Chapter 2

Dioxin and Furan Emissions and Its Management Practices

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Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/intechopen.80011

Abstract

Many changes like increment of the population and demanded services, expansion of industries, increasing of transportation demand, etc., have increased the emission of dioxin and furan. There was no indicative research conducted on the quantification and management practices of the unintentionally produced persistent organic pollutants like dioxin and Furan. A UNEP model for dioxin- and furan-related POPs management was commonly used to assess the main anthropogenic sources of dioxin and furan. In this book chapter, UNEP toolkit that was developed in 2013 is used to identify and quantify the sector-based emission of dioxin and furan. About nine main groups of anthropogenic POPs sources such as waste incineration, open burning process, ferrous and nonferrous metal production, etc., explicitly discussed in the report were identified. The case study in Addis Ababa showed that all organizations have no awareness about the dioxin and furan emission issues and follow very weak management styles. Finally, the book chapter suggests the reformulation of the national legal management framework, adaptation of best available technology with less POPs footprint, increasing public and stakeholder's awareness and participation and capacitating the concerned government organization.

Keywords: persistence, polychlorinated dibenzo dioxin, polychlorinated dibenzo furans, Stockholm Convention

1. Introduction

POPs are organic compounds that resist chemical, biological, and photolytic degradation due to their inherent characteristics. Their low water solubility and high lipid solubility facilitate their bioaccumulation in fatty tissues of living organisms. Many are also semi-volatile, which

enable them to be transported long distances through the atmosphere. Due to its persistence behavior, POPs are today present all over the world, found in every major climatic zone and geographic sector, including deserts, the Arctic, and the Antarctic were no major local POPs sources exist [1].

There exist several different forms of POPs, natural as well as anthropogenic. Those noted for their persistence and ability to bioaccumulate include many of the first-generation organochlorine insecticides, e.g., Dieldrin and DDT, as well as industrial products or by-products such as PCBs and dioxins. Due to their persistence and ability to accumulate and biomagnifies in living tissues, they can cause harm in the environment for an extensive amount of time [1].

In May 2001, the Stockholm Convention on Persistence Organic pollutant is one of a global, legally binding instrument, aimed at protecting human health and environment across the world from the harmful impact of persistent organic pollutant. According to the Stockholm Convention, this convention perhaps best understood as having five essential aims, such as eliminating dangerous pops by starting from the 12 worst, supporting the transition to safer alternatives, targeting additional POPs for action, cleaning up old stockpiles and equipment containing pops, and working together for POPs free nature.

Regarding the convention, Ethiopia has been proclaimed the ratification of this convention on 2nd day July 2002, Proclamation No. 279/2002, which is the Stockholm Convention on Persistence Organic Pollutant. There are articles that stated in the convention for the management of persistent organic pollutant. Article 5 of the convention deals with the unintentionally produced POPs. It requires each party to take measures to reduce the total releases derived from anthropogenic sources of Annex C chemicals, i.e., HCB, PCBs, dioxins, and furans.

Developing an action plan to identify, characterize, and address the unintentional release of these chemicals is the major obligation of each party. The action plan should evaluate current and projected releases, develop source inventories, and release estimates. It should also evaluate the efficacy of laws and policies relating to the management of such releases. In addition to the action plan, each party is required to (i) promote feasible, practical measures that can expeditiously achieve a significant on reduction of these releases; (ii) promote and/or require use of substitute materials or processes to prevent the formation of these chemicals; (iii) promote and implement, in accordance with the action plan, the use of best available techniques and best environmental practices for existing and any newly identified sources of the chemicals.

The main sources of unintentionally produced POPs cover a wide range of economic activities including industrial processes, such as ferrous and nonferrous metals production, cement and other minerals production, and production and use of chemicals and consumer goods, such as manufacture of pulp and paper, chemicals, petroleum, textiles, and leather products. The other categories include waste incineration, power generation and other fuel burning, transport; uncontrolled combustion processes such as agricultural and forest fires, drying of biomass, crematoria, dry cleaning, and tobacco smoking are also considered as having the potential for formation and release of these chemicals to the environment [2].

This book chapter evaluates the sources and management practice of the unintentionally produced persistence organic pollutants such as dioxin and furan especially in the service sectors.

Potentially available literatures covering the concept of persistence organic pollutant, the birth of the Stockholm Convention, identification, and quantification of unintentionally produced persistent organic pollutant, environmental and health impact of persistent organic pollutant, and policy and regulation framework of pops management were discussed. The global experience and practices of POPs are also discussed.

2. Methodology

This chapter was organized by reviewing of related literatures, collecting primary information, and compiling secondary from various sources. Related peer reviewed articles were compiled online from reputable journals, and secondary data were collected from relevant government offices.

A sector source-based cross-sectional study was carried out to generate quantitative information of UPOPs amount and evaluate sectoral offices management practices specific to dioxin and furan in the city. A UNEP model for POPs management was used to assess the main anthropogenic sources of dioxin and furan. The quantity of dioxin and furan released from the identified source groups was quantified by using UNEP toolkit default emission factor. Open- and close-ended questionnaires, FGD, and key informant interview were used to collect primary information.

Secondary data were collected from various organizations such as trade and industry birroue, Addis Ababa Environmental Protection authority, Ministry of Environment, Forestry and Climate Change, Addis Ababa city municipality, and other unmentioned source category organizations. The data collected from such kind offices were analyzed and presented in the form of supplementary information for the analysis. Relevant peer reviewed research articles, international and national legislations, and related literature were collected online and reviewed systematically at informative manner. The articles and standard literatures were read critically to synthesize the information.

3. Environmental and health impacts of dioxine and furan

PCDD/F and PCB are considered dioxin- and furan-like compounds under Stockholm Convention. PCDDs and PCDFs are unintentional by-products of incomplete combustion process of chlorinated products and known to be widespread and persistent in the environment [3]. 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD) has been known to be the most toxic congener of all PCDDs and was classified as a carcinogenic 24 substance by WHO's International Agency for Research on Cancer in 1997 [4]. Infants are more sensitive to the exposure of dioxins and dioxin-like compounds such as PCBs. Studies indicated that dioxins and dioxin-like compounds may interfere with thyroid hormone levels, increase risk of growth retardation, delay in developmental landmarks, cause neurocognitive deficits, and lead to reproductive impairments [5–8]. With short-term and high exposure level, TCDD can cause chloracne, a severe skin disease with acne-like lesions on the face and neck, which may also extend to the upper

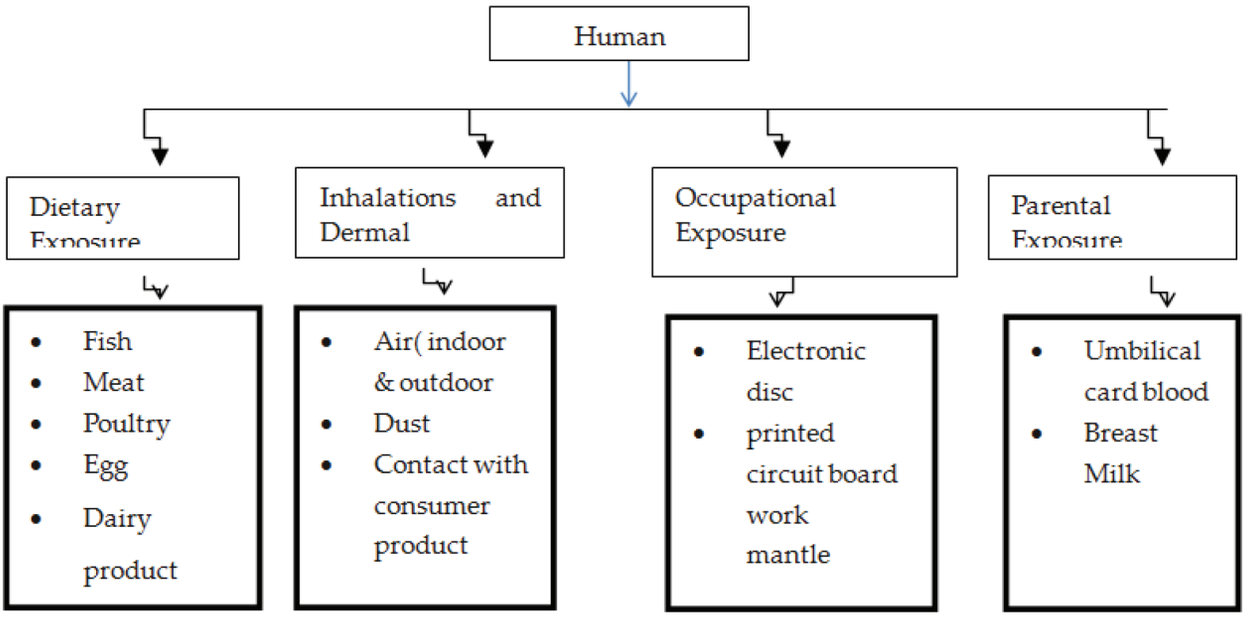

Figure 1. Overview of the human exposure pathways to POPs.

body in human [4]. With acute (14 days or less) oral exposure or intermediate (15–364 days) and chronic (365 days or more) exposure to PCDDs, liver's metabolism, biochemical, and weight change [4]. In Taiwan, several studies were done to determine the effect on children of Yu-Cheng women, who were transplacentally exposed to the pollutants. The results showed that prenatal exposure to PCBs and PCDFs could potentially result in reduced neurocognitive development, hyperpigmented skin and nails, and increased the risk of growth retardation [8]. Furthermore, Guo et al. [5] found that prenatal exposure possibly causes deterioration in semen quality, increases the percentage of abnormal sperm, and reduces daily sperm production in sexually matured men who experience in utero exposure.

In recent years, increasing concern has been given to polybrominated congeners of dibenzo-p-dioxins/furan. Brominated dioxins exert their toxic effects through the same mechanism as their chlorinated congeners, of which TCDD and its brominated congener 2,3,7,8-tetrabromodibenzo-p-dioxin (TBDD) presented almost identical potencies for the immune toxic effects on mice [9]. According to the Environmental Health Criteria 205, PBDD/Fs exhibits similar health effects to the animal as their chlorinated congener PCDD/Fs. With the oral exposure of TBDD, spermatogenic activity decreases and thyroid hormones changes in the Westar rate while growing retardation and histopathological changes in liver and thymus detects in the Sprague-Dawley rats. However, data on human exposure of PBDD/F are scarce. As it was shown in **Figure 1**, exposure ways of dioxine and furan are diverse. Only limited studies were done on these emerging pollutants, and most of them are concentrated on occupational exposure [4].

4. The birth of the Stockholm Convention

The issue of POPs begun to be addressed in the 1980s; Canada has brought it onto the international agenda [10–12]. In Canada, research found out and heightened the sensitivity of concerns of its northern indigenous populations. It was in the 1983, when the international

organizations like UNEP and WHO asked Canada to turn down Canada effort to seek international actions to reduce these chemical actions. During this time, the government of Canada has entered into force the convention of management of long-range transboundary air pollution [12]. Although its implementation was regional rather than global, the fact that the convention covered most of the northern hemisphere made it a feasible forum. Ultimately, the convention integrated POPs into its agenda, it created POPs agreement that covered many of the initial "dirty dozen" of these chemicals in the country.

Then, the issue once addressed at an international scale in the form of soft law by the 1992 Rio UN Conference on Environment and Development and Agenda 21. By 1995, the UNEP Governing Council initiated an assessment process regarding a list of 12 POPs subject to future regulation [13]. An Ad Hoc Working Group on POPs was established to develop a plan for assessing information on the chemistry, environmental dispersion, toxicity, sources, and socioeconomic impacts of a list of 12 chemicals called the "dirty dozen" [13]. By 1996, the working group concluded the need for global action to include the establishment of a global, legally binding instrument. Consecutive meetings that were held from 1998 to 2001 have succeeded to produce signatory document for countries. In 2001, in the conference that was held in Stockholm, Sweden, about 91 countries and the EU signed the Convention.

5. Identification and quantification of release of dioxin and furan unintentional persistence organic pollutant

One of the major goals of the Stockholm Convention on Persistent Organic Pollutants (POPs) is the continuing minimization and, where feasible, ultimate elimination of unintentionally produced POPs. Parties are required to identify, characterize, quantify, and prioritize sources of releases of unintentionally produced POPs and develop strategies with concrete measures, timelines, and goals to minimize or eliminate these releases. Toward this end, parties must develop action plans as part of their National Implementation Plans (NIP) to identify, characterize, and address the releases of unintentional POPs Listed in Annex C of Stockholm Convention. Action plans to be developed according to Article 5 of the Convention shall include evaluations of current and projected releases that are derived through the development and maintenance of source inventories and release estimates, taking into consideration the source categories listed in Annex C of the convention tool.

According to UNEP [14], toolkit has been assembled for the purpose of assisting each country in identifying and quantifying sources of unintentional POPs that are located within the country's borders and estimating releases from those sources. Sources of POPs releases are of four general types, three of which are active, ongoing processes and one is a legacy of historic activities:

- Chemical production processes, e.g., facilities or production units that produce chlorinated phenols or in which certain other chlorinated chemicals are manufactured or that produce pulp and paper using elemental chlorine for chemical bleaching;
- Thermal and combustion processes, e.g., waste incineration, combustion of solid, and liquid fuels, or production of metals in thermal processes;

- Biogenic processes in which PCDD/PCDF may be formed from precursors-manufactured chemicals such as pentachlorophenol that is structurally closely related precursors of PCDD/PCDF.
- Reservoir sources such as historic dumps containing PCDD/PCDF and other POPs contaminated wastes and soils and sediments in which POPs have accumulated over time.

Some additional source categories and a strategy for identifying new source categories are presented in the toolkit (Annex C). It describes a step-by-step process to estimate PCDD/PCDF releases from each source category to the following environmental media:

- Air,
- Water (surface and ground water, including marine and estuarine water),
- Land (surface soils) and to these process outputs: products (such as chemical formulations, including pesticides or consumer goods such as paper, textiles, etc.) and residues (including certain liquid wastes, sludge, and solid residues, which are handled and disposed of as waste or may be recycled).

6. World experiences in POPs monitoring and management

In recent years, the potential risks of POPs were considered seriously throughout the world. As such, regulatory control and measures were proposed to protect human health, the ecosystem, and the environment. According to report of Porta et al. [15], few countries including USA, Germany, and Arctic had established nationwide surveillance programs of human concentrations of POPs, while other countries have conducted population-wide studies on the distribution and concentrations of POPs.

6.1. United States

The United States has taken several actions to control and reduce the emission of POPs. Environmental Protection Agency (US EPA) controls and manages the release of dioxins and furans to air, water, and soil by the Clean Air Act and the Clean Water Act. According to the 1990 Clean Air Act, the US EPA identifies the major industrial sources of toxic air emission and sets regulations using a technology-based or performance-based approach to reduce toxic emissions. Industries must be scaled up to achieve the maximum control of hazardous air pollutants, including dioxins and furans [16]. In addition, the act demanded EPA to analyze the remaining risks and decide whether control measures have to be tightened. Apart dioxins management using clean air act, the Clean Water Act controls and manages the release of dioxins to water through a combination of risk-based and technology-based tools [17]. Moreover, EPA Superfund and Resource Conservation and Recovery Act Corrective Action programs were also helping to clean up the dioxin-contaminated land [18]. Several conventions and commissions were established on a regional basis to control and address regional environmental concerns.

Various activities have been performed by different sectoral offices to reduce the pollution and its effect on human health. The CDC [19] indicated that National Report on Human Exposure to

Environmental Chemicals (NRHEEC) in the United States has given an opportunity for ongoing assessment of the POPs exposure level of the U.S. population. This assessment program has linked POPs to the National Health Nutrition Survey (NHANES) and determined the concentration of some POPs in the blood and urine of the general population from 50 states. The program assessed POPs increased from 27 in 2001 to 148 by 2005. POPs that were assessed in the program included the pesticide POPs (aldrin, chlordane, DDD, DDE, DDT, dieldrin, endrin, heptachlor, mirex, toxaphene, etc), brominated compounds (PBDEs, polybrominated biphenyls (PBBs), etc), and other additional chemicals in 2005. Furthermore, fluorinated POPs, such as PFOA, PFOS, and its salts, were also found under the candidate chemicals in priority groups [19]. Ecotoxicology database (ECOTOX) program was also setup by the United States Environmental Protection Agency (US EPA) to study the human exposure. The aim of the program was to consolidate all toxicity data for aquatic and terrestrial organisms from peer-reviewed literature [20]. Currently, it is funded and being managed by the U.S. Department of Defense's Strategic Environmental Research and Development Programme (SERDP) and the U.S. EPA's Office of Research and Development (ORD) and the National Health and Environmental Effects Research Laboratory's (NHEERL's) Mid-Continent Ecology Division [20]. The US EPA finally made the database to be publicly available by the Toxics Release Inventory (TRI) program to track the emission levels and trends for toxic chemicals, including dioxins and furans, from major industries, point sources, stationary sources, and mobile sources [16].

6.2. Germany

In Germany, Environmental Survey (GerES) of POPs officially started in 1985. Serious four GerESs were conducted in the period of 1985–1986 (GerES I), 1990–1992 (GerES II), 1998 (GerES III), and 2003–2006 (GerES IV), respectively [21]. Blood and urine from the general population of ages between 25 and 69 were analyzed. In GerES II and GerES IV reports, addition subsamples were done for children aged between 6 and 14 years and another aged between 3 and 14 years [22].

6.3. Arctic

In Arctic, the human monitoring on POPs was done by the Arctic Monitoring and Assessment Programme (AMAP) in 1994 and 2002 to assess the contaminant levels in the blood (AMAP, 2000; AMAP, 2002). Blood samples from human living in the Arctic regions of the eight circumpolar countries, including Canada, Denmark/Greenland, Finland, Iceland, Norway, Russia, Sweden, and the United States, were collected and analyzed for POPs in order to evaluate the regional and spatial trends of pollution, to determine the sources and its pathways, and to determine human impact, including chronic effect, posed by POPs in this region. They have drawn spatial trends by evaluating the POPs level detected in the blood samples of human from different regions.

6.4. Canada

In Canada, pesticides-related POPs are managed under the Pest Control product Act (PCPA). For management of these pollutants, all import, used, and sold activities of pesticides must be registered at the Pest Management Regulatory Agency [23]. Under the Protocols on Persistent

Organic Pollutants, the production and use of aldrin, chlordane, chlordecone, dieldrin, endrin, hexabromobiphenyl, mirex, and toxaphene are banned. Also, the use of DDT, HCH (including lindane), and PCBs is restricted. The Toxic Substances Management Policy (TSMP) of the country is a preventive and precautionary approach to virtually eliminate all POPs listed under the Stockholm Convention and to minimize the release of such chemicals to the environment [24]. Furthermore, Canada has adopted a new program called Chemicals Management Plan to evaluate the negatively impacting chemicals by risk assessment approaches for determining whether a chemical usage restriction or ban [25]. Also, the National Pollutant Release Inventory (NPRI) of Environment Canada, in its Environmental Protection Act, 1999, necessitates all company or facility which has approximately 10 or more full-time employees and uses one or more of the listed hazardous substances to register and report the total amount of each of the hazardous substances used during the year [25].

6.5. The European Union

In the European Union (EU), REACH, a new legislation which deals with Registration, Evaluation, Authorization, and Restriction of Chemical substances, entered into force on June 1, 2007 [26]. Currently, around 30,000 marketed chemicals, new or existing, required to register under REACH, in which 1500 of the chemicals are subjected to permission before their use and their introducing to the market. Chemicals which require the authorizations are those which are classified as carcinogenic, mutagenic, or toxic to reproduction compounds; persistent, bioaccumulative, and toxic compounds. The authorization will only valid for a limited period of time. Under REACH, industries are responsible for assessing and to manage the risks posed by their chemical substances [26]. Furthermore, for chemicals that are imported or manufactured more than 1 ton per year per company, manufacturers and importers are responsible for gathering information on the properties of their chemical substances to ensure safe handling of such chemicals and to register such information in a central database run by European Chemicals Agency (ECHA). Chemicals that are imported or manufactured more than 10 tons per year per company have no chemical safety report which contains the chemical safety assessment, information on the persistent nature, bioaccumulative, and toxicity behavior of the chemicals and the human health and environmental risk assessment [27]. In addition to the chemical database, the European Community and 23 Member States will implement the publicly accessible database, European Pollutant Release, and Transfer Register (E-PRTR), succeeding the European Pollutant Emission Register (EPER). E-PRTR covers the releases of pollutants to air, water, land, and off-site transfers of waste releases from diffuse sources such as road traffic and domestic heating. Facilities which emission exceeded the limited set under the regulation are obligated to report to their member states. This report will be published annually [26].

7. Management practice of persistence organic pollutant in Ethiopia

According to NIP (2006), the management practice of persistence organic pollutant is weak after the convention ratified by the country. Even though there are some activities regarding the management of this persistence organic pollutant, there are several legislations which are

applicable to POPs in one way or another. Environmental Pollution Control Proclamation No. 300/2002 and Pesticide Registration and Control Council of State Special Decree No. 20/1990 are among the most important legislations for regulating POP chemicals in Ethiopia. However, analysis of the relevant legislations and their enforcement indicates that the legal system that relates to the management and use of chemicals in general and POPs in particular in Ethiopia is far from well developed. Lack of comprehensive approach and coverage is one of the major shortcomings of the legal framework. The other major gap and limitation in the area are a lack of legislations and standards in the following areas:

- Lack of rules that expressly ban the production, import and use of POPs pesticides
- Lack of legislation that directly and comprehensively regulates industrial chemicals, including PCBs;
- Lack of proper regulatory mechanism for the use of DDT;
- Lack of enabling legislations and standards to regulate releases of unintentionally produced POPs from different source categories;
- Lack of proper regulatory mechanism for the management of POPs stockpiles and wastes;
- Lack of proper regulatory framework on information gathering and exchange;
- Lack of regulatory framework on public awareness and participation

8. Main anthropogenic based dioxin and furan source categories

Contrast to natural phenomena, anthropogenic source is potential or potent for emission of persistence organic pollutant such as polychlorinated dibenzodioxin and polychlorinated dibenzofuran (PCDD and PCDF). Unintentional persistence organic pollutants (PCDD and PCDF) are produced from four general types of anthropogenic activities found in a given country and city ([2]).

- Chemical production process, e.g., facilities or production units that produce chlorinated phenol
- Thermal and combustion process, e.g., waste incineration, combustion of solid and liquid fuel, or production of metals in thermal processes:
- Biogenic process in which PCDD/PCDF may be formed from precursors-manufactured chemicals such as pentachlorophenol that are structurally closely related precursor of PCDD/PCDF
- Reservoir source such as historic dumps containing PCDD/PCDF and other pops contaminated waste and soil and sediments in which POPs have accumulated over time

However, it is impossible to found out these source categories in all countries, as well as cities at the same level. It has variations on the economic activities of the countries or cities. The detail source groups are discussed below.

8.1. Source group 1—waste incineration

Waste incineration is the predominant anthropogenic activity that contributes to the emissions of unintentional persistence organic pollutants such as dioxin and furan. Under waste incineration, five sub-categories are identified and listed such as municipal solid waste incineration, hazardous waste incineration, medical waste incineration, light fraction shredder incineration, sewage sled incineration, and animal carcass incineration [2].

8.2. Source group 2—ferrous and nonferrous metal production

Under this source groups eleven source categories were identified and listed. These source categories are iron ore sintering, coke production, iron and steel metal production, foundries, hot-dip galvanizing plants, copper production, aluminum production, lead production, zinc production, brass and bronze production, and magnesium production. Nonferrous metal production (e.g., Ni) like shredders and thermal wire reclamation and e-waste recycling are commonly found in Addis Ababa [2].

8.3. Source group 3—heat and power generation

There are five categories that are identified under this source group of heat and power generation. These are fossil fuel power plant, Biomass power plant, landfill biogas combustion, Household heating, and Cooking–Biomass and Domestic heating–Fossil fuel [2].

8.4. Source group 4—production of mineral products

Under this production of mineral product, there are six source categories activities responsible for the emission of dioxin and furan. These are cement kiln, lime production, ceramic production, brick production, glass production, asphalt mixing, and oil shale processing [2].

8.5. Source group 5—transport

Transport is one of source group that releases dioxin and furan organic pollutant due to the incomplete combustion of an engine. Under this source group, 4 stroke engine, 2 stroke engine, diesel engine, and heavy oil engine vehicles categories are responsible for emission of unintentional persistence organic pollutant [2].

8.6. Source group 6—open burning process

Due to the incomplete combustion of biomass, emission of PCDD/PCDF toward the environment Medias such as air, water, land and products will be occurred. Thus, under the group of open burning process only two categories were identified such as biomass burning (forest fire sugar cane etc.) and waste burning and accidental fires(accidental fire on vehicle and house) [2].

8.7. Source group 7—production and use of chemicals and consumer goods

According to UNEP toolkit [2], production and use of chemical and consumer goods are one of the anthropogenic activities for emission of persistence organic pollutants which have been classified under the source group of unintentional persistence organic pollutants. This

source group also classified into various categories such as pulp and paper mills, chlorinated inorganic chemicals, chlorinated aliphatic chemicals, chlorinated aromatic chemicals (per ton product), other chlorinated and nonchlorinated chemical (per ton product) petroleum refining, textile plants (per ton textile), and leather plants.

8.8. Source group 8—miscellaneous

This source group has classified into five categories. The source categories listed on toolkit guide are: drying of biomass, crematoria, smokehouses, dry cleaning, and tobacco smoking.

8.9. Source group 9—disposal

Waste disposal is an anthropogenic activity which contributes to the emission of the unintentional persistence organic pollutant so-called polychlorinated dibenzodioxins and polychlorinated dibenzofuran (PCCD/PCDF). Under this source group, landfills, waste dumps and landfill mining, sewage/sewage treatment, open water dumping composting, and waste oil disposal are source categories which have major contribution for emission of dioxin and furan [2].

9. Quantifications of dioxin and furan emission from different source group and categories

Inventory of PCDD/PCDF release has been conducted after identification of all source group and source categories. According to UNEP toolkit [2], the annual release of Dioxin and furan can be determined based on the computation of emission factor and activity data.

9.1. Emission factor for PCDD/PCDF

The default emission factors presented in the toolkit are driven from a variety of data sources from laboratory experiments, peer-reviewed, and literature dedicated experiment project to governmental or institutional report. The emission factors for each class are the best estimate based. Data on technology, process characteristics, and operating practices were taken from well-documented sources of sector offices. An expert judgment was also used.

9.2. Activities rate for PCDD/PCDF

Activity rate data are very significant data for quantification of the annual release of PCDD/PCDF in the study area, in which activity rates are value in unit per year of product manufactured (e.g., steel) or feed processed (e.g., municipal waste hazardous, coal, diesel fuel etc.), annual quantities of material released (e.g., M^3 of free gas, liter of kilogram or ton of sled generated etc.) [2].

10. Management practices of dioxin and furan

Based on the Stockholm Convention on persistence organic pollutants, countries who signed the treaty toward the management of persistent organic pollutant have to design management

system like BAT and BEP (best available technology and best environmental practice) to reduce and eliminate dioxin and furan organic pollutants. This agreement is not easily applicable in a developing country like Ethiopia, where the economy is still in progress and it has a major related impact during the developmental activities.

11. Case study: Ethiopia

11.1. Emissions and management practices

11.1.1. Medical waste incineration

About 50% the health care institutions in Addis Ababa have no furnace during medical waste incineration. Moreover, 100% of the currently using incinerator does not have an air pollution control system, and their medical waste incineration activity was not environmental sound and the organizations do not have disposal site to dispose the bottom ash. Therefore, the overall management practice of PCDD/PCDF from medical waste incineration is very weak.

11.1.2. Iron and steel production

The respondent of iron and steel factories was used the furnace for heating and melting purpose of the dirty and cleaned raw materials. During the production activities, all organizations do not have air pollution control system. The management practices of PCDD/PCDF emissions from iron and steel industries are very weak. The field visit to some factories confirmed that they produce their material by melting into furnaces without installing the air pollution control system and temperature control system.

11.1.3. Heat and power generation

The Dioxin and Furan is also easily emitted from household heating and cooking with biomass. The city residents commonly uses the three pit stoves, charcoal stove, and others stoves that do not have combustion control system. This emits the PCDD/PCDF from its open burning process.

11.1.4. Glass production

Glass factories that have a furnace to produce their products do not have dust control abatement and PCDD/PCDF is easily emitted to the environmental media.

11.1.5. Transport

Vehicles in the city have no emission reduction catalyst. The management of the unintentional persistent organic pollutant emitted from the vehicle through the incomplete combustion does not be managed properly.

11.1.6. Open burning process

The household heating and cooking with biomass is also one of the major contributors of dioxine and furan.

11.1.7. Textile production

Studies indicated that about 75% of the textile wastes from the industries were simply discharged to the sewerage line rather than treating and releasing into the water bodies, whereas 25% of textile wastes react to emission control [28]. This implies that majority of the industries have improper management of waste water released from their industries.

11.1.8. Leather refining

Regarding the emissions reduction management of PCDD/PCDF from leather refining industries, 7 or 99% of leather refining industry respondents revealed that their organizations have treated the wastewater via treatment plant. The rest 1% of industries do not have treatment plant but they are simply discharge into sewerage line, so that the PCDD/PCDF reduction was properly managed at leather refining industry.

11.1.9. Dry cleaning

The management practices of PCDD/PCDF from source category of dry cleaning have no optimum management practices for emission control. About 86.7% of respondent of dry cleaning industries revealed that their organization utilized chemical for dry cleaning and disposed the by-product through sewerage line, so that they easily generated and emit PCDD/PCDF without control.

11.1.10. Tobacco smoking

There are no management practices of PCDD/PCDF emission from tobacco smoking activities in the city.

11.1.11. Waste disposal

In the city of Addis Ababa, there is no management practices of leachate or seepage liquids disposed from solid waste. This implies that PCDD/PCDF can be easily emitted from these anthropogenic activities. Also, there is no adequate treatment of sewage that can control emission of dioxin and furan from sewage treatment.

11.2. Institutional policy and regulatory framework

Regarding the policies and legal framework for persistent organic pollutant, the researcher conducted an interview with higher expert working in Ministry of the environment, forest and climate in compliance and Monitoring directorate, and then some question were raised

about the policy and regulatory framework of persistence organic pollutant. Expert from the FDRE Ministry of Environment, Forestry and Climate Change has explained that Ethiopian has designed various policy and regulatory frameworks to govern the environment, e.g., environmental policy approved by the minister council, and this policy has regulatory framework these are, environmental Protection Organs establishment, environmental pollution control proclamation (300/2002) environmental Impact Assessment Proclamation (299/2002) and etc. However, all regulatory frameworks directly or indirectly influence or contribute for the management of persistence organic pollutants, but it is impossible to say that this is good enough for emission reduction of POPs. Therefore, these can be put as the gap and weakness on the existing legislative system for the management of POP chemical in Ethiopia, as well as in Addis Ababa city. In addition, the respondent described that at present there is no legislation that specifically deals with POPs chemicals other than pesticides. The only particular legislations are those which control and regulate pesticides. Therefore from the point views of the interview, it is implied that the management practices of the emission reduction of the persistence organic pollutants through legislative and regulatory framework have not been formulated.

12. Conclusion

The major anthropogenic sources of emission of dioxin and furan (PCDD/PCDF) have generalized as 9 source groups, 15 source categories, and 25 classes. To quantify the release of PCDD/PCDF, an activity rate data and emission factor of each source category is required. The default model of emission factor prepared by UNEP to convert the annual activity rate data into annual release OF PCDD/PCDF in g TQE for different environment media is mostly used if there is no experimentally proved emission factor data found.

Most of the service sectors in developing countries have no control system for emission of dioxin and furan. Also, the regulatory issue of dioxin and furan is risen in various stages of the environment policy and strategies; however, there is no separate guidelines and standards prepared for it. The management practice of dioxin and furan in developing countries is not satisfactory, so that it needs consideration technology, capacity building, and regulatory empowerment options.

12.1. Technology options

- Constructing a standard medical waste incinerator station with all facilities at a specific station from collecting, hauling, and transporting the medical waste from all the health care institution to the incinerator station. These flows of management highly reduce the emission of PCDD/PCDF from the uncontrolled medical waste incineration which undertaking at different health care institution in the city.
- Adoption of best available technology and best environmental practices in leather, textile, and minerals production processes to reduce or eliminate releases of PCDD/PCDF through detailed assessment of individual industries for BEP options for UPOPs reduction

and need and introduce and effectively implement guidelines on BAT and BEP to release sources of UPOPs (existing and new industry)

- Removal of barrier of introduction of technologies that minimize UPOPs through environmentally sound management practices

12.2. Capacity building option

- Conduct awareness raising and establishing network for information exchange through sensitizing the public and stakeholders on environmental and health impact of dioxin and furan
- Develop education and awareness materials on health and environmental effects of UPOPs,
- Establish free access Web and database on dioxin and furan.

12.3. Regulatory framework option

- To control and reduce the release of dioxin and furan through various environmental media, the countries need to work collaboratively in stakeholders with the regulatory formulating bodies.

Conflict of interest

There is no conflict of interest with all the content of this chapter.

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