 sacks 1 ton each 215 Drums (205 lit.) 10 Drums (310 lit.)	87632.5	98877.5

**Second phase:**

In the second phase, waste pesticides found are summarized in table (9).

**Table 21: Waste pesticides found in Sordod farm in the second phase.**

Ser. #	Contents	No of containers	Net wt. Kg/Lit.	Gross wt.
1	Solid waste DDT classified (3,1) UN # PGI (2761); designated pollutant of water life	92 Drums (205 lit.) open steel tops	9200	10120
2	Damaged hydrocarbon pesticides + empty DDT containers classified (3,1) UN # PGI (2761) ; designated pollutant of water life	125 Carton drums (205 lit.)	1000	1250
3	Sacks containing solid hydrocarbon pesticides + containers polluted with DDT classified (3,1) UN # Pg (2761) ; designated pollutant of water life.	63 Sacks 10 Kg each	315	315
4	Sacks 1 cubic meter each containing damaged solid pesticides + empty DDT and Falverate containers; classified UN # 3.33 pg 111	35 Sacks 1 ton each	1750 Kg	5250
5	Drums containing damaged solid pesticides + empty DDT mixed with Falverate containers, classified UN # 3.33 pg 111	3 Drums (205 lit.) open steel tops	120 Kg	150
6	Drums containing damaged solid hydrocarbon and chlorinated DDT pesticides + empty mixed with Falverate containers; classified UN 601 pg 2761	1 Drums (205 lit.) open steel tops	140 Kg	150 Kg



## 3.4. PCBs in Yemen

### 3.4.1. Introduction

The General Authority for Environmental Protection, in cooperation with the General Authority for Electricity has prepared the program and planned to implement the PCBs inventory which covered the entire governorates of Yemen. The purpose of the inventory of PCBs in Yemen is to help in the management of these dangerous chemicals on the human health and environment and to fulfill the requirements of Stockholm Convention. The relevant environmental sites of the PCBs inventory are power generation stations, main transforming stations, secondary distribution stations, maintenance workshops and stores.

### Results of the PCBs Inventory

A huge amount of information is collected by the groups that implemented this project. The following points can be extracted from the data collected:

- 1) Total number of transformers of different capacities existing in Yemen is 12129. Total number of transformers targeted in the process are 2098; those are the ones made before 1985. After careful study and inspection, even the old ones and the Indian ones from Askarel Company are free of PCBs. There are 1310 transformers in workshops for repair. There are 241 defected non-repairable transformers stores in junk yards of the workshops. There are 332 new transformers in the different Governorates. Table 23 summarizes the total details of the above information.
- 2) Sizes of transformers used in Yemen ranged between 5 and 55000 KVA. Installed transformers are made between 1930 and 2005. Older transformers are installed in the Southern Governorates: Aden, Lahj, Hadramaut, Abyan etc. The British built a number of electric power stations to serve their soldiers and civil servants in the big cities. The transformers of sizes 50, 500 and 1000 KVA are available in big numbers. The huge ones that exceed thousands are only available in small numbers.
- 3) Amount of oils used in Yemen is about 687 barrels per year. They are bought from the local market from the official agents of international companies like BP, Shell, Petromin, Adnoc, Gulf, Dalia, Caltex and Askaral. Usually a big tender is announced and the bidders give their best prices and specifications. The amount of oil in the stores of the authorities is about 301 barrels. All countries manufactured their own transformers except Yemen. If transformers were made locally, PCBs will be excluded. This is the most important recommendation of this study. The largest number of transformers was imported from Britain because of its previous connection with the southern Governorates followed by India, probably because of low prices. However, many transformers were imported from Italy, Belgium, Germany, Saudi Arabia, Turkey, France, Korea, Malaysia, Egypt, Holland, Emirates, Iran, Russia, Macedonia and others. International oils have changed and they no longer include PCBs. All Governorates used internationally certified oils and the relevant corporations import friendly environmental transformers.
- 4) Except for the old ones, no PCBs containing transformers were noticed. Even Hadramaut Governorate does not import Askarel anymore. They announce a



general tender, where all represented agents of international oil companies bid and the oil bought according to the aforementioned specifications.

- 5) Only 52 samples were suspected out of 2098 targeted in this project. The suspected samples were sent for analyses in the Kuwait institute for Scientific Research. Only 11 samples showed more than 1000 nanogram per gram of PCBs. The rest showed mostly traces of PCBs.
- 6) Possibility of getting rid of waste oil in an appropriate way is still missing in Yemen. Some waste oils were burnt in the cement, gypsum and lime factories. There is no waste oil recycling or manufacture in Yemen so far. The same applies to the rejected transformers and capacitors in the workshops that are left in junk yards beside the workshops for good.
- 7) Capacitors used in Yemen depend entirely on dry technology. This is an excellent characteristic to get rid of PCBs. Total number of installed capacitors in Yemen is 1112 and there are 40 new ones in the stores. Capacitors under repair in the workshops are 27. There are several Governorates that do not have any capacitors.
- 8) It has to be mentioned that the field survey of transformers showed the presence of only two containing PCBs (Askarel); one in Khormaksar Power Station, Aden and the other in the yard of Dhahban Center, Sana'a. The total number of transformers in Yemen includes many air transformers. Those were huge numbers sometimes as in the case of air transformers in Shabwa.

**Table 22: Distribution of transformers in the Governorates of Yemen.**

	Governorate	Transformers in the workshop		Transformers in stores	Targeted transformers	Total no. of transformers in Governorate	Notes
		Defected	For repair				
1	Sana'a	-	1000	100	434	3000	
2	Dhamar	-	29	-	10	893	
3	Ibb	37	17	-	87	971	
4	Beidha	6	9	18	10	300	
5	Aden	38	80	30	380	909	
6	Taiz	38	-	0	30	867	
7	Lahj	20	-	17	13	267	
8	Abyan	2	28	3	73	100	
9	Dhalea	24	-	14	-	371	Air transformers
10	Saadah	-	10	-	-	160	
11	Amran	-	8	2	1	183	
12	Mareb	-	60	-	-	220	After 1985
13	Al-Jouf	-	-	6	-	26	After 1985
14	Hodeida	20	20	-	82	300	
15	Mahweet	11	7	-	37	209	
16	Hajja	-	20	3	4	147	
17	Hadramaut	20	-	110	867	2008	
18	Mahrah	10	-	-	16	94	
19	Shabwah	0	17	19	04	804	720 Air transformers
20	Raimah						New Gov.
	<b>Grand total</b>	<b>241</b>	<b>1310</b>	<b>332</b>	<b>2098</b>	<b>12129</b>	



### ***3.4.2. Obstacles of Inventory Process***

Difficulties and obstacles that faced PCBs inventory process in Yemen are the short time span; hence some groups were unable to complete their work and used more team numbers; it was impossible to read the data on some of the oldest transformers especially those installed in humid areas at the sea shore, and the very old transformers; private sector projects refrained from giving information; the very huge areas of some Governorates made implementing the inventory process very difficult besides the hilly and mountainous areas that made the completion of task very difficult.

To sum it up a huge amount of excellent, punctual and dependable information was collected from their main sources in towns, big cities and even the countryside and private power stations during the inventory process that will become a good wealth for the Environmental Protection Authority and researchers in the future.

In spite of the previously mentioned bright points it is good to admit the occurrence of some mistakes and shortcomings in the process. Information collected during the inventory process of PCBs in Yemen is a step forward to the implementation of NIP.



### 3.5. DDT in Yemen

None of the POPs is produced or manufactured in Yemen. These materials have been prohibited since 1990 except D.D.T. which is still in use in limited quantities in the fight against malaria mosquitoes. The inventory of POPs materials held in 2004 clearly demonstrated that POPs do not exist in the environment of Yemen. The inventory included all governorates, with special focus on the places that deal with pesticides, both in terms of storage, use or sale.

There was also a program of cooperation and coordination with FAO to get rid of all the residual materials left at three intervals. These materials were found mixed with soil. As a result, the existence and locations are divided into three categories:

- A) High pollution sites
- B) Medium pollution sites
- C) Low pollution sites

These sites have been under liquidation of these materials in three stages, as shown in the following table (24):

**Table 23: Phases of disposal of obsolete pesticides and their quantities.**

Quantity, ton	Year	Category
262	1996	Highly contaminated soil with chemicals, including POPs (60% Chemicals + 40% high soil pollution by chemicals).
98	2002	Medium-contaminated soil with chemicals, including POPs
200	2004	Low contamination soil with chemicals and materials including POPs.



## **3.6. Dioxins and Furans (PCDD and PCDF) and HCB in Yemen**

### **3.6.1. Introduction:**

Dioxins and furans are considered persistent organic pollutants (POPs). More precisely, polychlorinated dibenzo-p-dioxins (PCDD) and polychlorinated dibenzofurans (PCDF) are two compounds falling within the twelve persistent organic pollutants stable in the environment, which are included in the Stockholm Convention of POPs.

Dioxins and furans together with polychlorinated biphenyls (PCBs) and hexachlorobenzene, (HCB) are included as persistent organic pollutants in Annex (C) of the Stockholm Convention of POPs.

None of the POPs is produced or manufactured in Yemen. These materials have been prohibited since 1990 including HCB.

Convention stipulates that all compounds listed in the Annex (C) of the Stockholm Convention on POPs require "further reduction to the minimum and wherever possible, get rid of them finally."

Paragraph (a) of Article (5) of The Stockholm Convention requires the development and implementation of an action plan to identify and characterize these compounds and exposure must include "the development and operation of the inventory of sources of these compounds and estimate their emissions".

Based on the report of the Commission on Tourism and Environment issued by the Yemeni Shura Council, dated September 2002, the air has become polluted, especially in the large cities and industrial areas. This is clearly reflected by the increasing amount of smoke and dust in addition to the invisible and non smell gases in the air. These contaminants arise from the processes of production, energy generation, transportation, household waste and residues, agricultural operations, quarries and other sources like moving wind in all directions and speed of movement, proliferation and the impact on the surrounding environment.

Requirements and the needs of the growing population with the rapid population growth and high rates reached (5.3%) in addition to the high levels of pollution associated with development activities and the social sectors, particularly transport and energy.

Breadth of urban growth, proliferation, construction of many roads and the establishment of many factories has led to the seizure of large tracts of the finest types of agricultural soils adjacent to the urban centers. As long as population growth continues to increase dramatically and migrations are continuous from the countryside to cities, urbanization will continue to expand and spread. This has meant that aggression on agricultural land will continue to be serious unless regulations that will direct the urban growth to non-agricultural land. This requires a serious government policy in the area of town planning.

Pesticides and chemical fertilizers used for agricultural production lead to the pollution of the soil, causing salinity. The use of waste materials in irrigation without purification leads to the corruption of the soil as they still contain many chemicals that affect the soil, and make it unfit for cultivation.



Environmental Action Program of the government has elevated in the 1990s and reflected in the establishment of General Authority for Environmental Protection. Government has also prepared Environmental Protection Act and was promulgated No 26 for the year 1995; thus in Yemen the environmental issue became a priority. Government's interest in the affairs of the environment and natural protectorates has been reflected in the constitutional amendments. Article (25) of the amended Constitution provides that "the State's responsibility to protect the environment and society and is a religious and patriotic duty of every citizen." Ministry of Tourism and Environment was established in 2001, as well as the establishment of civil society organizations, which were represented in several associations for the protection of the environment.

In area of studies and research, the Board of Environmental Protection has pursued more than twenty environmental studies and reports, in addition to the training and rehabilitation of some of the capabilities and expertise in this area, and a number of conventions and international protocols were signed. Yemen became an active member in many conventions, convinced by the importance of international and regional cooperation in this area.

Plan of General Authority for Environmental Protection in 2002 included the following:

1. Completing the environmental regulatory construction and the preparation of a number of scientific and technical environmental studies, together with increasing the environmental awareness and the issuance of press releases, reports, information, the organization of workshops, symposia and activating the role of censorship.
2. Updating procedures and follow-up for the National Action Plan on Biodiversity and the contingency plan of disaster, and the draft strategy for the women and environment, and the National Plan for the use of appropriate technology, clean energy, and strategy for health and environment, besides updating the National Plan of Action for the Environment.
3. Completing the establishment of the environment laboratory through the provision of materials and equipment.
4. The operation of the new and old air pollution control stations.
5. Despite the serious orientation of the Ministry and the General Authority for Environmental Protection, however, there are some difficulties and obstacles facing the environmental management that reduce its effectiveness and efficiency, the most clear of which are the following according to the report by the Yemeni Shura Council:
  - Lack of financial resources for environmental action and the lack of trained and specialized skills in the field of the environment.
  - Lack of environmental control.
  - Low level of environmental awareness.
  - Poor coordination and lack of clarity among some leaders on their functions of the environmental management and the role of the Authority.



- Multiplicity of government agencies associated with the environmental sector, given the lack of clarity in the terms of reference and the lack of coordination between those entities and the public, to protect the environment.

### **3.6.2. Formation of dioxins and furans:**

Dioxins and furans are formed inadvertently as secondary products in some of the processes and activities specified in annex (C) of the Stockholm Convention, in addition to the fact that the compounds of dioxins and furans are formed intentionally in industrial processes and discharges. They could enter into the operations as pollutants in raw materials involved in an industrial process and thus could exist within the process even when not formed. There are two methods of preparation of dioxins and furans:

#### **3.6.2.1. Formation in the thermal processes through two basic mechanisms:**

1. Manufacturing mechanism known as De Novo and are formed by non-extracted carbon structures and this does not correspond to the final product of dioxins and furans.

2. Through interactions of causing substances through aromatic radicals derived from the oxidation and others chemical processes.

#### **3.6.2.2. Formation in the wet chemical processes:**

Conditions of formation of the compounds of dioxins and furans in the thermal processes are:

1. High temperature (cooling period of 200-450 °C), or incomplete combustion.
2. Presence of non-organic carbon.
3. Presence of free chlorine.
4. Products containing dioxin and furan compounds.

Conditions of formation of dioxins and furans from chemical processes are:

1. High temperature (higher than 150 °C).
2. Basic medium conditions (especially during the purification process).
3. UV or free radicals.

Main sources where dioxins and furans are evolved directly:

- Air.
- Water.
- Land residues (waste liquid, sludge, and solid residues that are handled and disposed of as waste, or perhaps recycled).
- Products like chemical structures and consumer goods such as textile and paper.



### 3.6.3. Default emission factors:

#### 3.6.3.1. The main categories:

Waste incineration: This is the most source category examined in a good way for the explanation of the formation of dioxins and furans and reducing their emissions.

Burning waste must be dealt with as a priority action plan because of the early sources that require the use of the best available treatment techniques (BAT) and best environmental practices (BEP). It includes the waste incineration of groups of primary sources from the secondary category and way of emission of dioxins and furans as summarized in Table (26):

**Table 24: Waste incineration of groups of the secondary category from primary sources and way of emission of dioxins and furans.**

Secondary category	Way of possible emission		
	Air	Water	residue
Waste incineration			
Burning of civil solid waste	X	X	X
Medical waste incineration.	X	X	X
Burning hazardous waste	X	X	X
Light-fraction shredder waste incineration	X		X
Burning of waste sewage sludge	X		X
Waste incineration of waste wood and	X		X
Carcasses waste of animal incineration	X		X

#### 3.6.3.2. Burning of municipal solid waste (MSW):

MSW includes any type of solid waste generated by households and population activities or waste materials disposed by people normally during the period of a normal life as containing wastes similar to household generated from the commercial, industrial and agricultural activities. Despite changing components from one country to another, they are considered non-hazardous and common components. Table (27) summarizes the matrix of the survey of source categories.

**Table 25: A matrix of the survey of source categories.**

No.	Main categories	Air	Water	Earth	Products	Residues
1	Waste incineration	x				x
2	Ferrous and non-ferrous metal production	x				x
3	Power generation and heating	x		x		x
4	Production of construction Products	x				x
5	Transportation	x				
6	Uncontrolled combustion Processes	x	x	x		x
7	Production of chemicals and consumer goods	x	x			x
8	Miscellaneous	x	x	x	x	x
9	Disposal/landfilling	x	x	x	x	x
10	Identification of potential hot-spots	Possibly registered then special evaluation of site				



### **3.6.3.3. Assessment of release from unintentional production of Annex C chemicals (PCDD/PCDF)**

#### **3.6.3.3.1. Dioxin and Furans**

Yemen prepared its dioxin and furan (PCDD/PCDF) releases inventory report in 2006. The report was issued in the year 2007, in which the first draft of the “Standardized Toolkit for Identification and Quantification of Dioxin and Furan Releases” issued by UNEP Chemicals of 2003 was used.

The toolkit is used as a general form for estimating the quantities of dioxin and furan releases emitted from different probable sources. The main contents of the toolkit are:

1. Identification of the main categories of possible emitting sources as well as subcategories.
2. Quantification of these categories’ contribution to the emission quantities. This contribution is based on an adversely proportional relationship between the source strength and the extent of control systems development. The relationship is expressed by the emission factors (E.F) developed in several developed countries by carrying out extensive research for different sources.
3. Identification of the environmental media (vectors) receiving such releases. These vectors could be air, water, land, products or residues. The release quantity that the vector receives depends on the strength and the nature of the emitting source according to the following screening matrix. Table 2.10 shows the PCDD/PCDF main emission source categories and the possible receiving vectors.
4. Setting mathematical formula to calculate the annual releases from sources as follows:

Source strength (dioxin emissions / year) = (emission factor × activity rate)

Source strength is given in (g TEQ/a),

Emission factor is given in (g TEQ/t).

Activity rate is given in (t/a)

Where:

TEQ = Toxicity Equivalent.

g = Microgram.

t = ton (weight of products, waste, fuel etc)

a = Annum (year).

Data and information were collected from different sources and by using different approaches including: questionnaires, field visits, interviews, formal and informal communications, scientific references, previous studies and statistics.

#### **3.6.3.4. Inventory Results**

A summary of the results obtained were presented for each main source category and sub-category. The detailed explanation and calculations are presented in the final report of “The Final Report for Dioxins and Furans Releases” issued by the General Authority for Environmental Protection, 2007.



### Main Source Category 1: Waste Incineration

Currently there are no incinerators to burn municipal solid waste in Yemen. Hazardous waste incineration, sewage sludge incineration and waste wood and biomass incineration has not been monitored. Medical waste incineration is practiced in a number of hospitals in some provinces that have working incinerators, namely: The Capital Sana'a, Abyan, Ibb, Hajja and Taiz. Usually they use un-controlled intermittent combustion, without a system for controlling air pollution except for Ibn Khaldoun hospital at Lahj. Light-fraction shredder waste incineration with non-controlled sporadic combustion, without a system for controlling air pollution is available at The National Company of Industry and Commerce: Taiz Governorate, Alhouban, Ha-el Said Corporation. Animal carcasses incineration is practiced in old furnaces working on intermittent system, with partial or no air pollution control equipment for burning of remnants of dead animals and animals residues in each of The Capital Sana'a and Tamar Governorates.

Emission factors (E.F) used in calculations are 3500 µg TEQ/t 40,000 µg TEQ/t and 525 µg TEQ/t for air emission, and 75 µg TEQ/t, 200 µg TEQ/t and 920 µg TEQ/t for residues in municipal and medical wastes and good APC controlled medicinal waste 500 µg TEQ/t for air emissions in animal carcasses destruction. Table 28 shows the estimated PCDD/PCDF releases from waste incineration category.

**Table 26: Estimated PCDD/PCDF releases from main category 1 - waste incinerations.**

#	Sub-category	Annual release (g TEQ/a)					
		Air	Water	Land	Product	Residue	Total
1	Municipal solid waste incineration	11.63	0	0	0	2.49	14.12
2	Hazardous waste incineration	0	0	0	0	0	0
3	Medical solid waste incineration	33.41	0	0	0	6.79	40.2
4	Light fraction shredder waste incineration	۲, ۴۳	0	0	0	0	۲, ۴۳
5	Sewage sludge waste incineration	0	0	0	0	0	0
6	Waste wood and waste biomass incineration	2.5	0	0	0	25	27.5
7	Animal carcasses burning	۰, ۳7	0	0	0	0	۰, ۳7
<b>Total</b>		<b>50.34</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>34.28</b>	<b>84.6۲</b>

### Main Source Category 2: Ferrous and Non-Ferrous Metals Production

High waste recycling, including oil contaminating materials is active in Yemen. The amount of re-cycled iron exceeds 120,000 tons/year. Charcoal is one of the daily goods consumed in large quantities in Yemen. A number of factories in some governorates were observed. It is well known that the amount allocated to the factories do not represent all the factories and quantities produced, since coal is used in many great applications, ranging from use of hubble-bubble (Almadaah) and one of the best ways of cooking especially grilling meat, fish, chicken, etc. There are several iron and steel foundries too. Production of electrical cables and wires from copper was observed in some governorates. Processing of scrap aluminum, minimal treatment of inputs, simple dust removal and extrusion production are noticed through out the country. Open burning of cable was monitored in the coastal areas, in the Governorates of Taiz, Hodaida, Hadhramout coast (Mukalla), Shabwa, Lahj, Al-Mahra, Hajja and Abyan. A kiln with no dust control for zinc production is available in a plant in Hodaida. Currently, there are no plants for producing magnesium, but an investment project is under construction.



There are two factories outside Hodaïda in the direction of Hodaïda-Taiz road. They are extracting lead from scrap car batteries containing (PVC).

In iron production, emission factors used for air emissions are 20 µg TEQ/t and for residues it is 0.003 µg TEQ/t. In charcoal production, EF is 3 for air and 0.06 µg TEQ/t for residues. In iron and steel foundries, emission factor used for air emission is 10 µg TEQ/t and 15 for residues. In copper wires production, emission factor used for air emission is 800 µg TEQ/t and 630 for residues. In aluminum production, emission factor used for air emission is 150 µg TEQ/t and for residue it is 200 µg TEQ/t. In thermal wire reclamation, emission factor used for air emission is 5,000 µg TEQ/t. In zinc production, emission factor used for air emission is 1,000 µg TEQ/t. In lead production, emission factor used for air emission is 80 µg TEQ/t. Table 29 shows the estimated PCDD/PCDF releases from category of ferrous and non-ferrous metals production.

**Table 27: Estimated PCDD/PCDF releases from main category 3 - ferrous and non-ferrous metal production.**

#	Sub-category	Annual release (g TEQ/a)					
		Air	Water	Land	Product	Residue	Total
1	Iron ore sintering	3.05	0	·		0.0005	3.05
2	Coke production	1.26	·,·,·		0	0	1.29
3	Iron and Steel Production Plants	2.58		·	·	3.87	7.4°
4	Copper Production	49.58	0	0		39.04	88.62
5	Aluminum Production	0.75	0	0	0	0.20	0.95
6	Thermal Wire Reclamation	40.85	0	0	0	0	40.85
7	Zinc Production	3.6	0	0	0	0	3.6
8	Magnesium Production	·	0		0	0	·
9	Lead Production:	22,76					22,76
	<b>Total</b>	<b>121.38</b>	<b>·,·,·</b>			<b>43.11</b>	<b>167.57</b>

### Main Source Category 3: Power Generation and Heating

Waste oils are consumed in some scattered plants in some governorates especially cement factories and lime production factories. Heavy fuel oil is consumed in cement factories in Yemen. Diesel is consumed as a fuel for electric power stations, vehicles and other applications like asphalt production, bakeries, bricks, public bathrooms and slaughterhouses etc. Biomass (clean wood) is used in the lime production facilities in Hadhramaut and utilized in cooking in all governorates.

Emission factor used for air emission is 35 µg TEQ/t for waste oil, 2.5 for heavy fuel oil, 0.5 g for diesel fuel, 50 for biomass in lime production, 100 for biomass and 10 as residue for cooking. Table 30 shows the estimated PCDD/PCDF releases from category of power generation and heating.

**Table 28: Estimated PCDD/PCDF releases from main category 4 - power generation and heating.**

#	Sub-category	Annual release (g TEQ/a)					
		Air	Water	Land	Product	Residue	Total
1	Waste Fuel Power Plants	0.38					0.38
2	Heavy Fuel Energy Boilers	0.35					0.35
3	Light Fuel and Natural Gas Boilers	20.39					20.39
4	Biomass Power Plants	23.44					23.44
5	Biomass and Virgin Wood Stoves	53.77				5.38	59.15
	<b>Total</b>	<b>98.33</b>				<b>5.38</b>	<b>103.71</b>



### Main Source Category 4: Mineral Products

Table 31 shows the Estimated PCDD/PCDF releases from 5 Main category 4 – Mineral Products.

This category deals with manufacturing of cement, lime, bricks, ceramics and asphalt mixing which are all practiced in Yemen.

There are three cement factories in Yemen. They are distributed among three governorates; namely Taiz, Amran and Hodeida, with a total capacity of about 1.3 Mt/a. Heavy fuel oil (HFO) is the main fuel being used in the three plants. However there are three other factories under construction in Abyan, Hadhramaut and Aden. There are (36) incinerators (Keer) for the production of lime in Hadramawt coast. Seventeen of them are operating in Shamosha, and seven in Boish. The rest of incinerators are temporarily not functioning: (6) incinerator in Boish and (6) in Sheher. The main fuel used is timber, tires, waste lube oils, and sometimes animal dung is used and saw dust. The fuel used in Shamosa is timber and mostly not waste lube oils, while in Boish waste lube oil is used. In the Capital Sana'a, nine incinerators for red brick were visited. Only one red brick incinerator is noticed in Hadramaut coast (Mukalla). Asphalt is produced in several governorates namely, Capital Sana'a, Aden, Taiz, Mukalla, Sayoon, Lahj, Shabwa and Abyan with a total capacity exceeding 1.6 million tons per year.

The three factories have different emission factor to air of 0.05 µg TEQ/t for Taiz, 0.6 for Amran and 5 for Hodeida. Emission factor used for air emission is 10 µg TEQ/t for lime production, 0.2 for red brick and 0.07 for asphalt production.

**Table 29: Estimated PCDD/PCDF releases from 5 main category 4 – mineral products.**

#	Sub-category	Annual release (g TEQ/a)					Total
		Air	Water	Land	Product	Residue	
1	Cement Plants	1.65					1.65
2	Production of Lime	4.94					4.94
3	Production of the red bricks	7.74					7.74
4	Production of asphalt	0.11					0.11
<b>Total</b>		<b>14.44</b>					<b>14.44</b>

### Main Source Category 5: Transportation

Table 32 shows the estimated PCDD/PCDF releases from 6 Main category 5 – transport.

Diesel is the biggest consumed fuel in the various economic sectors, especially transport, energy and industrial sectors. According to official statistics, the consumption of diesel in The Capital Sana'a hit 29000 tons per month.

On the other hand, diesel is the most financially supported fuel. The government spent about 12 billion riyals a month to support the prices of diesel due to economic and social benefits.

The capacity of Marib refinery production of lead-free gasoline is around 600 thousand liters a day. This quantity is distributed to meet the needs of the transport sector as often mixed with leaded gasoline, which is sold as fuel for transport. The octane number rate in the different types of regular gasoline is around 83%.



The leaded gasoline is produced in Aden refinery and used to cover the local market. For fuel oil the total monthly consumption is about 70,000 tons and covers the needs of the industrial and productive sectors. There are two types of fuel oil; the type that contains 1% sulfur, and a lower quality second type that contains about 3.5% sulfur.

More than 550,000 registered vehicles run on leaded gasoline and more than 11000 on diesel fuel in the country. More than 20000 vehicles utilize heavy fuel oil. Around 100,000 double stroke vehicles are used in Yemen. Unleaded gasoline is used for modern and high class cars. For the sake of calculation of the total Dioxins and furans used the total amounts of fuel consumed in Yemen were utilized.

Emission factor used for air emissions to air is 2.2  $\mu\text{g TEQ/t}$  for four stroke leaded fuel engine (gasoline), 0.1  $\mu\text{g TEQ/t}$  for unleaded fuel without catalyst (gasoline), 4  $\mu\text{g TEQ/t}$  for heavy fuel 3.5  $\mu\text{g TEQ/t}$  for double Stroke leaded fuel engine (gasoline) and 0.1  $\mu\text{g TEQ/t}$  for double Stroke diesel engines.

**Table 30: Estimated PCDD/PCDF releases from 6 main category 5 – transport.**

#	Sub-category	Annual release (g TEQ/a)					Total
		Air	Water	Land	Product	Residue	
1	Four-stroke vehicles, leaded gasoline	1.95	0	0	0	0	1.95
2	Four-stroke diesel vehicles	0.18	0	0	0	0	0.18
3	Four-stroke vehicles, fuel oil	0.36	0	0	0	0	0.36
4	Double stroke vehicles, gasoline	1.03	0	0	0	0	1.03
5	Double stroke vehicles, diesel	0.0003	0	0	0	0	0.0003
<b>Total</b>		<b>3.51</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>3.51</b>

### Main Source Category 6: Uncontrolled Combustion Process

This category is the major (71%) PCDD/PCDF releasing source in Yemen.

This category includes combustion processes whether they are practiced on purpose or not. Sub categories of this category include: biomass burning such as forest, grassland and agricultural residues fires, waste burning either inside or outside landfill sites, accidental fires in house, factories and vehicles and open burning of wood residues.

A quantity of herbal grass plant spread in the mountains of scattered areas in the provinces of Hajja, Taiz, Ibb and Al-Mahweet is burnt yearly. The burning happens in the winter in a rate of 5 hectares in each area equals 160 tons per year. EF used for air, water and earth dioxins and furans releases are 5 and 4  $\mu\text{g TEQ/t}$ , respectively.

Burning of agricultural stacked residues is limited to poor combustion conditions. The investment region in Al-Jarr Valley, Abs Directorate, Hajja Governorate, contains more than (350) Mango and Palm Farms with 960000 Mango trees and 170000 Palm trees. The sick and infected branches are burnt at a rate of 480000 Kg/year. The quantity of badly burned branches, in the open field, once a year from palm trees = 85000 Kg / year. EF used for air and earth dioxins and furans releases are 30 and 10  $\mu\text{g TEQ/t}$ , respectively.

The amount of household waste generated from the governorates of the Republic approaches 0.5 million tons. EF used for air, water and earth dioxins and furans releases are 300 and 600  $\mu\text{g TEQ/t}$ , respectively.

The number of incidents of fires in homes and factories (per incident) in a number of governorates of the Republic / year is 486. EF used for air and residue dioxins and furans releases are 400  $\mu\text{g TEQ/t}$  each, respectively.



Incidents of fires in vehicles (per incident) in a number of governorates are about 250 per year. EF used for air and residue dioxins and furans releases are 94 and 18  $\mu\text{g TEQ/t}$ , respectively.

Table 33 shows the estimated PCDD/PCDF releases from 7 Main category 6 - Uncontrolled combustion processes.

**Table 31: Estimated PCDD/PCDF releases from 7 main category 6 - uncontrolled combustion processes.**

#	Sub-category	Annual release (g TEQ/a)					
		Air	Water	Land	Product	Residue	Total
1	Fires of grasslands and marshes	0.0018		0.0014			0.0032
2	Burning of Agricultural Staked Residues	0.02		0.01			0.03
3	Uncontrolled Household Waste Burning	135.16				270.33	405.49
4	Incidents of Fires in Homes and Factories	0.19				0.19	0.38
5	Accidental fires in vehicles	0.02				0.01	0.03
Total		135.39		0.01		270.53	405.93

### Main Source Category 7: Production and Use of Chemicals and Consumer Goods

Yemen does not produce paper from raw material such as raw pulp. The country imports its needs of paper from the international market. Hence pulp and paper burning boilers were not monitored. Same applies to PCBs, pesticide pollutants, production of chloranil and production of dichloroethylene, monovinyl chloride VCM and polyvinyl chloride PVC.

Quantity of the total production of petroleum products is about 6 million tons per year from Aden and Marib refineries.

There are three textile factories in the Capital Sana'a; one of them follows the public sector, while the other two manufacturers follow the private sector. Textile production in Yemen is based on using local cotton, and imported wool and polyester threads. The lower limit emission factor of 0.1  $\mu\text{g TEQ/t}$  is used for PCDD/PCDF releases to product

There are three tanneries in Sana'a and three in the province of Hodaida. They are all owned by the private sector. Different types of leather are produced there, and the lower limit emission factor of 10  $\mu\text{g TEQ/t}$  is used for PCDD/PCDF releases to product

Table 34 shows the estimated PCDD/PCDF releases from 8 Main category 7 - The production and use of chemicals and consumer goods.

**Table 32: Estimated PCDD/PCDF releases from 8 main category 7 - the production and use of chemicals and consumer goods.**

#	Sub-category	Annual release (g TEQ/a)					
		Air	Water	Land	Product	Residue	Total
1	Boilers burning (per ton of pulp)	0	0	0	0	0	0
2	Paper and Pulp	0	0	0	0	0	0
3	Chemical industries	0	0	0	0	0	0
4	Pesticide Pollutants	0	0	0	0	0	0
5	Production of Chloranil	0	0	0	0	0	0
6	Production of dichloroethylene, VCM and PVC	0	0	0	0	0	0
7	Petroleum Industries	0	0	0	0	0	0



8	Textile factory				0.00001		0.00001
9	Leather factories				0.0023		0.0023
Total					0.0023		0.0023

### Main Source Category 8: Miscellaneous

Table 35 shows the estimated PCDD/PCDF releases from 9 Main category 8 – Miscellaneous.

Most activities under this category such as drying of biomass, crematoria, and smoke houses are not applicable to Yemen. Only dry cleaning and tobacco smoking are applicable.

Dry cleaning process includes cleaning textiles with solvents such as perchloroethylene. Emission factor of 3,000 µg TEQ/t is used for PCDD/PCDF releases to residues from heavy textiles and 50 µg TEQ/t is used in normal textiles. In tobacco smoking, the emission factors used are 0.3 and 0.1 µg TEQ/t item for cigars and cigarettes, respectively.

**Table 33: Estimated PCDD/PCDF releases from 9 main category 8 – miscellaneous.**

#	Sub-category	Annual release (g TEQ/a)					
		Air	Water	Land	Product	Residue	Total
1	Dry cleaning					0.20	0.20
2	Tobacco	0.01					0.01
Total		0.01				0.20	0.21

### Main Source Category 9: Landfill and Waste Dumps

Table 36 shows the estimated PCDD/PCDF releases from 10 Main category 9 - Disposal/Landfill.

Waste landfill sites are scattered in almost all the Governorates. Because of the lack of industrialization in Yemen the calculations were done as urban environments. There are more than 40 landfills in Yemen usually around the towns and main cities.

The amount of household waste generated from the governorates exceeds 1.1 million tons of which 10-85 % is buried. The hazardous waste includes the medical and industrial remnants which are 56000 and 34000 respectively.

The sewage produced by treatment plants is without removing sludge.

Compost production is common in Yemen in Hadhramaut only. The composted materials include fish, remnants of the kitchen, remnants of the garden, remnants of farms and remnants of household organic waste.

Different emission factors were used in calculating the PCDD/PCDF releases in this category depending on classes of wastewater. They range between 30 for household waste to 200 for hazardous waste, and 2 and 100 g TEQ/l for water and residue of sewage produced by treatment plants without removing sludge in water and 0.5 g TEQ/t in open water dumping and 100 in case of composting. The percentages release of the different components of the dioxins and furans in Yemen is shown in Figure 9. Figure 10 illustrates the percentages of the air, water and residue of the dioxins and furans in Yemen. Table 37 summarizes the results of the total PCDD/PCDF releases in Yemen.

**Table 34: Estimated PCDD/PCDF releases from 10 main category 9 - disposal/landfill.**

#	Sub-category	Annual release (g TEQ/a)					
		Air	Water	Land	Product	Residue	Total



1	Non-hazardous waste		10.31				10.31
2	hazardous waste		18.01				18.01
3	Sewage and sewage treatment	2.00				99.77	101.77
4	Sewage treatment plants		122.00				122.00
5	Composting					2.45	2.45
<b>Total</b>		<b>2.00</b>	<b>150.32</b>			<b>102.22</b>	<b>254.54</b>

Table 35: Summary of estimated PCDD/PCDF releases in Yemen.

#	Sub-category	Annual release (g TEQ/a)					Total	%
		Air	Water	Land	Product	Residue		
1	Waste incineration	50.34	0	0	0	34.28	84.61	8.20
2	Ferrous and non-ferrous metal production	121.38	0			43.01	164.41	15.94
3	Power generation and heating	98.33				5.3770	103.70	10.05
4	Mineral products	14.44					14.44	1.40
5	Transport	3.5131	0	0	0	0	3.51	0.34
6	Uncontrolled combustion processes	135.39		0.01		270.53	405.93	39.36
7	Production and use of chemicals and consumer goods				0.0023		0.0023	0.00
8	Miscellaneous	0.01				0.20	0.21	0.00
9	Disposal/landfill	2.00	150.32			102.22	254.54	24.68
1-9	<b>Total</b>	<b>425.40</b>	<b>150.35</b>	<b>0.01</b>	<b>0.0023</b>	<b>455.62</b>	<b>1031.38</b>	<b>100</b>
	<b>%</b>	<b>41.25</b>	<b>14.58</b>	<b>0.00</b>	<b>0.00</b>	<b>44.18</b>	<b>100</b>	

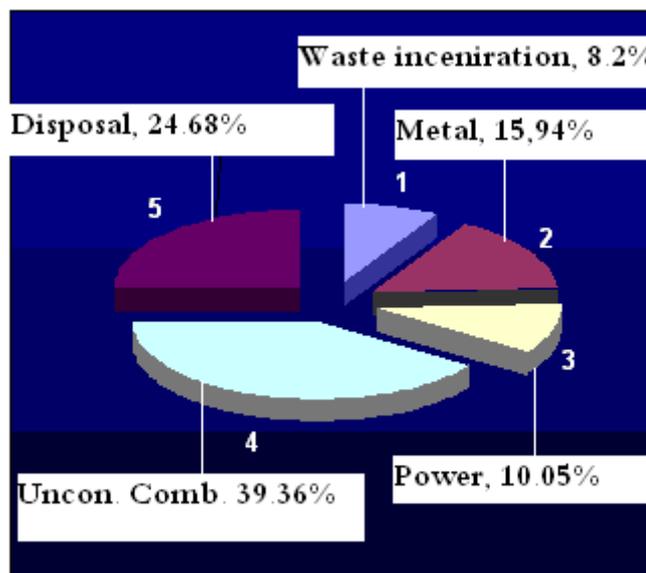


Figure 10: The percentages of the different components of the dioxins and furans in Yemen.

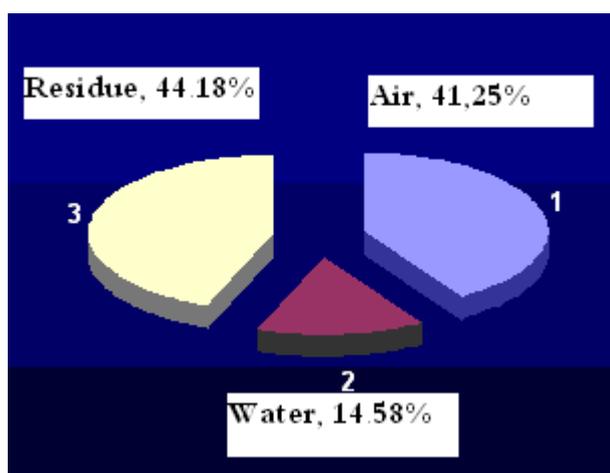


Figure 11: The percentages of the air, water and residue of the dioxins and furans in Yemen.



### **3.8. Impact of POPs on Health and Environment**

Among the pesticides that have been used in Yemen in the past, the organochlorinated pesticides (OCPs), which include all the pesticides listed in the POPs Convention, are thought to pose the biggest health and environmental risks due to their toxicity, persistence and bioaccumulation potential.

In the 1990s, their use in Yemen almost ceased. However, their intensive use in the past, their persistence in the environment and the related health risks still make of them a health and environmental threat.

The intense use of OCPs in the past, which reached a peak in the 1970s, caused pesticides accumulation in and contamination of soil and crops.

Presently it is well-known that some OCPs can persist in the soil for 10-20 years and more. This explains why DDT might be still detectable in the Yemeni environment, despite the fact that it was banned in 1990 and was not used in significant amounts since then.

Poor enforcement of specific rules and working instructions related to pesticides storage, transportation, preparation, use, etc., as well as insufficient awareness of the population on the health risks associated with pesticides, led to multiple violations of the regulations on handling toxic substances, including uncontrolled pesticide use on the individual plots of farmers.. This led to occupational health problems for many people directly involved in pesticides handling. This also contributed to the pesticides entering the environment and circulating in the food chains. Unfortunately, no attempt was made to detect pesticides and POPs residuals in foodstuffs (including DDT and HCB) e.g. fruits, canned goods, dairy products and meat. The contamination frequency would decrease during the last decade due to the banning of POPs since 1990. The same is true with regard to the breast milk of women living in villages where significant amounts of these pesticides were applied. The concentrations of pesticides in body fluids should give a clear correlation with the level of pesticide application in the fields.

The toxic effects of POPs on exposed people included reproductive dysfunctions and other functional disturbances in women, as well as increased frequency of masculine sterility, the incidence of both being related to the level of pesticides use. This is not true in Yemen since its citizens showed one of the highest fertilities in the world. The observed total fertility rate is 4.93 births per woman.

International epidemiological studies also revealed a correlation between the level of POPs use and the morbidity through chronic hepatitis and liver cirrhosis in the investigated areas. This might be true in Yemen. There are many health lever problems. Research findings identified a strong positive correlation between the general level of pesticides use and infant mortality. The rate of infant mortality is 82.4 children per 1,000 children according to the Yemeni Family Health Survey of 2004.

The demonstrated chronic effects on children and teenagers related to pesticides application included immune system disruptions, as well as physical and mental retardation. This might be applicable to Yemen. There are many sick children and all



kinds of cancers are available. Detailed studies are needed to correlate that to POPs. The comprehensive estimation of health status revealed an evident general worsening of children's and teenagers' health indices in areas with high level of pesticides application. It is considered that as a result of excessive use of pesticides the health status of at least two generations would be affected.

The burden of morbidity resulted from the acute and chronic effects of exposure to organic chemicals is significant in Yemen and has important social and economic costs. Prevention of further exposure of the population to POPs pesticides is one of the public health imperatives. Since the banning of POPs in 1990s in Yemen, the number of large pesticide users was in a continuous decline. Consequently, the number of people professionally exposed to pesticides at the work place also decreased. This does not mean, however, that the total number of exposed people decreased in the same proportion, since many peasants continue to apply pesticides on their individual plots in smaller amounts and under less controlled conditions. This might in fact have increased the risks of pesticide use, instead of decreasing them.

The assessment of impacts of POPs on population and the environment revealed lack of comprehensive and reliable environmental monitoring and epidemiological data, making it difficult to establish and quantify direct dose-response and other relationships between individual POPs and measurable environmental and health effects.

The following analyses have to be performed in Yemen:

- a) Monitoring of POPs residues in mother's milk.
- b) Monitoring of POPs residues in food stuff, water, air, soil, sediments and animal products.
- c) Monitoring of PCBs level in electrical equipment.
- d) Monitoring of dioxins and furans from emission sources.
- e) Investigating of probable POPs contaminated sites.
- f) Monitoring of POPs, PCBs, dioxins and furans in food products in Yemen.
- g) Acquire data on PCBs, dioxins and furans in the local animal feed of animal origin.
- h) Conduct periodic POPs monitoring of workers with exposure to these substances over a long period of time.
- i) Assess the long range transport of POPs air pollutants and their impact on ecosystem.
- j) Regular and periodic POPs monitoring.
- k) Integrate PCBs analyses into the drinking water monitoring program.
- l) Ensure the systematic update of the information on POPs emissions.



## 4. Strategy

The main objective of the NIP is implementing a sustainable policy, ensure the protection of human health and the environment from the impact of POPs by developing and regularly improving the most effective and optimal POPs management system.

The guiding principles of the policy are to obtain a thorough image of the risk caused by POPs to Yemen's population and environment by identifying the location of the sites, their scale and their urgency; protect human health and the environment from the harmful impact of POPs by reducing and decreasing POPs emissions and leakages, as well as gradually ceasing the use of POPs or POP-containing equipment; promote the cooperation between individuals and entities that are directly or indirectly involved in POPs created problems or are capable of solving these problems; attract donations from the Global Environmental Facility, for measures that could promote a decrease or elimination of the risk caused by POPs to human health or the environment.

The Government of Yemen has ratified the Stockholm Convention, Basel and Rotterdam conventions and is prepared to do its share to manage, phase-out and eliminate the chemicals now regulated and substances to be regulated in the future following the international agreements, conventions and practices considered suitable and applicable in the conditions of Yemen.

Further the Government of Yemen will note that the management and phasing out of the Persistent Organic Pollutants, within the framework of the Stockholm Convention and beyond it, requires international and regional cooperation, in which Yemen is actively participating.

The use of the pesticides and PCBs are largely based on research and technology conducted by developed, industrial countries. Yemen has had very modest opportunities to participate and contribute to this development in the past and considers, therefore, that the adverse effects of these substances should be mitigated with the support of those countries which directly and indirectly have benefited from the introduction of these chemicals. Yemen has never produced POPs chemicals and is no more importing or using the regulated pesticides. Yemen naturally recognizes its role in this development and will behave in a responsible and contributive way as a member of the international community.

The unintentional production of dioxins and furans in Yemen is very much related to the economic development and the practices of burning the agricultural residues, waste and wood. Dioxins and furans are one of the largest health hazards. However, the new energy sources are one alternative to reduce the production of dioxins and furans, or at least reduce the future growth.

Further Yemen aims to apply the Polluter Pays Principle (PPP) when mitigating the POPs generated problems. This principle would make a more direct link between the roots and causes and the corresponding financial phase-out costs. However, taking into consideration that the economic structure in the country is rapidly changing the PPP has limited opportunities regarding the problems from the past, but the PPP is to be incorporated in the further new activities.

Yemen is continuously revising and updating its regulatory framework regarding the environmental issues and environmental management. The POPs management, phase-out and elimination issues are being integrated in the climate change policy as appropriate, in



general in the framework of the management of chemicals and, increasingly in the industrial regulations and waste management.

The Government of Yemen has reviewed the NIP for POPs reduction and/or elimination submitted, by the Environmental Protection Authority and will adopt it and is committed to undertake adequate activities in order to comply with the tasks included in the NIP action plans and meet the Stockholm Convention provisions at the same time.

### **11.1. Actions to be Undertaken to Realize the National Objectives for POPs**

To attain the state objectives for the protection of human health and the environment from POPs in the short-term, medium-term or long-term period, the following tasks should be undertaken:

- Ensure the compliance of Yemeni legislations with the requirements of the Convention and Protocol;
- Resolve the waste management problems related to past pesticide usage;
- Develop the necessary institutional and technological basis for the safe waste management of PCB containing equipment and PCB containing waste, as well as implement the timely and safe collection and elimination of PCB containing waste;
- Improve the current monitoring of POPs emissions and implement preventive measures to decrease POPs emissions resulting from accidental fires and the combustion of wastes;
- Complete the planned POPs polluted site assessments and management;
- Create a system for the exchange of focused information and experience among local, regional and international institutions, as well as effectively attract and use international financing;
- Inform specific target groups of the requirements arising from the Convention and Protocol, as well as educate the target groups most affected by POPs about the potential harm from these substances and the possibilities for reducing their quantity;
- Initiate the POPs monitoring and evaluate the necessity for new monitoring;
- In order to facilitate future planning, collect data on POPs concentrations in humans and food products.
- Reduce POPs emissions while emphasizing POPs point-source emissions;
- Ensure the efficient control of POPs distribution and optimize the monitoring of POPs polluted sites;
- Develop an efficient cooperation between stakeholders and concerned state institutions, NGOs and scientific research institutions, thus promoting the successful solution of POPs related problems;
- Inform and educate enterprises and the population on POPs emission sources, thus promoting a reduction in POPs emissions and improve public awareness



about the choice of alternative materials versus POP-containing materials and the benefits of this use;

- Evaluate the obtained experience and optimize POPs monitoring in the environment, food and humans.
- Promote active public involvement in solving POPs related issues;
- Reduce the quantities of POPs generated by human activity and promote the sustainable use of natural resources, foster public awareness of the hazardous impact of POPs on human health and the environment, as well as gradually develop a sense of responsibility among the population for the reduction of POPs emissions.

#### ***4.2. NIP Implementation***

The implementation of the NIP is coordinated by the Ministry of Water and Environment.

No later than two years after the Stockholm Convention takes effect, the NIP must be sent to the Conference of the Parties of the Convention (Conference of the Parties – COP).

The Ministry of Environment represents Yemen in the COP and submits the following information via the Convention Secretariat (Secretariat):

- information on measures undertaken to comply with the requirements of the Stockholm Convention;
- an evaluation of effectiveness of the measures used to achieve the objectives of the Stockholm Convention;
- statistical data on the total production, import and export quantities or reasonable estimates for each one of the substances<sup>1</sup> listed in Annex A and Annex B;
- list of the recipient countries to which each of these substances was exported or imported from;
- report on the progress achieved in implementing the strategy process for the requirements of the 5th paragraph of the Stockholm Convention;
- reports and other information on monitoring for the presence of chemical substances and their global movement listed in Annexes A, B and C to the Stockholm Convention;
- information on violations of Article 17 of the Stockholm Convention

The NIP must be regularly reviewed based on to the requirements of the Stockholm Convention, as well as the amendments that need to be introduced according to COP requirements. It is useful to review the NIP within the task schedule for the implementation of the state objectives every five years and make the necessary amendments to ensure compliance with the terms of the NIP tasks. Any amendments to the NIP need to be reported to the Secretariat.

The NIP review and amendments are developed by the Ministry of Water and Environment, while the Cabinet of Ministers approves changes to the NIP.



The main stakeholders must be consulted prior to the review and amendments to the NIP, including: global, regional and sub-regional organizations (for example, GEF, UNDP); national stakeholders; NGOs working with women's groups and with children's health protection issues.

The implementation strategy serves as a road-map; how to reach the objectives set in the Stockholm convention. The main elements of the strategy, from the Yemeni perspective, are as follows:

\* Yemen has eliminated the use of the nine pesticides mentioned in Annex A. In practice this objective means that Yemen will not allow the re-use or re-introduction of these substances, which are no more used and, further, will actively seek cooperation and means to manage and eliminate there existing obsolete stocks. The pesticide strategy is supported by a concrete action plan.

\* Yemen will identify, label and remove from use the equipment using polychlorinated biphenyls (PCBs) and make efforts to reduce the possible exposures and to control risks as far as the equipment containing PCBs is still in use. Furthermore, Yemen will make efforts to manage and treat the PCBs containing equipment and PCBs as substances by the agreed deadlines of 2025 and 2028, respectively. An accelerated phase-out of PCBs is sought. The PCBs elimination strategy is supported by a concrete action plan.

\* Yemen will restrict the application of DDT in disease vector control when in utmost need only, if ever, and apply it in accordance with the WHO recommendations. To avoid the risks, however, Yemen will seek an entry to the DDT in the register of exemptions as established by the Stockholm Convention.

• Yemen will identify the known and assumed sources of the production of dioxins and furans and will further put extensive efforts and other resources to reduce the unintentional production by adopting the Best Available Technologies (BAT) and the Best Environmental Practices (BEP). The strategy is supported by concrete action plans covering the most important and critical emission sources.

### **4.3. Operational Objectives**

The implementation strategy consists of five major parts covering the actual, operational objectives in the management, phase-out and elimination of POPs; the five parts are:

- a) Development and setting up the necessary legal and administrative framework including the awareness raising within the stakeholders, non-sector specific support activities such as information exchange, monitoring and reporting mainly to inform the international community and the parties of the Stockholm Convention to keep Yemen in the page of the development.
- b) Management of POP pesticides and their obsolete stocks,
- c) Management of unintentional production of dioxins and furans,
- d) The management and elimination of PCBs, and
- e) Management and/or elimination (as appropriate) of DDT in vector control.

The overall strategy to reach the objectives established above will be a combination of several measures including direct government involvement (regulations and law enforcement efforts), support to the local actors, direct market instruments like possible subventions and tax-breaks, seeking international cooperation and co-funding.



An essential part of the POPs management and phase-out efforts is the extensive regional and international cooperation regarding both the impacts assessment as well as the management and phase-out measures, both regulatory and technical.

The major, tangible implementation strategies are supported by action plans and largely quantified programs and projects while some POPs areas still need further elaboration within the opted strategy before being tuned into more tangible actions and projects. Further, the important support activities like monitoring, reporting and POPs related research and development are also dealt with.

#### **4.4. Priorities**

The overall strategy is based on national priorities that have been set, based on consultations and other discussions involving all the relevant stakeholders. Before setting these priorities the NIP compilation process made efforts to provide all stakeholders with complete information regarding the current status, the known facts and the estimated impacts using legal and regulatory requirements, estimated and/or known environmental and ecological impacts, human exposure and urgency as priority criteria.

The priority issue and its criteria were discussed in detail at a special meeting of the stakeholders. Each individual member assessed the priority of each POPs problem category (pesticides, PCB, DDT, and dioxin and furans by source category) by giving her/his qualified opinion and priority order. The priorities adopted are as follows:

First Priority the management and proper disposal of obsolete pesticide stocks (together with the contaminated soils surrounding the pesticide storages and the contaminated pesticide containers)

Second priority is the uncontrolled combustion mainly waste burning including hazardous wastes.

Third priority group consists of measures to manage dioxin and furan releases from waste incineration, power generation and heating (e.g. biomass/wood burning for domestic purposes,) from the production of chemical and consumer goods and from the production of mineral products

Fourth priority covers the management and phase-out of PCB in transformers and capacitors

Fifth priority includes waste disposal at landfills and its transportation.

The abovementioned priority order makes the baseline in the sequence of the proposed actions and the Government of Yemen is applying this order whenever appropriate and expects that the external parties supporting the implementation also follow the said order.

The Stockholm Convention doesn't set any specific time frames in the restriction and elimination of the controlled POPs except that the PCBs contaminated equipment containing liquid stocks should be identified, labeled and removed from use by 2025 and that PCB as liquid is managed (in practice destructed) in an environmentally sound manner by 2028. Yemen notes that the above mentioned deadlines are subject to review by the conference of parties and that earlier phase-out and elimination measures may be not only environmentally but also economically reasonable.

The implementation of POPs management and phase-out in Yemen is scheduled to start, in the mode as stipulated in the Stockholm Convention, immediately. The preliminary



target being that the tangible, concrete measures will take place within 2007-2010 after which time period the POPs management will be turned into a more routine best environmental practices supported by regulatory framework, monitoring and research and development.

#### **4.5. Coordination**

The POPs in Yemen are scattered over several economic sectors as well as over a very wide geographical context. The strategy is, however, to keep all the efforts coordinated and monitored by one institution within the Government, i.e. by the General Environmental Protection Authority but leave enough space and resources for the sectors involved to guarantee a smooth and non-frictional work.

The existing coordination unit does not have further mandate to coordinate the implementation of the NIP. However the General Environmental Protection Authority should be strengthened to establish specific POPs project to safeguard the utilization of results already achieved and to serve as a coordinating body within the government and, as appropriate, within other agencies. Hence the General Environmental Protection Authority will be the lead agency in the implementation of the NIP with the following TOR:

1. Undertake regular monitoring and evaluation of the NIP implementation.
2. Update the NIP after a period of five years or earlier if the prevailing political situation in the country necessitates so.
3. Coordinate the execution of action plans.
4. Facilitate fund raising for the project proposals in the present NIP.
5. Facilitate information exchange with General Secretariat of the convention and the other relevant agencies.
6. Act as a national focal point for all information database and dissemination pertinent to POPs.
7. Create linkages with international agencies to gain technical support and any recent advancement in the POPs issues.

#### **4.6. Monitoring and Evaluation**

The monitoring and evaluation of the NIP implementation will be undertaken by the General Authority of Environmental Protection and the funding agencies, national and/or international through consensus workshops. The purpose of monitoring and evaluation process is to measure the impacts of the activities on the set goals of the action plans to see how much achievement in the elimination of POPs has been reached.

### **3.4 Development and capacity-building proposals and priorities**

The main objective of Stockholm Convention is to protect human health through the elimination of the hazardous chemicals: chlorinated pesticides, PCBs, dioxins and furans from the environment. This can be achieved by improving and establishing legal and administrative measures to get rid of present and future production and use of POPs, increasing awareness on the dangers of using these chemicals, and to identify safe alternatives for chlorinated pesticides.



The preliminary inventory done in this work has been assessed in light of the current situation in Yemen. Measures to reduce or eliminate POPs from intentional and unintentional production and use have been identified. Based on this, the following capacity building proposals are suggested:

### **I. Management Capacity Building**

The following will be considered:

1. Adopting the National Implementation Plan (NIP). This will be the focal point for all POPs activities in the country and will communicate with the secretariat of the Stockholm convention and with all institutions and stakeholders working with POPs in the country.
2. Adjustment of laws and legislations by the Ministry of Environment to consider all issues related to POPs regarding manufacture, unintentional production, trade, handling, storage, use and disposal.
3. Assigning responsibilities to different institutions to avoid overlapping and duplication.
4. Development of human resources to be able to implement and enforce legislations and guidelines and environmental sound management of POPs.

### **II. Technological Infrastructural Capacity Building**

With regard to infrastructure capacity building the following is adopted:

- Identify and assess the few laboratories in the country capable of dealing with POPs analysis and assessment.
- Upgrade the facilities at the different institutions dealing with POPs and their analysis.
- Establish a center for the analysis of dioxins and furans, PCBs., POPs etc within the frame work of the POPs Institute
- Put a plan for interlab comparison, proficiency testing and lab accreditation.
- Training on safe collection and storage of POPs wastes
- Establishment of POPs waste destruction and or decontamination facilities.
- Get rid of POPs stockpile pesticides in an environmentally sound manner.
- Suggestion of alternative pesticides, natural enemies and their safe use and storage.
- Arrange for proper storage of stockpiles until the possibility exists for getting rid of them in an environmentally sound matter or exporting them outside the country to a place where safe destruction of these chemicals is possible.
- Education on handling of these compounds.
- Collect all the information available at all institutions working on residues of POPs about levels of these compounds in the environment.
- Prepare a detailed workplan for field investigation all over the country to assess the degree of pollution with these compounds or their degradation products.



- Preparation of a national plan to combat diseases that affect humans using integrated vector management concept.
- Train the customs officers in dealing with chemicals and provide the cross points at the boarders and quarantine centers with pesticide data base and ensure that the scientific name and Cas. No. for each chemical is used.
- Monitoring is necessary and missing in this country. Set standards for the levels of the different POPs that are allowed for different environmental elements including: water, soil, sediments, and follow the pollution with these compounds in the food chain until mother's milk and human tissues are reached and set limits for POPs in these matrices. This can be based on international experience and the surveys that are conducted in the country. A Poson Institute, Yemeni Authority for Food Health Security and National POPs Institute are suggested.
- Establish a computerized data base on POPs and make this available for all stakeholders and researchers.

### **III. Awareness Program**

A detailed awareness plan is to be prepared including the following:

1. POPs: how are they produced, their danger, and how do they accumulate in the environment for the different sectors of the society.
2. Make the people, especially the farmers, aware of alternative pesticides and their safe use.
3. Educate decision makers and legislators on the danger of these compounds.
4. Introduce these compounds to the students in the curricula in high schools and at universities.
5. Make the information about POPs available to the public by different means.
6. POPs awareness campaigns should address NGOs, physicians and women societies.

### **3.6 Resources requirement**

#### **I. Institutional Framework Requirements:**

- The Ministry of Environment personnel should be capable of controlling the use and emission of POPs chemicals in the country.
- The Ministry of Environment personnel should be technically and legally aware of all issues related to complying with Stockholm's convention.
- Regular Monitoring of these chemicals to check for compliance with standards can be conducted either by the ministry of environment personnel or be contracted to an accredited institution/s in the country.
- Plant personnel should be trained to be capable of checking the emissions of POPs on continuous basis.
- Coordination between all institutions working on POPs should take place to avoid unnecessary duplication.



- There should be a policy set for POPs issues and application of Stockholm convention and this should be institutionalized and be independent of who the decision maker is.

## **II. Capacity Building Requirement**

Capacity building is required in the following areas:

- Laboratories dealing with monitoring and analysis of POPs:

These should be upgraded in terms of instruments, space, and training of personnel. Accreditation of these labs is essential to ensure the quality of the data obtained by these labs.

- There is a need to establish a lab in the country capable of analyzing dioxins and furans.
- Establishing a data base for POPs is essential .A net work between all stakeholders should be created.
- Research in POPs regarding their release and transfer in the environment, health effects, safe alternatives, safe destruction and disposal, advances in analytical methods for their analysis and monitoring is highly required.
- Human resource development in all the above mentioned areas is a necessity for the successful implementation of the Stockholm convention. This requires conducting training courses on the, national and international level, information exchange, training towards graduate degrees (masters and PhDs), and conducting awareness workshops.

To achieve these requirements funding is required. This has been estimated to reach a total value of US\$ 65,260,000.



## ***4.7. Activities, Strategies and Action Plans***

### **4.7.1. Activity: Strengthening of Institutional System and Improvement of Legislative Basis.**

#### Objective

The main objective of this activity is to ensure the compliance of Yemeni legislation to the requirements of the Convention and Protocol and develop an effective mechanism for the fulfillment of these requirements, as well as maintain control over the compliance with these requirements.

#### Activities:

1. Establish a National Implementation Unit in the General Authority for Environmental Protection with detailed responsibilities.
2. Ensure the compliance of Yemeni legislation with the requirements of the Convention and Protocol by revision of existing legislation; identification of gaps; recommendations for amendments; stakeholders consultations.
3. Introduce Yemeni legislations on POPs pesticides.
4. Introduce Yemeni legislations on POPs emissions.
5. Introduce Yemeni legislations on POPs polluted sites.
6. Introduce Yemeni legislations on commercialization of insecticides for public and hygienic use.
7. Promote the use of best available technologies and improve the control over the use of these technologies.
8. Increase the expertise of environmental inspectors responsible for the control of POPs sources.
9. Improve the knowledge of municipal employees on polluted sites management, including POPs polluted sites.
10. Support to the creation of a Yemeni Authority for Food Health Security.
11. Enforce adequate monitoring practices of POPs emissions and implement preventive measures to decrease unintentional POPs emissions.
12. Enhance efficient cooperation between stakeholders and concerned institutions, NGOs, local communities and research centers.
13. Establishment of a Poison Institute.
14. Preparation of a special program to build the capacity of workers in the area of chemicals.
15. Establishment of the National Environmental Laboratory, namely samplings and analyses of dioxins and furans, pesticides, PCBs ..etc.
16. Establishment of the Yemeni National POPs Institute concerned by POPs information, management, monitoring and analyses.



#### **4.7.2. Activity: - Measures to reduce or eliminate emission from intentional production and use.**

##### Objectives:

The objectives of this activity are to improve or to establish legal and administrative measures to get rid of present and future production and uses of Pops.

##### Activities:

1. Reinforcement of national capacities with regard to technical expertise, ecologically sound management, scientific documentation and BAT/BEP on POPs.
2. Periodical evaluation of the Stockholm Convention implementation in Yemen every five years.
3. Undertake appropriate activities of development research and transfer of know-how through cooperation with advanced countries with regard to POPs.
4. Inspection and monitoring of POPs in the environment, in framework of the evaluation of the Stockholm Convention.
5. Installing a pilot site for destruction of equipment contaminated by PCBs.
6. Elimination of obsolete POPs pesticides.
7. Development of an integrated strategy for management of chemicals use in the fight against disease vectors, including DDT.
8. Study on identification and feasibility of decontamination of all sites contaminated by PCBs and POPs;
9. Updating inventories of dioxins and furans, pesticides, PCBs every five years.
10. Reduce POPs emissions from fires in waste disposal sites.

#### **4.7.3 Activity: Production, import, and export, use, stockpiles, wastes of Annex A POPs pesticides**

##### Objectives:

The objectives of action plan are to continue to enforce banning POPs pesticides and to eliminate their residues in the environment components through proper environmental approaches.

##### Activities:

1. Define stockpiles of existing banned POPs pesticides.
2. Label and repack of POPs pesticides stockpiles properly.
3. Store and/or dispose of POPs pesticides stockpiles in an environmentally sound manner.
4. Decrease the risk of human health and the environment caused by PCBs.
5. Collect PCBs containing waste.
6. Ensure the timely and safe destruction of PCBs containing waste.



7. Develop a national strategy of communication on POPs.
8. Information, training and education of the public including workshops, seminars, conferences, etc..
9. Support NGOs concerned with environmental issues and protection of population health with regard to POPs.
10. Training of Customs employees and environment inspectors in the field of POPs and chemical products.
11. Training of national professional staff in public and private sectors on POPs.
12. Enlightening of media representatives on POPs.
13. Provide the public with health and environmental information regarding POPs and put into practice measures of labelling and sensitizing consumers.
14. Maintain, update and administration of website on POPs ([www.pop-yemen.org](http://www.pop-yemen.org)).

#### **4.7.4. Production, Import and Export, Use, Identification, Labeling, Removal, Storage and Disposal of PCBs and Equipment Containing PCBs.**

##### Objective

The main objective is to prepare inventories on equipment containing PCBs, prepare technical standards concerning analysis, transportation, storage, exchange, decontamination and destruction of PCBs; and develop system for monitoring of contaminated areas and point sources.

##### Activities:

1. Conduct comprehensive field surveys in order to complete the PCBs inventories on the national level.
2. Promote the replacement of PCB-containing equipment, thus promoting the timely collection and destruction of PCB containing waste.
3. Introduce Yemeni legislations on PCBs containing equipment and materials.
4. Develop guidelines for collection and safe disposal of contaminated oils and equipment.
5. Define, label, and store stockpiles of existing contaminated oils and equipment.
6. Clean or replace contaminated equipment.
7. Dispose of PCBs stockpiles and/or contaminated equipment in an environmentally sound manner.
8. Promote recycling of each type of waste in an appropriate technological way.

#### **4.7.5. Activity: Production, Import and Export, Use Stockpiles and Wastes of DDT**

##### Objectives:

The main objectives of this action plan is to prepare and adopt of a strategy for control, completion, collection, and disposal of DDT, and secure environmentally sound destruction of stockpiles of DDT in Yemen.



Activities:

1. Define stockpiles of existing banned DDT.
2. Label and repack of DDT stockpiles properly.
3. Store and/or dispose off DDT stockpiles in an environmentally sound manner.
4. Conduct a planned assessment of POPs polluted sites.
5. Develop a national program for POPs polluted sites.
6. Ensure availability of a record of POPs generating contaminants.

**4.7.6. Activities: Register of exemption and the continuing need for exemption**

Objective:

Periodical assessment and evaluation of the POPs situation may indicate the need for specific exemption, in such case the Convention secretariat will be informed.

Activities:

1. Ensure a constant information exchange on POPs with the Convention Secretariate and the Government of Yemen.
2. Ensure availability and transparency of POPs information and the efficient resolution of POPs related problems in Yemen.
3. Encourage the public involvement in the resolution of POPs related problems.
4. Promote development and implementation of projects on POPs related problems.

**4.7.7. Plan actions: Measures to reduce releases from unintentional production:**

Objectives:

The main objective of this activity is to take necessary measures in order to reduce the releases of PCDD/PCDF, PCBs and HCBs.

Activities:

1. Control of solid waste open burning.
2. Develop and activate proper procedures to collect and dispose of medical waste in environmentally sound manner.
3. Improve usage and/or disposal of sludge generated from wastewater plants.
4. Improve current disposal operations by adopting sanitary land filling of waste.
5. Study the feasibility of upgrading existing and/or constructing regional medical waste incinerators.
6. Enhance and support renewable energy projects, rationalize energy use and encourage production and use of clean fuels such as natural gas and bio-fuels.



7. Expand the knowledge on the impact of PCBs on human health and the environment for the social groups most affected by the PCBs.
8. Ensure that industries using PCBs containing equipment or waste are aware of the regulations for the destruction of all BCPs equipment by 2010 and provide the means, knowledge and mechanisms for the fulfillment of the requirement.

#### **4.7.Λ. Activity: measures to reduce releases from stockpiles and wastes**

##### Objective:

The main aim of this activity is to reduce the releases from stockpiles and wastes by adopting the most applicable and acceptable measures.

##### Activities:

1. Adopt acceptable international standards and codes of practices in order to ensure safe storage of POPs stockpiles and waste
2. Apply best available technology and best environmental practices (BAT/BEP) in order to reduce and dispose off waste in safe and an environmental friendly manner.
3. Encourage participation of private sector in waste management.

#### **4.7.9. Activity: Identification of Stockpiles, Articles in Use and Wastes**

##### Objective:

The objective of this activity is to develop proper strategies to identify stockpiles of all POPs, and suspected contaminates.

##### Activities:

1. Develop and collect a database on hot spots, stockpiles, waste and contaminated sites
2. Develop and adopt measures to reduce releases of waste, stockpiles containing or contaminated with POPs, including PCBs compounds.



#### **4.7.10. Management of stockpiles and appropriate measures for handling and disposal of articles in use.**

Objective:

Management of identified stockpiles of POPs and undertake sound environmental measures for final disposal to protect the environment.

Activities:

- 1- Establish realistic procedures for handling, disposal of stockpiles, articles in use and waste.
- 2- Complete database of hotspot and contaminated sites.
- 3- Management of waste in an environmental sound manner.

#### **4.7.11. Identification of contaminated sites (Annexes A, B and C chemicals) and remediation in an environmentally sound manner**

Objective:

During the preparation of PCBs inventory, no attempt was made to identify contaminated sites with PCB compounds due to time and budget limitations as well as the absence of analytical capability of such compounds. Furthermore, no reliable data is available to decide which site is contaminated. From historical review and experience few suspected sites could be identified. These include old power stations, workshops for repairing transformers and capacitors and free zones at Zarqa and Aqaba.

Activities:

1. Conduct an inventory of contaminated areas with an analysis of the ecological risks and evaluate the need for decontamination.
2. Establish a national center for capacity building and technology transfer.
3. Develop and upgrade proper labs for quantity analysis and provide existing analysis labs with advanced facilities to get accurate data and accelerate analysis procedures, to be internationally accredited.
4. Remediation of POPs contaminated sites.

#### **4.7.12. Activity: Facilitating or undertaking information exchange and stakeholders involvement.**



Objectives:

The aim of this activity is to develop an efficient information exchange at the national, regional and international levels and create mechanism for stockholder involvement in issues related to POPs

Activities:

1. Create and improve existing information exchange mechanisms on national level.
2. Develop new information exchange mechanisms to fulfill the needs emerged from the progress of POPs related issues on national, regional and international levels.
3. Support, encourage, strengthen and maintain involvement of various stakeholders in POPs related issues.
4. Synergize different international agreements related to chemical and POPs issues.
5. Enable an easy access of public to data and available information.
6. Ensure exchanging educational and public awareness tools related to POPs and their alternatives at national and international levels.

**4.7.1<sup>۳</sup>. Activity: Public awareness, information, and education**

Objectives:

The main targets of this activity are to raise the public awareness on the POPs management related issues and specifically on its impact on human health and environment; and to encourage education on POPs include POPs in study programs of school and universities.

Activities:

1. Create and approve a national plan for protecting public health from impacts resulted from exposure to POPs
2. Develop a strategy for raising awareness campaigns.
3. Raise awareness for decision-makers on POPs related issues.
4. Make information on POPs available to the public through different media channels (TV, radio, press and printed materials).
5. Raise awareness on POPs related issues to public through different activities, focusing on specific target groups, such as industrial and agricultural sectors, women and children, etc.
6. Publish different guidelines on the impacts and hazards of POPs on health and environment for the different exposed target groups.
7. Set a long-term plan to include POPs subjects in the programs of different educational stages.
9. Improve the public awareness and knowledge of POPs, their harmful effects on human health and the reasons for the generation of POPs.
10. Improve the knowledge of general practitioners and Gynecologists of the impact of PCBs on human health.



11. Encourage postgraduate studies to conduct research in different POPs issues and provide the needed funds and facilities.

#### **4.7.14. Activity: Effectiveness evaluation (article 16)**

##### Objectives:

The main aim of this activity is to ensure the effectiveness of the programs and measures undertaken. The effectiveness will be evaluated periodically after this convention is enforced. The periodicity of the evaluation of the effectiveness will be decided by the Ministry of Water and Environment.

##### Activities:

1. Assign responsibilities to different institutions to avoid overlapping and useless repetition.
2. Update inventories on current health, and environment hazards of POPs
3. Analyze samples taken from different POPs suspected sites
4. Establish a system for monitoring, evaluating and follow up.
5. Develop centers for analysis of dioxins and furans.
6. Upgrade the facilities at the different institutions dealing with POPs analysis.
7. Support and encourage accreditation of labs for the POPs analysis.
8. Develop a system for safe storage of collected POPs wastes.
9. Develop of POPs waste destruction and/or decontamination facilities.

#### **4.7.15. Activity: Reporting**

##### Objective:

The main objective of this activity is to ensure the collection and proper dissemination of data to all interested parties and stakeholders.

##### Activities:

Ensure and support reporting in compliance with the requirement of the Stockholm Convention.

#### **4.7.16. Activity: Technical and financial assistance.**

##### Objectives:

The main target of this activity is to identify the financial assistance needed for NIP implementation.

##### Activities:

- 1) Form an expert committee to identify the country needs of laboratories and related technical facilities. These facilities should be procured in earlier stages of the NIP project in the context of the Stockholm Convention on POPs.



- 2) Provide financial resources are needed for building the capacity of local specialists in PCDD/PCDF, PCBs and other POPs subjects through appropriate training programs. Such programs can be implemented inside and outside the country in coordination with donors and the Stockholm Convention secretariat.
- 3) Construct regional medical waste incinerators. At least an incinerator is needed in every Governorate.
- 4) Secure the needed financial and technical support for cleaning up and remediation measures that could be needed for the contaminated sites.
- 5) Enhance and support the renewable energy projects, rationalizing the energy use and encouraging the production and the use of clean fuel.
- 6) Safe storage and destruction of any POPs stockpiles in Yemen and ensure their proper disposal with the assistance of the international institutions in accordance with the Basel Agreement.
- 7) Develop a national program for control of vectors of human diseases that are born by biological vectors, using the Integrated Vector Management (IVM) technique, including provision of support to such programs as the alternative pesticides are costly.

#### **4.7.17. Activity: Research, development and monitoring (Article 11)**

##### Objectives:

The prime objectives of this activity are to monitor the environmental contamination with POPs and to conduct research on minimizing and eliminating POPs compounds and their releases in Yemen environment.

##### Activities:

1. Encourage research on POPs and their alternatives
2. Establish a National POPs Monitoring Committee for environmental monitoring of POPs for supervising research, development, discussing results and suggesting ideas, by the Yemeni government. This committee might consist of members from Ministry of Water and Environment, Ministry of Agriculture, Ministry of Health, Ministry of Finance, Ministry of Higher Education and Scientific Research, University of Sana'a (Chemistry Department), University of Sana'a (Center of water and environment) and five academicians.

Accreditation for each selected laboratory should be made. The monitoring of POPs in the environment can be:

- a) Monitoring of POPs residues in mother's milk.
- b) Monitoring of POPs residues in food staff, water, air, soil, sediments and animal products.
- c) Monitoring of PCBs level in electrical equipment.
- d) Monitoring of dioxins and furans from emission sources.
- e) Investigating of probable POPs contaminated sites.
- f) Monitoring of POPs, PCBs, dioxins and furans in food products in Yemen.



- g) Acquire data on PCBs, dioxins and furans in the local animal feed of animal origin.
- h) Conduct periodic POPs monitoring of workers with exposure to these substances over a long period of time.
- i) Assess the long range transport of POPs air pollutants and their impact on ecosystem.
- j) Regular and periodic POPs monitoring.
- k) Integrate PCBs analyses into the drinking water monitoring program.
- l) Ensure the systematic update of the information on POPs emissions.



**Estimation of time and budget for the implementation of the different action plans**

#	Action plan	Time span	Year	Budget \$
<b>1</b>	<b>Strengthening of Institutional System and Improvement of Legislative Basis</b>			<b>19,140,000</b>
	Establish a National Implementation Unit in the General Authority for Environmental protection with detailed responsibilities.	12 m	2009	220,000
	Ensure the compliance of Yemeni legislation with the requirements of SC and Protocol by revision of existing legislations; identification of gaps; recommendations for amendments; stakeholders consultations.	12 m	2008	120,000
	Introduce Yemeni legislations on POPs pesticides.	36 m	2009	300,000
	Introduce Yemeni legislations on POPs emissions.	36 m	2009	300,000
	Introduce Yemeni legislations on POPs polluted sites.	36 m	2009	300,000
	Introduce Yemeni legislations on commercialization of insecticides for public and hygienic use.	36 m	2009	300,000
	Promote the use of best available technologies and improve the control over the use of these technologies.	36 m	2009	400,000
	Increase the expertise of environmental inspectors responsible for the control of POPs sources.	24 m	2009	400,000
	Improve the knowledge of municipal employees on polluted sites management, including POPs polluted sites.	24 m	2009	400,000
	Support to the creation of a Yemeni Authority for Food Health Security.	60 m	2010	3,000,000
	Enforce adequate monitoring practices of POPs emissions and implement preventive measures to decrease unintentional POPs emissions.	36 m	2009	900,000
	Enhance efficient cooperation between stakeholders and concerned institutions, NGOs, local communities and research centers.	36 m	2009	700,000
	Establishment of a Poison Institute.	60 m	2010	3,000,000
	Preparation of a special program to build the capacity of workers in the area of chemicals.	36 m	2009	400,000
	Establishment of the National Environmental Laboratory, namely samplings and analyses of dioxins and furans, pesticides, PCBs ..etc.	60 m	2010	5,000,000
	Establishment of the Yemeni National POPs Institute concerned by POPs information, management, monitoring and analyses	60 m	2010	3,000,000
<b>2</b>	<b>Measures to reduce or eliminate emission from intentional production and use</b>			<b>5,950,000</b>
	Reinforcement of national capacities with regard to technical expertise, ecologically sound management, scientific documentation and BAT/BEP on POPs.	36 m	2009	300,000
	Periodical evaluation of the Stockholm Convention implementation in Yemen every five years.	36 m	2009	300,000
	Undertake appropriate activities of development research and transfer of know-how through cooperation with advanced countries with regard to POPs.	60 m	2009	400,000
	Inspection and monitoring of POPs in the environment, in framework of the evaluation of the Stockholm Convention.	36 m	2009	500,000
	Installing a pilot site for destruction of equipment contaminated by PCBs.	36 m	2009	450,000
	Elimination of obsolete POPs pesticides.	24 m	2009	1,400,000
	Development of an integrated strategy for management of chemicals use in the fight against disease vectors, including DDT.	36 m	2009	400,000
	Study on identification and feasibility of decontamination of all sites contaminated by PCBs and POPs;	60 m	2010	600,000
	Updating inventories of dioxins and furans, pesticides, PCBs every five years.	36 m	2009	900,000
	Reduce POPs emissions from fires in waste disposal sites.	36 m	2009	700,000
<b>3</b>	<b>Production, import, and export, use, stockpiles, wastes of Annex A POPs pesticides</b>			<b>9,440,000</b>
	Define stockpiles of existing banned POPs pesticides.	36 m	2009	250,000
	Label and repack of POPs pesticides stockpiles properly.	24 m	2009	1,200,000
	Store and/or dispose of POPs pesticides stockpiles in an environmentally sound manner.	36 m	2009	800,000
	Decrease the risk of human health and the environment caused by PCBs.	60 m	2010	900,000
	Collect PCBs containing waste.	36 m	2010	900,000
	Ensure the timely and safe destruction of PCBs containing waste.	36 m	2010	700,000
	Develop a national strategy of communication on POPs.	36 m	2009	300,000
	Information, training and education of the public including workshops, seminars, conferences, etc..	48 m	2010	1,200,000
	Support NGOs concerned with environmental issues and protection of population health with regard to POPs.	60 m	2009	600,000
	Training of Customs employees and environment inspectors in the field of POPs and chemical products.	36 m	2010	600,000
	Training of national professional staff in public and private sectors on POPs.	36 m	2009	600,000
	Enlighten media representatives on POPs.	24 m	2009	700,000
	Provide the public with health and environmental information regarding POPs and put into practice measures of labeling and sensitizing consumers.	36 m	2009	450,000
	Maintain, update and administration of website on POPs (www.pop-yemen.org).	60 m	2010	240,000
<b>4</b>	<b>Production, Import and Export, Use, Identification, Labeling, Removal, Storage and Disposal of PCBs and Equipment Containing PCBs.</b>			<b>4,540,000</b>
	Conduct comprehensive field surveys in order to complete the PCBs inventories on the national level.	36 m	2010	300,000
	Promote the replacement of PCB-containing equipment, thus promoting the timely collection and destruction of PCB containing waste.	48 m	2010	1,200,000
	Introduce Yemeni legislations on PCBs containing equipment and materials.	24 m	2010	300,000
	Develop guidelines for collection and safe disposal of contaminated oils and equipment.	36 m	2010	300,000
	Define, label, and store stockpiles of existing contaminated oils and equipment.	36 m	2010	800,000
	Clean or replace contaminated equipment.	24 m	2009	800,000
	Dispose of PCBs stockpiles and/or contaminated equipment in an environmentally sound manner.	36 m	2010	600,000
	Promote recycling of each type of waste in an appropriate technological way.	36 m	2010	240,000
<b>5</b>	<b>Production, Import and Export, Use Stockpiles and Wastes of DDT</b>			<b>3,440,000</b>
	Define stockpiles of existing banned DDT.	36 m	2010	800,000
	Label and repack of DDT stockpiles properly.	24 m	2009	800,000
	Store and/or dispose off DDT stockpiles in an environmentally sound manner.	36 m	2010	600,000



	Conduct a planned assessment of POPs polluted sites.	36 m	2010	400,000
	Develop a national program for POPs polluted sites.	36 m	2010	600,000
	Ensure availability of a record of POPs generating contaminants.	36 m	2010	240,000
<b>6</b>	<b>Register of exemption and the continuing need for exemption</b>			<b>500,000</b>
	Ensure a constant information exchange on POPs with the Convention Secretariate and the Government of Yemen.	36 m	2010	200,000
	Ensure availability and transparency of POPs information and the efficient resolution of POPs related problems in Yemen.	36 m	2010	100,000
	Encourage the public involvement in the resolution of POPs related problems.	36 m	2010	100,000
	Promote development and implementation of projects on POPs related problems.	36 m	2010	100,000
<b>7</b>	<b>Measures to reduce releases from unintentional production</b>			<b>3,550,000</b>
	Control of solid waste open burning.	36 m	2010	450,000
	Develop and activate proper procedures to collect and dispose of medical waste in environmentally sound manner.	48 m	2010	900,000
	Improve usage and/or disposal of sludge generated from wastewater plants.	36 m	2010	300,000
	Improve current disposal operations by adopting sanitary land filling of waste.	48 m	2010	600,000
	Study the feasibility of upgrading existing and/or constructing regional medical waste incinerators.	24 m	2010	200,000
	Enhance and support renewable energy projects, rationalize energy use and encourage production and use of clean fuels such as natural gas and bio-fuels.	36 m	2010	600,000
	Expand the knowledge on the impact of PCBs on human health and the environment for the social groups most affected by the PCBs.	36 m	2010	300,000
	Ensure that industries using PCBs containing equipment or waste are aware of the regulations for the destruction of all BCPs equipment by 2011 and provide the means, knowledge and mechanisms for the fulfillment of the requirement.	24 m	2010	200,000
<b>8</b>	<b>Measures to reduce releases from stockpiles and wastes</b>			<b>1,100,000</b>
	Adopt acceptable international standards and codes of practices in order to ensure safe storage of POPs stockpiles and waste	36 m	2010	600,000
	Apply best available technology and best environmental practices (BAT/BEP) in order to reduce and dispose off waste in safe and an environmental friendly manner.	36 m	2010	300,000
	Encourage participation of private sector in waste management.	24 m	2010	200,000
	Identification of Stockpiles, Articles in Use and Wastes			300,000
	Develop and collect a database on hot spots, stockpiles, waste and contaminated sites	36 m	2010	100,000
	Develop and adopt measures to reduce releases of waste, stockpiles containing or contaminated with POPs, including PCBs compounds.	24 m	2010	200,000
<b>9</b>	<b>Management of stockpiles and appropriate measures for handling and disposal of articles in use.</b>			<b>500,000</b>
	Establish realistic procedures for handling, disposal of stockpiles, articles in use and waste.	36 m	2010	300,000
	Complete database of hotspot and contaminated sites.	36 m	2010	100,000
	Management of waste in an environmental sound manner.	24 m	2010	100,000
<b>10</b>	<b>Identification of contaminated sites (Annexes A, B and C chemicals) and remediation in an environmentally sound manner</b>			<b>1,900,000</b>
	Conduct an inventory of contaminated areas with an analysis of the ecological risks and evaluate the need for decontamination.	36 m	2010	300,000
	Establish a national center for capacity building and technology transfer.	36 m	2010	800,000
	Develop and upgrade proper labs for quantity analysis and provide existing analysis labs with advanced facilities to get accurate data and accelerate analysis procedures, to be internationally accredited.	24 m	2010	700,000
	Remediation of POPs contaminated sites.	24 m	2010	100,000
<b>11</b>	<b>Facilitating or undertaking information exchange and stakeholders involvement.</b>			<b>900,000</b>
	Develop new information exchange mechanisms to fulfill the needs emerged from the progress of POPs related issues on national, regional and international levels.	36 m	2010	100,000
	Support, encourage, strengthen and maintain involvement of various stakeholders in POPs related issues.	36 m	2010	200,000
	Synergize different international agreements related to chemical and POPs issues.	24 m	2010	200,000
	Enable an easy access of public to data and available information.	24 m	2010	100,000
	Ensure exchanging educational and public awareness tools related to POPs and their alternatives at national and international levels.	48 m	2010	200,000
	Create and improve existing information exchange mechanisms on national level.	48 m	2010	100,000
<b>12</b>	<b>Public awareness, information and education</b>			<b>2,100,000</b>
	Create and approve a national plan for protecting public health from impacts resulted from exposure to POPs	36 m	2010	300,000
	Develop a strategy for raising awareness campaigns.	48 m	2010	200,000
	Raise awareness for decision-makers on POPs related issues.	48 m	2010	100,000
	Make information on POPs available to the public through different media channels (TV, radio, press and printed materials).	48 m	2009	200,000
	Raise awareness on POPs related issues to public through different activities, focusing on specific target groups, such as industrial and agricultural sectors, women and children, etc.	48 m	2010	100,000
	Publish different guidelines on the impacts and hazards of POPs on health and environment for the different exposed target groups.	36 m	2010	300,000
	Set a long-term plan to include POPs subjects in the programs of different educational stages.	48 m	2010	100,000
	Improve the public awareness and knowledge of POPs, their harmful effects on human health and the reasons for the generation of POPs.	48 m	2010	100,000
	Improve the knowledge of general practitioners and Gynecologists of the impact of PCBs on human health.	48 m	2010	200,000
	Encourage postgraduate studies to conduct research in different POPs issues and provide the needed funds and facilities.	48 m	2010	500,000
<b>13</b>	<b>Effectiveness evaluation (article 16)</b>			<b>3,100,000</b>
	Assign responsibilities to different institutions to avoid overlapping and useless repetition.	36 m	2010	300,000



	Update inventories on current health, and environment hazards of POPs	36 m	2010	600,000
	Analyze samples taken from different POPs suspected sites	48 m	2010	300,000
	Establish a system for monitoring, evaluating and follow up.	48 m	2010	200,000
	Develop centers for analysis of dioxins and furans.	48 m	2010	400,000
	Upgrade the facilities at the different institutions dealing with POPs analysis.	48 m	2010	500,000
	Support and encourage accreditation of labs for the POPs analysis.	36 m	2010	100,000
	Develop a system for safe storage of collected POPs wastes.	48 m	2010	200,000
	Develop of POPs waste destruction and/or decontamination facilities.	48 m	2010	500,000
<b>14</b>	<b>Reporting</b>			<b>200,000</b>
	Ensure and support reporting in compliance with the requirement of the Stockholm Convention.	48 m	2010	200,000
<b>15</b>	<b>Technical and financial assistance.</b>			<b>2,200,000</b>
	Form an expert committee to identify the country needs of laboratories and related technical facilities to be procured in earlier stages of the NIP project in the context of the Stockholm Convention on POPs.	24 m	2010	100,000
	Provide financial resources needed for building the capacity of local specialists in PCDD/PCDF, PCBs and other POPs subjects through appropriate training programs. Such programs can be implemented inside and outside the country in coordination with donors and the Stockholm Convention secretariat.	48 m	2010	400,000
	Construct regional medical waste incinerators. At least an incinerator is needed in every Governorate.	60 m	2010	600,000
	Secure the needed financial and technical support for cleaning up and remediation measures that could be needed for the contaminated sites.	48 m	2010	100,000
	Enhance and support the renewable energy projects, rationalizing the energy use and encouraging the production and the use of clean fuel.	60 m	2010	600,000
	Safe storage and destruction of any POPs stockpiles in Yemen and ensure their proper disposal with the assistance of the international institutions in accordance with the Basel Agreement.	48 m	2010	200,000
	Develop a national program for control of vectors of human diseases that are born by biological vectors, using the Integrated Vector Management (IVM) technique, including provision of support to such programs as the alternative pesticides are costly.	48 m	2010	200,000
<b>16</b>	<b>Research, development and monitoring (Article 11)</b>			<b>6,400,000</b>
	Encourage research on POPs and their alternatives	60 m	2009	900,000
	Establish a National POPs Monitoring Committee for environmental monitoring of POPs for supervising research, development, discussing results and suggesting ideas, by the Yemeni government. This committee might consist of members from Ministry of Water and Environment, Ministry of Agriculture, Ministry of Health, Ministry of Finance, Ministry of Higher Education and Scientific Research, University of Sana'a (Chemistry Department), University of Sana'a (Center of water and environment) and five academicians.	48 m	2010	200,000
	Accreditation for each selected laboratory should be made.	48 m	2010	400,000
	Monitoring of POPs residues in mother's milk.	24 m	2010	200,000
	Monitoring of POPs residues in food stuff, water, air, soil, sediments and animal products.	48 m	2010	600,000
	Monitoring of PCBs level in electrical equipment.	48 m	2010	400,000
	Monitoring of dioxins and furans from emission sources.	36 m	2010	400,000
	Investigating of probable POPs contaminated sites.	48 m	2010	200,000
	Monitoring of POPs, PCBs, dioxins and furans in food products in Yemen.	36 m	2010	800,000
	Acquire data on PCBs, dioxins and furans in the local animal feed of animal origin.	48 m	2010	300,000
	Conduct periodic POPs monitoring of workers with exposure to these substances over a long period of time.	48 m	2010	800,000
	Assess the long range transport of POPs air pollutants and their impact on ecosystem.	36 m	2010	400,000
	Regular and periodic POPs monitoring.	48 m	2010	300,000
	Integrate PCBs analyses into the drinking water monitoring program.	36 m	2010	300,000
	Ensure the systematic update of the information on POPs emissions.	48 m	2010	200,000
	<b>Total</b>			<b>65,260,000</b>