The Republic of Sudan

National Implementation Plan

For the Stockholm Convention

November, 2014

The Republic of Sudan

National Implementation Plan

For the Stockholm Convention

November, 2014

Table of Contents

List of Abbreviation

ABS	Acrylonitrile-butadiene-styrene
AFFF	Aqueous film forming foams
ASP	Africa Stockpiles Programme
BAT	Best available techniques
BEP	Best environmental practices
BFRs	Brominated flame retardants
BHC	Benzene Hexachloride
BOD	Biological Oxygen Demand
cbi	Confidential business information
CITES	Convention in Trade of Threatened and Endangered Species
COP	Conference of the Parties
CRT	Cathode Ray Tube
DDE	Dichlorodiphenyldichloroethylene
DDT	1,1,1-trichloro-2,2-bis (4-chlorophenyl)ethane
DNA	Designated National Authority
PPD	Plant Protection Directorate
EEE	Electric and electronic equipment
EIA	Environmental Impact Assessment
EU	European Union
E-Waste	Electronic waste
FAO	Food and Agriculture Organization
GC-MS	Gas chromatography–mass spectrometry
GDP	Gross domestic product
GEF	Global Environment Facility
GHS	Globally Harmonized System of Classification and Labelling of Chemicals
GLP	Good Laboratory Practice
GMO	Genetically Modified Organism
GMP	Global Monitoring Plan
HBB	Hexabromobiphenyl
HBCD	Hexabromocyclododecane
HCB	Hexachlorobenzene
HCENR	Higher Council for Environment and Natural Resources
HCH	Hexachlorocyclohexane
HIPS	High Impact Polystyrene
HPLC	High-performance liquid chromatography
HQ	Hazard Quotient
ILO	International Labor Organization
IMF	International Monetary Fund
IPCS	International Programme on Chemical Safety
IPM	Integrated Pest Management
IPRSP	Interim Poverty Reduction Strategy Paper
IVC	Integrated Vector Control
L	Liters
LCD	Liquid-Crystal Display
LDCs	Least Developed Countries

MEAs	Multilateral Environmental Agreements
MEFPD	Ministry of Environment, Forestry and Physical Development
MNCC	Multi-stakeholder National Coordination Committee
MoA	Ministry of Agriculture
MoED	Ministry of Education
MoH	Ministry of Health
MoJ	Minstry of Justice
MoI	Ministry of Industry
MoT	Ministry of Technology
MED	Ministry of Electricity and DAMS
NAP	National Action Plan
NAPA	National Adaptation Programme of Action
NCS	National Comprehensive Strategy
NEC	National Electricity Corporation
NGOs	Non-Governmental Organizations
NIOSH	National Institute for Occupational Safety and Health
NIP	National Implementation Plan
NPC	National Pesticides Council
NPC	National Pesticides Committee
NPEM	National Plan for Environmental Management
OCs	Organochlorines
OCP	Organochlorine pesticides
ODS	Ozone Depleting Substances
OECD	Organisation for Economic Co-operation and Development
Ops	Obsolete pesticides
PAHs	Polyaromatic hydrocarbons
PBDEs	Polybrominated diphenyl ethers
PBT	Polybutylene terephthalate
PCBs	Polychlorinated biphenyls
PCDD	Polychlorinated dibenzo-p-dioxins
PCDF	Polychlorinated dibenzofurans
PeCBz	Pentachlorobenzene
PCP	Pentachlorophenol
PERSEGA	Protection of the Red Sea and Gulf of Adan
PFCs	Perfluorocarbons
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctane sulfonic acid
PFOSF	Perfluorooctane sulfonyl fluoride
PIC	Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade
POPs	Persistent Organic Pollutants
PPB	Parts per billion
PPD	Plant Protection Department
PTS	Persistent Toxic Substances
PUR	Polyurethane
PVC	Polyvinyl Chloride
RAMSAR	Convention on Wetland of International Importance

SAICM	Strategic Approach to International Chemicals Management
SC	Stockholm Convention
SCP	Sustainable Consumption and Production
SEA	Socio-Economic Assessment
SSMO	Sudanese Standards and Meterology Organization
SUVL	Sudanese Universities Virtual Libraries
T	Tonnes
TC	Technical Committee
TEQ	Toxic equivalent
TOT	Training of the trainers
TVs	Televisions
UNCCD	United Nation Convention on Combating Desertification
UNEP	United Nation Environment Programme
UNFCCC	United Nation Framework Convention on Climate Change
UNIDO	United Nation Industrial Development Organization
UPOPs	Unintentionally produced POPs
US EPA	United States Environment Protection Agency
UV	Ultraviolet
VCP	Vector Control Programs
WCED	World Commission on Environment and Development Experts Group on Environmental Law
WEEE	Electric and electronic equipment waste
WHO	World Health Organization
WP	Wettable powders
Wt	Weight
XRD	X-ray Diffraction
XRF	X-ray fluorescence

List of Tables

List of Figures

Executive Summary

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

The Republic of Sudan signed the SC in 2001 and ratified the Convention in 2006. The SC initially addressed the dirty dozen POPs of pesticides (aldrin, chlordane, DDT, dieldrin, endrin, heptachlor, mirex and toxaphene), industrial chemicals (hexachlorobenzene and PCBs) and unintentional POPs (dioxins, furans, HCB and PCB). In 2009, the Conference of the Parties (COP), listed nine additional POPs namely, pesticides: chlordecone, lindane and related waste isomers alpha-hexachlorocyclohexane and beta-hexachlorocyclohexane; industrial chemicals: hexabromobiphenyl, tetrabromodiphenyl and pentabromodiphenyl ether, hexabromodiphenyl and heptabromodiphenyl ether, pentachlorobenzene, perfluorooctane sulfonic acid and related substances; and by-product pentachlorobenzene.

All these substances are designated as POPs and are toxic, persistent, bio accumulate and can be transported over great distances. The SC imposes the obligation on the parties to develop, within two years of the ratification of the Convention, a NIP describing the national situation in respect of the substances covered by the SC, and the strategies that have been developed to implement their obligations under the SC. The SC also requires all parties to develop an Action Plan. In this National Action Plan (NAP) the parties to the SC must specify what strategies they will be developing to meet the obligations of the SC.

Sudan had developed its first NIP in 2007 and now in this document an updated NIP is provided having been prepared with funds made available by the Global Environment Facility (GEF) and with the assistance of the United Nations Industrial Development Organisation (UNIDO).

The NIP describes the background of POPs issues in Sudan and the current situation of POPs based on updated and new established inventories. Furthermore, the NIP details all strategies and actions which need to be undertaken in order to meet the obligations of the Convention.

Inventories of POPs chemicals listed in Annex A, B and C of SC have been successfully compiled during the NIP preparation process. The inventories were robust enough for assessment of the presence of different POPs categories, as well as for priority setting considerations for the action plan. Several inventories will, however, need to be improved within the NIP implementation process.

This NIP gives an overview of Sudan current level of compliance with the SC requirements in respect to “initial POPs” listed in the Convention Annexes, as a proof of Sudan’s commitment in reducing and eliminating the POPs substances. It also gives an overview on the situation of the new listed POPs in the country and how Sudan is planning to address the new listed POPs in an integrated manner.

The updated NIP has taken into account both GEF 2020 and GEF-6 Strategies in managing POPs. It also aims at taking an integrated and systemic approach based on the causal chain of environmental changes, and identifying the key underlying drivers to tackle. Where useful, hazardous chemicals (POPs, ODS, mercury and others) will be addressed together (inventory development, information databases, waste management and contaminated site assessment). Furthermore considerations are made from end of pipe solutions to advancing green chemistry more precisely to substitution of POPs including non-chemical alternatives as can be seen in the case of alternatives to pesticide. This is part of an approach

to move to more sustainable consumption and production patterns highlighted as a goal in the first draft of the sustainable development goals and by 2020 to achieve environmentally sound management of chemicals and all wastes throughout their life cycle. The waste management in Sudan is closely related to the overall development of the country and the currently existing waste management systems can hardly cope with the volume of wastes generated, including wastes containing POPs.

At the policy level, Sudan is aiming to link and harmonize different activities in chemical management (POPs, mercury, ODS, SAICM) as well as climate change mitigation considering short-lived climate pollutants whose emission reduction can directly link to unintentional POPs reduction, particluarly in open burning. Also, due to an overlap in reducing unintentional POPs and mercury in a range of industrial source categories, Sudan will aim at harmonizing the implementation of these two conventions. Moreover, waste management and destruction of hazardous chemicals need to be addressed in a holistic manner and should address all type of hazardous chemical wastes and their destruction, where appropriate, securing the co-funding in implementation.

The integrated management of POPs issues integrated, as part of country's framework action plans (chemical management plans, waste management plans, contaminated sites action plans etc.), will result in an effective and efficient implementation and self-confidence and attract international donors.

Same as for environment protection, the Government of Sudan gives priority to overall poverty reduction; reduced unemployment, especially among youth; revitalization of agriculture and industry; strengthening of the private sector; combating environmental degradation; the impacts of climate change; and the risks of natural disasters. While economic growth is critically important for the Republic of Sudan, it is the pattern and the way of measuring growth that will determine its sustainability. Shifting away from using GDP as measure to more sustainable indicators and improving standards of living for all remain a major challenge. The Interim Poverty Reduction Strategy Paper (IPRSP), together with the 3-Year Salvation Economic Program (2012-2014) and the 5-Year Development Plan (2012-2016), offer a more holistic view of poverty, recognizing environment and disaster risk reduction and management as key factors. Strengthening populations' resilience to environmental risks and climate change, along with improved effectiveness of relevant institutions for sustainable management of natural resources, including water, forests, biodiversity and land are representing the new priorities in relation to poverty reduction. The implementation of the SC NIP will contribute to this wider frame by improving chemical and waste management related to POPs. When updating NIP, Sudan has taken into account the following socio-economic aspects: food and water safety (including POPs exposure of population); POPs exposure of vulnerable and highly exposed groups; treatment of POPs-contaminated materials and the cost of destruction; end of life management and; and cost of POPs contaminated soil and site remediation.

Considering the socio-economic burdens of POPs and related waste management, the following approaches and principles need to be taken into account during NIP implementation: the precautionary approach; extended producer responsibility and the polluter pays principle. In order to promote the internalization of environmental and social costs, the polluter should bear the cost of pollution with due regard to the public interest in line with Principle 16 of the Rio Declaration. Furthermore to prevent future pollution of POPs the substitution approach will be considered for POPs and POPs-like chemicals in the frame of sustainable production and consumption.

Dedicated action plans have been developed for institutional and regulatory strengthening measures; use and wastes of pesticides including DDT; management of PCBs; new listed industrial POPs (POP-PBDEs and PFOS and related chemicals); reduction of releases of unintentional POPs; identification, management and disposal of stockpiles and for the identification and remediation of contaminated sites. Enhancement of POPs monitoring is also included in the action plans. The sources of POPs and related hazardous chemicals (e.g. pesticides), and their impact on the population, have to be assessed during the implementation of NIP for an appropriate socio-economic assessment.

Action plans have been developed for continuing the awareness raising and education on POPs. Environmental Education has been incorporated in the curricula of several universities. Environmental colleges and environmental departments have been created including environmental education of imams.

Priority areas in the action plans are development of an integrated regulatory frame for chemicals, wastes and contaminated sites; management of pesticide and PCB stockpiles and wastes; phase out of POPs in current use and introduce alternative products and processes, including integrated pest management; management of wastes including E-waste and end of life vehicles; development of POPs databases (pesticides, contaminated sites, industrial chemicals, unintentional POPs etc.); implementation of BAT/BEP; integrated awareness raising on chemicals and wastes and assessment of contaminated sites; streamlining the national reporting system for POPs; designing and implementing a POPs monitoring system and strengthening the capacities; increasing the research in the POPs and chemicals fields; building an effective information exchange mechanism in the fields of POPs including consumer protection and strengthening the custom control for preventing the illegal traffic and counterfeit of POPs chemicals.

The implementation strategy of the updated NIP addresses POPs issues through environmentally sound management of chemicals and wastes. This underlines the importance of maximizing synergies and coordinating action plans related to chemicals and waste and chemicals and waste related international obligations. The implementation strategy for managing chemicals and wastes takes into account the links to strategies for addressing climate change (in particular addressing short lived climate change pollutants) as well as the links to sustainable development in particular the suggested SDG goal on sustainable consumption and production.

In accordance to the above MoE will allocate resources for the implementation of the Stockholm Convention. However, a key part of the implementation strategy will involve seeking of international assistance from both bi-lateral and multi-lateral sources based to meet the financial resquirements estimated in the updated NIP and the synergies with the implementation of other MEAs.

1. Introduction

Section 1 outlines the purpose and structure of the National Implementation Plan (NIP), including a summary of the Stockholm Convention (SC), its aims and its obligations. It also describes the mechanism used to develop the NIP and the stakeholder consultation process. A summary of the Persistent Organic Pollutants (POPs) issue provides the context and background outlining the chemicals, their uses and the problems they cause.

1.1. Stockholm Convention requirements

The SC on POPs entered into force for Sudan on 17 May 2004. The SC imposes a worldwide ban on the production and trade in eight pesticides (aldrin, chlordane, DDT, dieldrin, endrin, heptachlor, mirex and toxaphene), two industrial chemicals – hexachlorobenzene (HCB) and polychlorinated biphenyls (PCBs) - and four unintentionally produced POPs: polychlorinated dibenzo-p-dioxins (PCDD) and dibenzofurans (PCDF), PCB an HCB from 2004 onwards. These substances designated as POPs are toxic, persistent and can be transported over great distances through the air and water. POPs can cause adverse effects on the environment and health because they bioaccumulate in organisms. This can result in cancer, endocrine disrupting effects and disruption of the immune system.

In 2009, the Conference of the Parties (COP), by decisions SC-4/10 to SC-4/18, adopted amendments to annexes A (elimination), B (restriction) and C (unintentional production) of the SC to list nine additional chemicals as persistent organic pollutants which are the following pesticides: chlordecone, alpha hexachlorocyclohexane, beta hexachlorocyclohexane, lindane, pentachlorobenzene; industrial chemicals: hexabromobiphenyl, hexabromodiphenyl ether and heptabromodiphenyl ether, pentachlorobenzene, perfluorooctane sulfonic acid, its salts and perfluorooctane sulfonyl fluoride, tetrabromodiphenyl ether and pentabromodiphenyl ether; and by-products: alpha hexachlorocyclohexane, beta hexachlorocyclohexane and pentachlorobenzene.

In 2011, the Conference of the Parties (COP), by decision SC-5/3, adopted an amendment to annex A (elimination) by listing technical endosulfan and its related isomers.

In case of some POPs substances listed in annex A and B, the Convention has noted acceptable purposes and specific exemptions as presented in the table 1 below.

Table 1 - Acceptable purposes/specific exemptions for POPs listed in the Convention

Chemicals	Annex	Specific exemptions/Acceptable purposes
Hexabromodiphenyl ether and heptabromodiphenyl ether	A	Production: none Use: recycling of articles that contain or may contain hexabromodiphenyl ether and heptabromodiphenyl ether, in accordance with provisions of Part IV of Annex A
Lindane	A	Production: none Use: human health pharmaceutical for control of head lice and scabies as second line treatment
Technical endosulfan	A	Production: As allowed for the parties listed in the Register Use: Crop-pest complexes as listed in accordance with the provisions of part VI of this Annex
Tetrabromodiphenyl ether and pentabromodiphenyl ether	A	Production: none Use: recycling of articles that contain or may contain tetrabromodiphenyl ether and pentabromodiphenyl ether, in accordance with provisions of Part V of Annex A
Perfluorooctane sulfonic acid its salts and perfluorooctane sulfonyl fluoride	B	Production: for the use below Use: several acceptable purposes and specific exemptions in accordance with Part III of Annex B
DDT(1,1,1-trichloro-2,2-bis (4-chlorophenyl)ethane)	B	Production: Disease vector control use in accordance with Part II of this Annex Use: Disease vector control use in accordance with Part II of this Annex

Source: Stockholm Convention website

Paragraph 1 of Article 7 of the Stockholm Convention states that each Party shall develop and endeavour to implement a plan for the implementation of its obligations under the Stockholm Convention, which needs to be transmitted to the Conference of the Parties within two years of the date on which this Convention enters into force for it. Article 7 also calls for a review and update of the plan on a periodic basis and in a manner the Conference of the Parties specify.

To determine whether a Party has a need to review and update its national implementation plan, the Party concerned should assess whether it is affected by any external or internal factors, such as those referred to in paragraphs 4 and 5 of the annex to decision SC-1/12.

According to paragraph 7 of the annex to decision SC-1/12, for those changes in the obligations arising from amendments to the Convention or its annexes, a Party will review and update its implementation plan, and transmit the updated plan to the Conference of the Parties within two years of the entry into force of the amendment for it, consistent with paragraph 1 (b) of the Convention.

The SC also requires all parties to develop an Action Plan. In the National Action Plan (NAP) the parties to the SC must specify what strategies they will be developing to meet the obligations of the SC.

Among others, the provisions of the Convention require each party to:

•Prohibit and/or eliminate the production and use, as well as the import and export, of the intentionally produced POPs that are listed in Annex A to the Convention (Article 3)

Annex A allows for the registration of specific exemptions for the production or use of listed POPs, in accordance with that Annex and Article 4, bearing in mind that special rules apply to PCBs. The import and export of chemicals listed in Annex A can take place under specific restrictive conditions, as set out in paragraph 2 of Article 3.

•Restrict the production and use, as well as the import and export, of the intentionally produced POPs that are listed in Annex B to the Convention (Article 3)

Annex B allows for the registration of acceptable purposes for the production and use of the listed POPs, in accordance with that Annex, and for the registration of specific exemptions for the production and use of the listed POPs, in accordance with that Annex and Article 4. The import and export of chemicals listed in Annex B can take place under specific restrictive conditions, as set out in paragraph 2 of Article 3.

•Reduce or eliminate releases from unintentionally produced POPs that are listed in Annex C to the Convention (Article 5)

The Convention promotes the use of best available techniques and best environmental practices for preventing releases of POPs into the environment.

•Ensure that stockpiles and wastes consisting of, containing or contaminated with POPs are managed safely and in an environmentally sound manner (Article 6)

The Convention requires that such stockpiles and wastes be identified and managed to reduce or eliminate POPs releases from these sources. The Convention also requires that wastes containing POPs are transported across international boundaries taking into account relevant international rules, standards and guidelines.

•Target additional POPs (Article 8)

The Convention provides for detailed procedures for the listing of new POPs in Annexes A, B and/or C. A Committee composed of experts in chemical assessment or management - the Persistent Organic Pollutants Review Committee, is established to examine proposals for the listing of chemicals, in accordance with the process set out in Article 8 and the information requirements specified in Annexes D, E and F of the Convention.

•Other provisions of the Convention relate to the development of implementation plans (Article 7), information exchange (Article 9), public information, awareness and education (Article 10), research, development and monitoring (Article 11), technical assistance (Article 12), financial resources and mechanisms (Article 13), reporting (Article 15), effectiveness evaluation (Article 16) and non-compliance (Article 17).

1.2. The Republic of Sudan, the Stockholm Convention and MEAs

The Republic of Sudan signed the Stockholm Convention on the 23rd of May 2001, and further ratified it in 2006. Therefore, the Government of Sudan was eligible for assistance in the form of an enabling activity project to create sustainable capacity, including preparation of first POPs National Implementation Plan (NIP), to meet the country's obligations under the Convention. The first NIP was developed during 2004 – 2006, with financial support from GEF and technical assistance from UNDP and was submitted to the Secretariat of SC on 4th of September 2007.

Further, Sudan has ratified in 2006 the Basel convention on the Control of Trans-boundary Movements of Hazardous Wastes and Their Disposal (Basel Convention) and the Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (PIC),

The National Implementation Plan on the POPs management and phase-out, together with the ratification of the above mentioned two conventions geared the country very well into the international community in POPs management and enabled Sudan to participate in the technical cooperation, information exchange and dissemination.

The NIP described how Sudan would meet its obligations under the Stockholm Convention to manage and phase-out Persistent Organic Pollutants (POPs) and to manage POPs-contaminated sites in an environmentally sound manner facilitating dialogue, information exchange and co-operation between relevant stakeholders – including the governmental, non-governmental, academic and private sectors. The scope of NIP was to ensure that POPs were well taken into account in strategy formulations for different economic and technical sectors.

1.3. NIP development methodology

The Sudanese NIP review process was triggered by the changes in the obligations arising from amendments to the Convention or its annexes, according to paragraph 7 of the annex to decision SC-1/12.

The NIP update process has followed the guidance provided by the SC (updated in 2012 to include the POPs listed in 2009 and 2011). The NIP Update Country Team considered the following documents in their work:

- Guidance for Developing a National Implementation Plan for the Stockholm Convention on Persistent Organic Pollutants (2012)
- Guidance on calculation of action plan costs for specific POPs (updated in 2012)
- Guidance on Socio-Economic Assessment for National Implementation Plan Development and Implementation under the Stockholm Convention (2007) (not revised)
- Guidance for the inventory of perfluorooctane sulfonic acid (PFOS) and related chemicals listed under the Stockholm Convention on POPs (Draft, 2012) (new)
- Guidance on best available techniques and best environmental practices for the use of perfluorooctane sulfonic acid (PFOS) and related (Draft, 2012) (new)
- Guidance for the inventory of polybrominated diphenyl ethers (PBDEs) listed under the Stockholm Convention on POPs (Draft, 2012) (new)
- Guidance on best available techniques and best environmental practices for the recycling and waste disposal of articles containing polybrominated diphenyl ethers (PBDEs) listed under the Stockholm Convention on POPs (Draft, 2012) (new)
- Guidance for the control of the import and export of POPs (Draft, 2012) (new)
- Labelling of products or articles that contain POPs-initial considerations (Draft, 2012) (new)

Moreover the following SC and BC available resources have been consulted:

•Step-by-step companion guide to the review and updating of the National Implementation Plans – 2011;

•Lessons learned and good practices in the development of national implementation plans for the Stockholm Convention on Persistent Organic Pollutants, 2006;

•New POPs – Publications;

•PCBs – Guidance documents on PCBs;

•BAT/BEP – Guidelines on best available techniques and provisional guidance on best environmental practices;

•Toolkit – Standardized toolkit for Identification and Quantification of Dioxins and Furan Releases;

•Waste and Stockpiles •Training tool;

•POPs Waste;

•Technical guidelines adopted under Basel Convention. •E-Waste;

The update process of National Implementation Plan (NIP) to manage and phase-out persistent organic pollutants was initiated in January 2013 by nominating the Higher Council for Environment and Natural Resources (HCENR) as the responsible implementing agency of the Government. UNIDO was the executing agency and the Global Environment Facility (GEF) was the main funding source. The work started in January 2013 by assessing the current capacity, establishing a specific office at HCENR, appointing project director and assistants and compiling a draft work plan. A steering committee, called Multi-stakeholder National Coordination Committee (MNCC) representing different governmental authorities, businesses and NGOs was formed.

No.	Main Stakeholder
1	MINISTRY OF INDUSTRY
2	MINISTRY OF AGRICULTURE AND FORESTRY
3	MINISTRY OF HEALTH
4	MINISTRY OF JUSTICE
5	AGRICULTURAL RESEARCH CORPORATION
6	NATIONAL CHEMICAL LABORATORIES
7	NATIONAL PESTICIDES COUNCIL
8	SUDAN ENVIRONMENT CONSERVATION SOCIETY (NGO)
9	Universities
10	Ministry of Environment, Forestry and Physical Development

The MNCC had 5 plenary sessions during the NIP update compilation process. In addition to the plenary sessions the MNCC has formed several temporary working groups in particular for inventory development. Prior to the inventory a training workshop was held with the support of UNIDO and an international consultant. In the workshop the main steps of inventory process were introduced based on the SC Guidance materials.

The preparation of POPs pesticide inventory (Annex A, Part I substances and DDT) was led by the National Consultant who also developed the pesticide inventory of the first NIP and such the former technical

capacity created was used in updating of NIP. He was supported by a team of technical staff. The compilation of phase-out strategies and action plans were monitored by an expert group of key stakeholders. The strategy of DDT use for malaria vector control was elaborated by the pesticide working group.

The PCB related inventory activities were carried out by the National Electricity Corporation (NEC), which is the sole producer and distributor of electricity in Sudan. The NEC experts prepared the inventory of transformers and the Ministry of Energy participated in developing and formulating the strategy and actions plans.

The polybrominated diphenyl ethers (PBDEs) inventory was led by a national consultant who also participated in the first NIP development. Her work was supported by an expert team covering the main sectors of inventory (EEE/WEEE and transport sector).

The inventory of perfluorooctane sulfonic acid (PFOS) and related chemicals was led by a national consultant who was task team leader in preparing the first NIP. These activities were supported by the PFOS task team.

Assessing and preparing the inventory of unintentional production of POPs (Annex C source categories, dioxins and furans) was led by the same national consultant who did the UPOPs inventory in the first NIP. His work was supported and monitored by an expert group. The expert group was also involved in developing the reduction strategy and action plan.

Further working groups were dealing with other relevant topics such as awareness raising, socio-economic considerations and gender issues.

All working groups mentioned above initiated their work by receiving training and guidance by international experts, who highlighted the key issues to be addressed.

Task team members, stakeholders and their staff participated in the process. HCENR wishes to acknowledge the contribution of the private industries, businesses and NGOs who supported this work providing POPs related technical data and information.

The experience gained through updating NIP is a good asset for the forthcoming awareness raising and information dissemination regarding the management and phase-out of POPs as well as mitigating their adverse effects.

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

- Inventory report for Pesticides and action plan;
- Inventory report for PCB and action plan;
- Inventory report for PBDE and action plan;
- Inventory report for PFOS and action plan;

- Inventory report for unintentional POPs and action plan;
- Assessment of National POPs Monitoring and Research and Development (R&D) Capacity for Persistent Organic Pollutants (POPs) in the Sudan. An Updated Report;
- Up Date of the Levels of POPs chemicals in the Environment and Human exposure.

1.3.1. Socio-Economic Assessment

There is a growing body of information and data on the links between pollution and health that demonstrates the negative impacts of pollution, contaminants from indoor exposure (including heating/cooking, chemicals used indoor and consumer products) and contaminated sites having high impact on health in developing countries[1,2]. The numbers of people affected worldwide are now estimated to be of the order of 200 million[1]. POPs, POPs-like chemicals[3] and other toxic chemicals (including e.g. heavy metals or endocrine disrupting chemicals[4,5]) play a crucial role. Therefore a more critical assessment of social burdens of pollution from industrial production and chemical exposure is needed.

References to socio-economic assessment can be found throughout the text of the Stockholm Convention[6]. These references indicate the importance of a socio-economic assessment when implementing the obligations under the Convention and when developing the updated NIP. GEF 2020 long-term strategy suggests aligning global environmental objectives with priorities of national and global socioeconomic development.

Annex F Information on socio-economic considerations of SC provides an indicative list of items to be taken into consideration by Parties when undertaking an evaluation regarding possible control measures for chemicals being considered for inclusion into the Convention. The preamble to Annex F states that: "An evaluation should be undertaken regarding possible control measures for chemicals under consideration for inclusion in this Convention, encompassing the full range of options, including management and elimination. For this purpose, relevant information should be provided relating to socio-economic considerations associated with possible control measures to enable a decision to be taken by the Conference of the Parties".

The Conference of the Parties, in its decision SC-1/12 requested the Secretariat of SC, in collaboration with other relevant organizations and subject to resource availability, to develop among others, additional

---

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

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

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

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

5 Many POPs are at the same time endocrine disrupting chemicals.

6 UNEP (2007) Draft guidance on socio-economic assessment for national implementation plan development and implementation under the Stockholm Convention. UNEP/POPS/COP.3/INF/8.

guidance on social and economic assessment, and in doing so to take into consideration the particular circumstances of developing countries and countries with economies in transition. In response to that request, the Secretariat developed the draft guidance on socio-economic assessment for national implementation plan development and implementation under the Convention. According to the guidance, the Socio-Economic Assessment (SEA) is a systematic appraisal of the potential social impacts of economic or other activities such as the management of POPs in all sectors of society (including local communities and groups, civil society, private sector and government). It is a mean of analyzing and managing the intended and unintended social impacts, both positive and negative, of planned interventions (policies, programs, plans and projects) and any social change processes invoked by those interventions. Social impacts are the changes to individuals and communities that come about due to actions that alter the day-to-day way in which people live, work, play, relate to one another, organize to meet their needs and generally cope as members of society.

In the context of managing POPs, social and economic impacts might include:

- contamination of air, water and soil and threat to food safety and drinking water safety;
- degradation of ecosystem services[7]
- vulnerability arising from exposure to POPs;
- deterioration or improvement in health[8];
- loss or improvement in livelihoods;
- changes in cost of living;
- cost of contaminated site management and remediation;
- changes in employment , income and workplace protection;
- changes in levels of equity of wealth distribution;
- opportunities for enterprise development (including Small and Medium Enterprises);
- changes in demand for public services, such as health and education.

The Socio-Economic Assessment assisted and will assist in taking actions that are appropriate and effective. Socio-Economic Assessment provides a basis for minimising the negative impact on the population and improving equitable outcomes for the most vulnerable groups. However the socio-economic assessment lacks information on external costs. The unknown external cost can bias decisions and need to be compensated by taking precautionary approaches.

The human resource capacity on socio-economic assessment in Sudan is rather limited and need to be improved throughout the implementation of updated NIP. This has been done also in a PERSGA project where the socio-economic impact has been assessed for an asphalt mixing facility.

Socio-Economic Assessment can help at any phase of development of the national implementation plan and during its implementation. If priorities have already been set in Phase I-III of the national

7 Millenium-Ecosystem Assessment (2005) Ecosystems and Human Well-being: General Synthesis. http://www.maweb.org/documents/document.356.aspx.pdf

implementation plan, then a socio-economic assessment can be used in order to gain insight into the impacts of mitigation measures already decided. In this case, a brief investigation may be conducted for Phase IV. The results will assist in developing NIP communication strategies and rule out the worst excesses of inequitable impact. However, to be able to track the impact of mitigation measures, a baseline investigation would have to be carried out in Phase I – III of NIP development, thus making the exercise more resource intensive, but yielding more useful information.

For Sudan the following socio-economic considerations are highlighted as most relevant. These key areas are considered as a frame for implementation without trying to apply usual socio-economic calculations requiring sophisticated single stakeholder assessments and often not leading to a practical outcome for developing countries where such information is not available:

A) Food and water safety (including POPs exposure of population)

The basis for sustainable development is healthy food and safe drinking water as well as clean and fertile soils. This environmental frame is the basis for the long term development of a healthy society. Within this frame an economy can develop which should serve society and protect the environmental. Sudan is highly vulnerable to desertification and to climate change (in particular draught) which poses an additional burden on soil and water resources. Therefore water and food security are of key importance for Sudan, hence the country has a strong commitment to the Convention on Climate Change and the UN Convention to Combat Desertification. Integrated the socio economic dimension of food and water safety is a major, cross cutting issue for these conventions and need to be addressed in an integrated way.

B) Exposure of vulnerable and highly exposed groups

POPs have a particular impact on vulnerable groups. These include children which e.g. for new listed PBDE have in average a higher exposure compared to adults[8]. POPs are also a particular threat for young woman with the risk of negative effect on reproductive health[9] and on the health of the next generation. POPs and other pollutants can be transferred during pregnancy to the foetus and via breast milk to the baby causing developmental and other adverse effects e.g. PFOS has been correlated to sub fecundity[10] and PBDE to reduced IQ in children[11].

The reproductive health of men is also impacted by POPs and other chemicals. In industrialized countries since the 1950s the sperm quality is decreasing[12,13]. Chemicals including POPs (e.g. PCB, DDT) but also other chemicals such as certain phthalates and organophosphates[13] play a crucial role in the decline of

[8] US EPA (2010) An Exposure Assessment of Polybrominated Diphenyl Ethers. EPA/600/R-08/086F, May 2010.
9 CHE/Commonweal (2009 Hormone Disruptors and Women's Reproductive Health.
[10] Fei C, McLaughlin JK, Lipworth L, Olsen (2009) Maternal levels of perfluorinated chemicals and subfecundity. J Hum Reprod. 24, 1200-1205.
11 Herbstman et al. (2010) Prenatal exposure to PBDE and neurodevelopment. Environ Health Perspect 118(5): 712-719. http://ehp03.niehs.nih.gov/article/fetchArticle.action?articleURI=info%3Adoi%2F10.1289%2Fehp.0901340
12 Sharpe R (2009) Male Reproductive Health Disorders and the Potential Role of Exposure to Environmental Chemicals http://www.chemtrust.org.uk/wp-content/uploads/ProfRSHARPE-MaleReproductiveHealth-CHEMTrust09-1.pdf
13 Jurewicz J, Hanke W, Radwan M, Bonde JP (2009) Environmental factors and semen quality.Int J Occup Med Environ Health.22, 305-329.

sperm quality. The correlation of lower sperm quality in young men and the levels of PFOS (and PFOA) in human tissues was also described.[14]

The impact assessment of POPs and POPs-like[15] chemicals in possible combination with the approx. 100,000 chemicals on health poses a great challenge. Various POPs have endocrine effects which add to endocrine effects of hundreds of other chemicals.[16] In Sudan experiments have shown that Norway rats (*Rattus norvegicus;* Sprague Dowely Strain)) treated with endosulfan produced endocrine effects[17].

Occupational exposure includes farmers exposed to POPs and other hazardous pesticides. In an agricultural country such as Sudan pesticides can still be considered as chemicals with the highest impact on human health and the environment. Fire fighters may be exposed to new listed POPs such as PFOS, PBDEs and unintentional POPs such as PCDD/F and related PBDD/F[18]. In the implementation of NIP the ILO conventions of occupational health relevance will be considered within the socio-economic frame.

C) Cost of destruction and end of life management and treatment

Export of POP-contaminated materials back to the original producers for destruction costs about US$2,000 to US$5,000/t.[19] The management costs for the worldwide total of approximately 3 million tonnes of PCB-containing equipment alone have thus been estimated at between US$6 billion and US $15 billion.[20] The situation is similar for pesticide stockpiles. There has been hardly any progress over the past decade in Africa[21], where 50,000 tonnes of stockpiles has an estimated management cost of US$250 million.

The Sudanese government has closely followed the global challenge posed by POPs pesticides and PCB stockpiles. The governments of developing countries can hardly deal with this burden. The change in GEF financing to 1:6 financing scheme cannot be beared by the least developed countries. Other stakeholders such as the former producers of PCBs including Monsanto, Bayer, or Kaneka have their corporate responsibility and sustainability commitments. Extended producer responsibility is the core of corporate responsibility. Therefore the former manufacturers of PCBs have to take their responsibility in the management and treatment of their products.

---

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

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

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

17 Abdalla & Bashir (2013) Endocrine Effect of endosulfan on Norway rats (Rattus norvegicus, Sprague Dowely Strain)

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

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

20 Stockholm Convention (2010) Stockholm Convention (2010) PCB Elimination Club (PEN) magazine. Issue 1 12/2010. http://chmpopsint/tabid/738/Defaultaspx. Accessed 19 Aug 2012

21 World Bank (2013 REwference**

D) Cost of contaminated soil and site remediation

The cost and the management challenge of contaminated sites from more than a century industrialization are enormous and cannot adequately be managed even in industrialized countries[22,23]. Beside heavy metals, PAHs also POPs are important contaminants at contaminated sites. After soil and ground water has been contaminated it is costly and difficult to restore them that they might serve again for food production or residential purposes. Therefore prevention has the highest priority. The experience of the last decade Stockholm Convention implementation has shown that developing countries are not in the position to appropriately manage POPs and do not have the technologies to adequately destroy POPs stockpiles. Also the management of these stockpiles have revealed the high cost of end of life destruction of POPs in developing countries. Therefore the updated applies the precautionary approach. The risk assessment of these chemicals considering their potential synergistic effects is being performed.

Considering these socio-economic burdens in the preparation of NIP update the following approaches and principles have been taken into account:

- the precautionary approach will be considered for the implementation of the Convention;
- the substitution approach will be applied for POPs and POPs-like chemicals where feasible;
- the extended producer responsibility and the polluter pays principle will be applied. To promote the internalization of environmental and social costs and the uses of economic instruments, taking into account that the polluter should bear the cost of pollution with due regard to the public interest considering Principle 16 of the Rio Declaration.

1.3.2. Gender policy in NIP development and implementation

Efforts to ensure sound management of chemicals, including POPs have important gender dimensions, because in daily life, men, women, and children are exposed to different kinds of chemicals in varying concentrations. Biological factors, notably size and physiological differences between women and men and between adults and children, influence susceptibility to health damage from exposure to toxic chemicals. Also social factors, primarily gender-determined occupational roles, also have an impact on the level and frequency of exposure to toxic chemicals, the kinds of chemicals encountered, and the resulting impacts on human health.[24.]

It is important that these gender dimensions be reflected at both site and policy level interventions for sound chemical management. The gender analysis is used to identify, understand, and describe gender differences and the impact of gender inequalities in a sector or program at the country level. Gender analysis is a required element of strategic planning and is the basic foundation on which gender integration is built. Gender analysis examines the different but interdependent roles of men and women and the relations between the sexes. It also involves an examination of the rights and opportunities of men and women, power relations, and access to and control over resources. Gender analysis identifies

[22] European Environmental Agency (2014) Progress in management of contaminated sites (LSI 003) - Assessment May 2014.
[23] Faber D (2008) Capitalizing on Environmental Injustice. The Rowman & Litlefield Publishing Group, Inc.
[24] United Nation Development Programme, Gender Mainstreaming. A Key Driver of Development in Environment and Energy, Energy and Environment Practice. Gender Mainstreaming Guidance Series;

disparities, investigates why such disparities exist, determines whether they are detrimental, and if so, looks at how they can be remedied[25].

Consistent with the GEF Policy on Gender Mainstreaming and the GEF-6 approach on gender mainstreaming, GEF projects funded under this strategy will not only acknowledge gender differences within their design but determine what actions are required to promote both women's and men's roles in chemical management, disproportionate chemical exposure and vulnerability, as well as sustainable alternatives. For the NIP update project two task team leaders (for PCBs and for PBDEs) where woman. Also the teams where gender balanced ensuring that different gender perspectives where considered in the inventory development and in the action plan development. Already in the first NIP Sudan has in particular taken care of the contamination of mother milk and has participated as first African country in the WHO human milk study. A woman NGO was involved in the project and took care of the entire WHO breast milk study in Sudan.

1.3.3. Consistency with NIP update guidance

The NIP structure is consistent with the GEF initial guidelines for enabling activities for the SC on POPs, and the interim guidance for developing a NIP (UNEP and The World Bank Group), including strategies required under articles 5 and 6 of the Convention. The process of developing NIP was supported financially by the GEF and UNIDO.

1.3.4. Further considerations

1.3.4.1. GEF strategies and visions; updated sustainable development goals

As the Global Environment Facility is the principal entity for the financial mechanism dealing with POPs, Sudan has correlated its vision to protect human health and the environment from POPs taking also into account GEF 2020 Strategy, as well as the GEF-6 Strategy.

Sudan aims at taking an integrated and systemic approach based on the causal chain of environmental change, and identifying the key underlying drivers to tackle in implementing SC. This approach matches with Sudan's future development plans and can contribute to overcome many challenges such as the daunting challenge of reconstruction, development and peace building. Where useful, hazardous chemicals (POPs, ODS, mercury and others) are to be addressed together in inventory development, information databases, waste management and contaminated site assessment.

In the case of POPs considerations are made from end of pipe solutions to advancing green chemistry[26] more precise to substitution of POPs chemicals including non-chemical alternatives as can be seen in the case of Sudan's activities on alternatives to pesticide. For Sudan focusing on the direct drivers by reducing the use of POPs in production and supply chains through, for example, the deployment of alternatives to harmful chemicals, as well as, working on more upstream in the causal chain focusing on research and development in particular by developing better alternatives in pest control. This is part of the approach

[25] United States Agency for International Development (2011), Tips for Conducting a Gender Analysis at the Activity and Project Level. Additional Help for ADS Chapter 201;
[26] Global Environment Facility (2013) GEF 2020. Strategy paper for the Global Environment Facility;

to move to sustainable consumption and production patterns highlighted as a goal in the first draft of sustainable development goals and "*by 2020 achieve environmentally sound management of chemicals and all wastes throughout their life cycle in accordance with agreed international frameworks and significantly reduce their release to air, water and soil to minimize their adverse impacts on human health and the environment*". [27]

1.3.4.2. Considering forward looking information and strategy

Policymakers knowledgeable about possible future developments should advise decision-makers in order to avoid unsustainable decisions which can lead to negative consequences on human health and the environment. Therefore, the updated NIP needs to consider the precautionary approach and needs forward looking information for sustainable long-term planning to avoid failures on chemicals management and their consequences including problems in recycling and waste management. A knowledge base for Forward-Looking Information and Services developed by the European Environment Agency[28] aims to support such long-term planning and can be considered, as appropriate, during NIP implementation.

1.4. NIP structure

The updated NIP is closely structured according to the NIP update guidance.

27 PROPOSAL OF THE OPEN WORKING GROUP FOR SUSTAINABLE DEVELOPMENT GOALS. 19. July 2014.

28 European Environmental Agency (2011) Knowledge base for Forward-Looking Information and Services (FLIS) A platform to support long-term decision-making

2. Country baseline

Section 2 provides basic background information relevant to NIP. It describes the current situation and state of knowledge in the country on POPs and the status of institutional and other capacity to address the problem.

2.1. Country profile

A brief country profile is given in order to place NIP strategies and action plans in a country-specific context. It summarizes information on geography and population, membership in regional and sub-regional organizations, the country's political and economic profile, profiles of potentially important economic sectors in the context of the POPs issue and overall environmental conditions and priorities in the country.

2.1.1. Geography and population

Republic of Sudan with a total area of one thousand eight hundred eighty two square kilometres (1.882.000) is located in the north eastern part of Africa. Its highly diverse landscape ranges from desert to rich savannah forest, and its abundant natural resources include oil, timber, extensive agricultural land, and marine and inland fisheries. The country is also culturally diverse and comprises hundreds of distinct tribal and ethnic groups.

Its territory crosses over 18 degrees of latitude (21.49 East-38.34 East and 23.8 North-8.45 North). Sudan is bordered by seven countries: Egypt, Eritrea, Ethiopia, The Central African Republic, Chad, Libya and Southern Sudan.

The majority of Sudan land is very flat, with extensive plains in an altitude range of 300 to 600 m above sea level. Isolated mountain ranges are found across the country, including the Red Sea hills in the far north-east, the Jebel Marra plateau in the west and the Nuba Mountains in the centre. The average elevation of these mountains is 1,000 m above sea level, but the highest point is Jebel Marra in the Western Sudan, which reaches more than 3000 m. The dominant river system in Sudan is the Nile, whose basin extends over 70 percent of the country. The Nile river two main tributaries, namely the Blue and White Nile, flow into Sudan from Ethiopia and Uganda and meet in Khartoum, before flowing north into Egypt. In an otherwise arid terrain, the Nile plays a crucial role in the country's various ecosystems. Sudan also has over 750 km of coastline and territorial waters in the Red Sea, which include an archipelago of small islands. Twenty-nine percent of Sudan's total area is classified as desert, 19 percent as semi-desert, 27 percent as low rainfall savannah, 14 percent as high rainfall savannah, less than one percent as true mountain vegetation and the forests cover about 11.6% of the total area of the country. Note that the precise figures in each class are highly dependent upon the classification system and date; the above are based on recent FAO figures.The population of Sudan is estimated to around thirty three millions (Last census, 2008), with an annual growth rate of 2.8% after the cessation of the South. The population density is varied from 2-3 in semi-arid areas to 218-230 in rich savannah ecological zone.Table 2 shows the population distribution and the characteristics, which are relevant in assessing the adverse impacts of POPs. The rural areas are characterized by use of pesticides and biomass burning and the subsequent

unintentional production of harmful dioxins and furans. Waste burning and other waste management related operations, in addition to industrial sources are the source of dioxin and furans, heavy metals and other pollutants in urban areas. Harmful impacts of POPs and other pollutants are severely affecting the young children and their mothers.

Table 2 - Total Projected Population of States

Year	2013		2008	2013	2013	2013	
State	Estimated population		Population growth rate 2008	Rural population % of Sudan	Urban population % of Sudan	POPULATION UNDER 5 YEARS OLD	
	Number	%				Number	%
Northern	813,685	2.25	2.10			94,631	1.7
River Nile	1,309,129	3.62	2.40			167,397	3
Red Sea	1,366,991	3.78	4.70			171,646	3.1
Kassala	2,133,663	5.90	2.50			283,919	5.1
Al Gedarif	1,739,478	4.81	1.10			310,152	5.6
Khartoum	6,534,795	18.07	3.10			778,713	14.2
Al Gezira	4,285,408	11.85	1.80			616,912	11.2
White Nile	2,086,650	5.77	2.30			332,465	6
Sinnar	1,580,357	4.37	1.80			255,955	4.6
Blue Nile	965,573	2.67	3.20			183,191	3.3
North Kordofan	3,073,921	8.50	5.30			558,010	10.1
South Kordofan	1,811,805	5.01	2.20			352,829	6.4
North Darfur	2,231,305	6.17	4.00			371,233	6.7
West Darfur	1,529,728	4.23	- 0.10			281,611	5.1
South Darfur	4,701,291	13.00	4.30			813,112	14.8
SUDAN	36,163,778	100.00	2.8	65.2	34.8	5,477,145	100

Source: The Central Bureau of Statistics, 2013

2.1.2. Political profile

Sudan is a Federal Republic composed of 18 states (wilayat, singular - wilayah); Al Bahr al Ahmar (Red Sea), Al Jazira (Gezira), Al Khartoum (Khartoum), Al Qadarif (Gedaref), An Nil al Abyad (White Nile), An Nil al Azraq (Blue Nile), Ash Shimaliyya (Northern), Gharb Darfur (Western Darfur), Janub Darfur (Southern Darfur), Janub Kurdufan (Southern Kordofan), Kassala, Nahr an Nil (River Nile), Sharq Darfur (Eastern Darfur), Shimal Darfur (Northern Darfur), Shimal Kurdufan (Northern Kordofan), Sinnar, Wasat Darfur (Central Darfur) and Gharb Kurdofan (West Kurdofan).

The Political and administrative structure is based on two levels of governance:

- Legislative power;
- Executive power

The administrative divisions are periodically subjected to changes by the government in creating new states or abolishing others and hence creating new geographical borders.

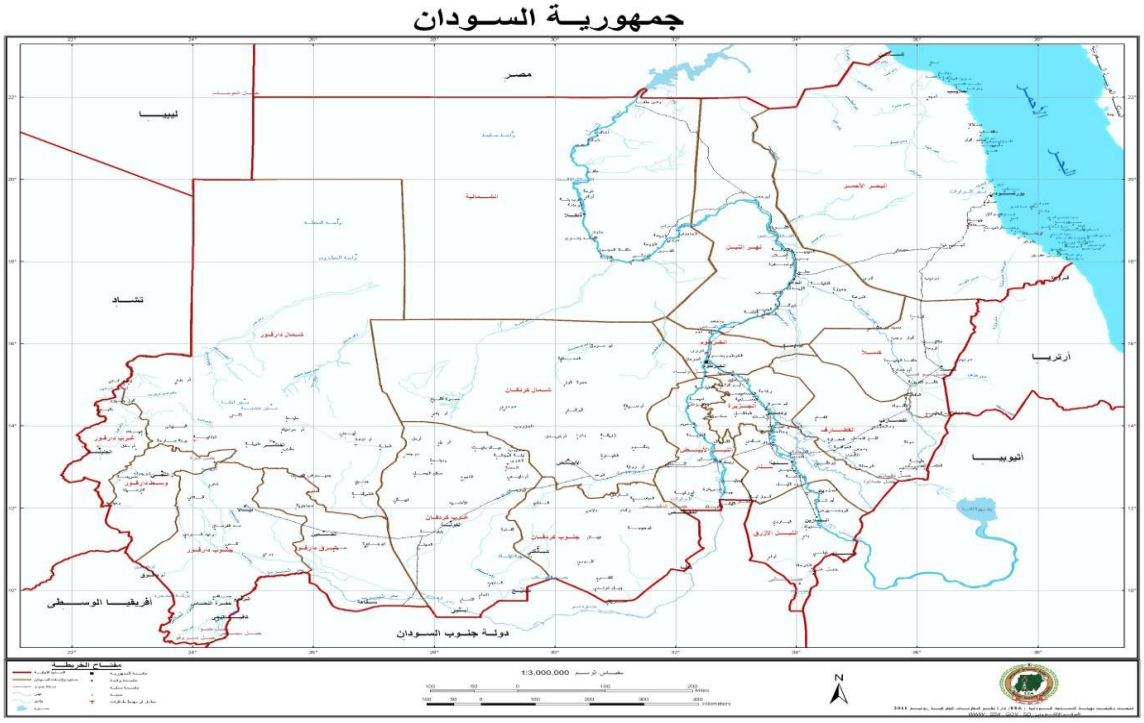


Figure 1 - Administrative regions of Sudan

The Government of Sudan is in the process of drafting a new constitution to replace the Interim National Constitution ratified 5 July 2005. The legislature branch is a bicameral National Legislature consists of a Council of States (50 seats; members indirectly elected by state legislatures to serve six-year terms) and a National Assembly (450 seats; 60% from geographic constituencies, 25% from women's list, and 15% from

party lists; members to serve six-year terms) **elections:** last held on 11-15 April 2010 (next to be held in 2015).
The Judicial branch consists of Constitutional Court of nine justices; National Supreme Court; National Courts of Appeal; other national courts; National Judicial Service Commission will undertake overall management of the National Judiciary.

2.1.3. Profiles of economic sector

Sudan is a developing country that had to deal with social conflict, civil war, and the July 2011 secession of South Sudan - the region of the country that had been responsible for about three-fourths of the former Sudan's total oil production. The oil sector had driven much of Sudan's GDP growth since it began exporting oil in 1999. For nearly a decade, the economy boomed on the back of increases in oil production, high oil prices, and significant inflows of foreign direct investment. Following South Sudan's secession, Sudan has struggled to maintain economic stability, because oil earnings now provide a far lower share of the country's need for hard currency and for budget revenues. Sudan is attempting to generate new sources of revenues, such as from gold mining, while carrying out an austerity program to reduce expenditures. Agricultural production continues to employ 80% of the work force. Sudan introduced a new currency called the Sudanese pound following South Sudan's secession. Sudan population after the cessation of South Sudan is estimated at about 33 million, and the area of the country is about 1,882,000 km^2. Roughly 40% of the population lives in urban and 60% in rural areas. Agriculture is the main activity whether irrigated or rain-fed. Surface water resources are used extensively for production of crops; while groundwater is used mainly for drinking water and other economic activities. In fact the use of groundwater in rural areas is important for drinking water, animal watering, for industry and agriculture and for producing cash crops.

Irrigation projects are considered major components of development plans. This is because of the food security issue; in addition they produce commodities for export to earn foreign currency and also producing raw materials for local industry. Many other benefits are obtained from irrigation projects such as offering jobs for rural inhabitants, reducing poverty, and thereby achieving rural development in the general context. Urban centres are also benefitting through receiving agricultural products and getting relief from the influx of villagers' invasion seeking marginal jobs. Sudan started irrigation projects early last century with the Gezira Scheme (GS), and through the years many other irrigation projects were constructed in different parts of the country. Today the irrigated areas exceed four million feddans (about 1.68 million hectare) second to Egypt in the African Continent.

Rain-fed agriculture constitutes the major portion of the livelihood of many inhabitants in Sudan. Water in rural areas is the centre for the livelihood of the villagers, for drinking, farming, livestock watering and all other services. Rainfall covers vast areas in the country and the estimated cultivated areas annually depend on the amount of rainfall, and vary between 15 million to more than 30 million feddans; in comparison to the irrigated areas which are about 4 million feddans. Rain-fed agriculture is a good tool for rural development and offer job opportunity for many populations and revives the country economy.

Sudan has a comparative advantage in vast irrigable lands, easy to irrigate and in the 1996 Food Summit in Rome was considered one of four countries capable of providing sufficient food to feed the world population. Agriculture consumes about 90% of the country water uses.

Real gross domestic product (GDP), grown modestly in 2012 and 2013 owing mainly to the loss of oil revenue following the secession of South Sudan in July 2011.

The government of Sudan has attempted to address heightened economic and social challenges through the introduction of austerity measures.

2.1.4. Environmental overview (including relation of environment and waste/chemicals)

At the beginning of the 20th century the population of Sudan was only three millions and the economy was a subsistence one. Modernization of the economy and social progress started with education well before World War Two. Massive agricultural schemes like the Gezira (2.5 million feddans) were launched after the World War One. This involved building dams and irrigation works (10 thousand km of canalization in the Gezira scheme). Although pilot projects, to test production techniques, preceded the full scale launching of the project, environmental impacts, like deforestation, population movements, salinization and water related diseases, were not even considered. The goal of the scheme was the production of long-stable cotton for export. Economic progress followed in many directions, influenced by the colonial powers, trying to bridge the gap between production growth and a stagnant economy.

2.1.4.1. Sudan's State of Environment and main environment problems

The main aspects on the state of environment in Sudan are related to:

a) Soil degradation, due to receding isohyets towards the south of the country. Consequently the vegetation cover north of latitude 12 disappeared almost completely. This is also due to repeated use of fire deforestation, drought and the dearth of reforestation efforts. Compacting of soils and deforestation become very significant problems around water points especially after the 'anti-thirst campaign' of the 1960s. Sand dune movement accelerated rates of desertification.

b) Deterioration of water resources: Global Warming, drought and desertification accelerated rates of deterioration in water resources both qualitatively and quantitatively. The annual discharges of the Nile system have decreased during the past two decades. It is postulated that rainfall over the Ethiopian Highlands will decrease in the order of 15%, which would result in a 30% decrease in the discharge of the Ethiopian tributaries of the Niles. Dams across the Nile in Sudan have serious siltation problems. This is due to the high load transported down from the Ethiopian Plateau as well as from degraded watersheds. Lower water current velocities are a consequence of decreased volume of discharge. This makes Sudanese rivers vulnerable to invasion by weeds and water-related diseases. Perhaps the Nile is one of the least polluted rivers in the world. Sources of contamination include sugar estates, power plants and agricultural chemicals. The infrastructure of rainwater drainage systems has recently deteriorated. Incidences of malaria and enteric diseases are prevalent during the rainy season. The wide use of domestic water storage tanks has also made malaria an endemic disease.

c) Deterioration in biodiversity: The annual rate of deforestation is close to 504 thousand hectares. Only 30,000 ha are reforested. Sudan lost a number of wild life species in the last two decades; many more are endangered or vulnerable. It is mostly due to habitat destruction. Several grasses

and herbs have disappeared due to overgrazing, repeated droughts and fires. Fires are responsible for the annual loss of 30% dry fodder otherwise available to wild life and the 103 million heads of livestock. Awareness and sensitivity to environmental issues is weak among the public and the policy makers. It must be stressed that the overwhelming limitations of land use in Sudan are the periodic droughts experienced in the Sahelian Belt. Population distribution is inversely proportional to vegetation cover in such a way that 78% of the Sudanese inhabit northern areas with only 33% of cover (which already decreased to 18%). The remaining 22% inhabit the southern parts with 67% of the forest area. Most of the economic development was established in northern parts of the country. Horizontal expansion in large-scale rain-fed mechanized agriculture replaced the traditional subsistence one. The areas under plough are currently 36 million feddans for the rain-fed sector and 4 million for the irrigated sector. Productivity is very low notwithstanding the use of agricultural chemicals and hydrocarbon fuel. Farming marginal lands (with precipitation less than 300m) is particularly disastrous. Farming and distorting flood plains, seasonal watercourses have far reaching effects.

As regards to Sudan's main environmental problems, recurring droughts and desertification have led to an increase in environmental consciousness. The fact that environmental issues affect all aspects of life in the country is gaining acceptance. The basic environmental problems of Sudan are related to the absence of an acceptable strategic master land use plan, the growing conflicts in land use policies, the depletion of natural resources and the unchecked population growth (due to lack of a coherent Population Policy). These problems are made worse by the limited perception of the environmental issues as well as the total neglect for the impacts of agricultural policies. The adoption of 'modernization' in agriculture (which is actually not modernization but horizontal expansion in agricultural practices with very little vertical direction) has become an instrument of interference in the traditional sector and takes away from its resources the lands, forests, ranges, pastures and wildlife.

A listing of environmental problems includes:

- Horizontal expansion in rain-fed and irrigated agriculture;
- The weak and inactive inclusion of the environmental dimensions in policies, strategies, plans and programs of management of resources;
- Environmental evaluation does not exist specially after execution of projects;
- The economy and society, in spite of the century-long attempts at 'modernization' are still dominated by subsistence way of living;
- The economy is still affected seriously by the yearly, seasonal and geographical variability of rainfall for crop and livestock production;
- Dependence on imported seeds and agricultural chemicals has increased cost of production;
- Loss of land productivity and marketing policies decreased cash surplus;
- The civil war in the Blue Nile, South Kordofan and Darfur States has economic and social costs;

- Population distribution and rural-urban migration due to desertification has led to deterioration of natural resources;
- Problems of poor sanitation, industrial pollution and limited food hygiene have become more complex;
- The energy crisis is aggravating desertification and affecting climate change;
- Vast water resources need improved management;
- Waste management and recycling are far lacking behind BAT/BEP;
- Environmental education has only been recently incorporated in school curricula; and
- Laws and legislation concerning the environment are not effective and law enforcement measures are not integrated.

2.1.4.2. Environmental Management Structure

Sudan has recognized the importance of natural resources management since the beginning of the 20th century. Legislation in forest and wildlife was enacted in 1902. The Sudan Government participated in Stockholm Conference on Environment and Human Development (1972) and the UN Conference on Desertification (1976). It established the first Government Environmental Committee in 1977 and attended the Earth Summit in 1992 and Johannesburg Summit in 2002.

In 1992, the Higher Council for Environment and Natural Resources (HCENR) was established as the central government agency to coordinate sustainable development efforts. In 1995, the government created the Ministry of Environment and Tourism, now Ministry of Environment, Forestry and Physical Development (MEFPD) to oversee environmental management. Other ministries with major responsibilities for natural resources management, land use planning and socioeconomic development are also members of the board of HCENR, including the Ministries of Agriculture and Irrigation, Water Resources and Electricity; Industry and Commerce; Energy and Mining; Justice; Health; Culture and Information; General Education and Higher Education.

In June 1993, the HCENR, then chaired by the President, reviewed its structure and mandate. The Council of Ministers Decree 316, 2006 revised the HCENR membership to designate the MEPD as president of the council and add the following members:

- Minister of Agriculture and Forestry; Minister of Irrigation; Khartoum State Governor; Minister of Environment of GOSS; State Ministers of the Ministries Of Finance and National Economy; Health; Energy; Science and Technology; and Animal Resources;
- Under-Secretaries of the Ministries of Wildlife and Tourism; and Information and Culture; Director-General of Sudanese Standards and Meteorology Organization (SSMO);
- Directors of the Institutes of Environmental Studies of the University of Khartoum; and
- Representatives of the private sector and NGOs.

The key developments in respect to environmental protection are represented by the Higher Council for Environment and Natural Resources (HCENR).

The Higher Council for Environment and Natural Resources (HCENR) was established in response to the many calls by the academic community for a body to shoulder the co-ordination of efforts needed to tackle the many and complex issues of environmental degradation.

The formation of the council was the culmination of various organizational efforts begun by a memorandum form the Sudan delegation to the Stockholm Conference of 1972, which recommended the formation of a permanent council on man and the environment.

A committee on man, the environment and development was formed in 1972 within the National Council for Research, chaired by the secretary general of the council who had ministerial status. The assistant secretary general became secretary of the committee.

The committee was functioned until 1978 when it was expanded to become the National Committee on the Environment, and its scope of work was expanded to include the Red Sea coastal and marine environment.

One of the major achievements of the national committee was the drafting of law on environmental policies. Foreign assistance was solicited for this purpose. Following the drought year of 1984 and its aftermath, a Commission on Relief and Rehabilitation was established. It was intended to relief the national committee from the humanitarian problems that were associated with the drought and displacement.

The decision was to maintain the national committee on the environment as research body since it is part of an institution charged principally with a research mandate. HCNER came into being in 1992 and all the functions of the committee were transferred to it. The Prime Minister originally chaired the council and its members included the concerned ministers of health, agriculture, irrigation etc.

This arrangement soon proved impractical and in reality, the council was almost non-functional and remained dormant. The creation, in 1995 and for the first time in Sudan, of the Ministry of Environment and Tourism amalgamated the council into the new ministry, which simplified the organizational set up and allowed the council to function more effectively under a minister rather than the Prime Minister.

The primary role of HCENR is to act as the technical arm of the ministry. Its functions at present are the long term planning and co-ordination at the national level. The HCNER has responsibility for drawing and coordinating national policies and plans as well as proposing legislation for environmental protection and conservation of natural resources. It has a secretariat which functions in an advisory and liaison capacity to the Ministry of Environment, Forestry and Physical Development under whose auspices it falls at the present.

The secretariat also acts as Sudan focal point for regional and international environmental concerns. State councils, composed of the concerned state ministries, have been established. The state councils are charged with the follow up of national policies, compilation of resource assessment data and co-ordination of programs implemented in the state.

2.1.4.3. Chemical Management/Chemical profile in Sudan

Sudan imports considerable amounts of chemicals, which include formulated medicines and pharmaceutical products, raw materials for the local pharmaceutical industry, organic and inorganic chemicals for soap distilling, local manufacture of paints, dry cleaning, inks, laboratory chemicals, chemicals for teaching, clinical diagnosis and analytical purposes. Other chemicals include perfumes and cosmetics, manufactured pesticides, tanning and dying material. However, this list of chemicals is not exhaustive moreover; it is likely to be supplemented with new chemicals as a result of the flourishing petroleum and mining industries in the country.

It follows from the above that chemicals are of cross-sectoral nature, that is to say, various aspects of chemicals management and use fall within the purview of diverse ministries, government units and research institutions. Many of these bodies are entrusted with certain legal measures to manage the various aspects of chemicals and hazardous substances, such as manufacture, trade, storage, transportation, use and disposal. On the other hand available national mechanisms, although are interdisciplinary and sectoral in nature (e.g. National Pesticides Council, NPC, National Medicine and Poisons Board, NMPB), yet they cover only limited classes of chemicals and they have quite specified mandates that do not fulfil the required level of coordination. Furthermore, diverse classes of chemicals, such as industrial and consumer chemicals are left without regulatory measures.

It is extremely difficult, if not impossible, for these diverse bodies to enforce the regulatory measures that fall within their jurisdiction in an effective and sustainable way in the absence of a high degree of coordination and cooperation among them. In this context, it is worth noting that the absence of coordination among the various entities is a major factor hindering the implementation and enforcement of almost all the legal measures on the management of chemicals and hazardous substances. An Inter-ministerial Coordination Committee for Chemicals Management was proposed under the SAICM project but was yet enacted. The proposed coordination mechanism is an inter-ministerial committee with a permanent competent and technical body with a power to establish permanent and/or ad hoc sub-committees, whenever the need arises. The inter-ministerial committee is of coordinative nature and will not interfere with the executive role and legal mandates of various ministries and governmental units.

2.1.4.4. Waste Management in Sudan and related health/environmental threats

The waste management is closely related to Sudan's stage of development and currently existing waste management systems can hardly cope with the generated waste. Solid waste management is a real challenge in Sudan, taking into account the increased rate of urbanization, population growth and globalization of trade with increased cheap imports of consumer goods and increase in waste volume. Solid waste management in most areas of Sudan are not yet considered as a priority service at national and local planning and implementation. Like in most other developing countries solid waste management suffer from inefficiency. Even larger cities are characterized by irregular solid waste management services. Waste burning is a normal practice in backyard and on dump sites. Dumping sites are not in compliance with standards of sanitary landfills. Waste is collected without proper treatment using poor techniques with a lack of recycling activities and energy recovery.

Solid waste management activities in Sudan started in major towns since the Turkish rule 1841. However there is still no integrated system for waste management in place. Localities are concerned with collection, transportation and treatment of domestic solid waste.

The legal frame work for waste management include: Environmental Protection Act 2001, Public Health Act 2008 and the Sudanese Standards and Metrological Organization (SSMO) Act which set standards for pollutants emitted from industrial activities. Guidelines were developed for solid waste, hazardous waste and medical waste management. However legislations in Sudan do not cope yet with the recent developments in particular with the diversity of waste, source segregation, recycling, resource recovery, polluter pays principle, extended producer responsibility. Furthermore there is a serious problem of law enforcement. Khartoum has a relatively proper system for solid waste collection and transfer to the dumping sites, but this system does not exist in other states.

Characterization and Quantification of waste in Sudan:

- The amount of solid waste generated per day in Sudan was estimated at 22,000 t;
- Fifty percent of this amount is an organic matter (11,000 t/day);
- The averages generation waste /person /kg per day= 0.65 kg;
- Khartoum state alone produce 23% of this amount;
- Illegal dumping, open burning and messes are common among different areas;
- The waste composition/types are given in table 3 below.

Table 3 - Average waste composition in Sudan

No	Waste type	Proportion %
1	Paper and cardboard	11.8%
2	Plastics	12.7%
3	Organic matter	49.5%
4	Dust and ash	13.4%
5	Metals	1.7%
6	Woods	0.2%
7	Leathers	0.4%
8	Glass	3.5%
9	Cotton and Jute	4.6%
10	Couch	0.3%
11	Others	1.9%
Total		100

Source: Supervisory Authority for Cleaning – Khartoum State (2011)

2.1.4.5. Industrial technology level and related emissions

Another threat to the environmental integrity is industrial emissions. The emissions from industrial facilities depend on the type of facility, the technologies installed for emission control and the emission standards as well as their enforcement.

Situation with emission standards

Sudan has a process for development of emission standards: The SSMO has a (multidisciplinary) committee, called Environment and Sanitation Committee, formed from environmental specialists (scientists and engineers) from the universities, ministries of, Engineering Affairs, Energy, Environment, Industry, Irrigation and Health), SSMO and a member from Consumer Protection Organization (NGO) responsible for setting or adopting standards on air emission and waste water quality.

In Sudan, Laws were set to measure air quality standards for the common air pollutants in urban areas and emission standards for several air pollutants. The Committee has set industrial emissions values (particles, CO, CO2, NOx, SO2 etc.) for specific industries and activities including e.g. foundries, steel, lead smelting and recycling, tanneries, oil production and refineries, thermal power generation, cement, waste incinerators. In the source emission standard (No SD 2389/2012) and some of the specialized standards the level of Dioxins and Furan has been included.

However, the limitation of information, the absence of the control strategy and the unclear process used for standards development led to the formulation of the current standards which are facing several constraints. There are large enforcement challenges with the implementation of emission standards due to institutional, legal, administrative, public awareness, technical and financial reasons.

The lack of controlling pollutant releases from industries and other facilities leads to environmental contamination of water, air and soil with the risk of generating contaminated sites over time. Therefore, legislation has to be formulated so that it becomes an effective instrument for protecting the environment.

The Sudanese Standards and Metrology Organization (SSMO) started to issue national environmental standards since the year 2002. In May 2002, it issued the national standard No. MSDG 173, regarding the minimum water pollutant levels after treatment inside the factory. Regarding air pollution for any industry the SSMO issued on April 2003 the Standard No. MSDG 2389 (the maximum allowable air pollutant levels at source) which is the same as the Arab Industrial Development and Mining Organization Standard. Regarding the final treatment the SSMO issued the standard MSDG 174 containing the maximum allowable levels of industrial pollutant after final treatment to be discharged in rivers, shown in table 4.

Table 4 - Maximum Limits for Discharge of the Industrial Pollutant in Rivers and near beaches

Pollutant	In Rivers	Near beaches
Concentration of (hydrogen)(ph)	6-10	6-10
Temp (C^o)	$2^o \succ$ surrounding	$2^o \succ$ surrounding
Suspended Solids (SS)	40 mg/L	40 mg/L
Biological Oxygen Demand (BOD)	35 mg/L	35 mg/L
Oil and Grease (O&G)	3 mg/L	3 mg/L
Mercury (Hg)	0.1 mg/L	0.1 mg/L
Cadmium (Cd)	0.01 – 0.02 mg/L	0.01 – 0.02 mg/L
Cyanide (CN)	0.1 mg/L	0.55 mg/L

Source: Sudanese Standards and Metrology Organization Khartoum May 2002

Situation of technology level and technology requirement

Best Available Techniques and Best Environmental Practices (BAT/BEP) measures have not yet been introduced at industrial facilities in Sudan. Therefore most of the industrial source categories listed in SC Annex C, Part II and III have the potential for comparatively high formation and release of unintentional POPs. The original NIP action plan included a BAT/BEP component, however it was not implemented due to the lack of funding. Furthermore there was a lack of monitoring capabilities and analytical laboratory instrumentation in the country. To develop the appropriate capabilities for implementing BAT/BEP measures in newly established industries covered by SC Annex C the BAT/BEP requirements will be integrated in the permitting process.

2.1.4.6. Contaminated sites

At present there is no strategy for contaminated sites management in Sudan. Also there is no coordinated survey and inventory for contaminated sites and no central database where information on contaminated sites is compiled.

Already in the original NIP (and other activities on the evaluation of the environmental situation in Sudan) Sudan has discovered that there are many POPs/PTS contaminated sites in in the country which can be categorized as follows:

A) POPs contaminated sites, including POPs pesticides storage sites and application sites, PCBs use and maintenance sites and potentially PCDD/F contaminated sites;

B) Heavy metal contaminated sites from mining activities or industrial activities of metal industry;

C) PAH contaminated sites (sites where ashes from combustion processes were stored and used and sites where high PAH containing asphalt was used);

D) Mineral oil and BTX contaminated sites (e.g. from oil production. refining and use).

A preliminary list of POPs contaminated sites is compiled in 2.3.7. The environmentally sound management of contaminated sites have to be addressed to avoid the continuous release of pollutants that may pose a heavy burden to human health and the environment.

Persistent Organic Pollutants (POPs) and other Persistent Toxic Substances (PTS) have accumulated in soils and sediments, in landfills, dumps, stockpiles resulting in contaminated sites mainly over the last half

century[29,30,31]. Historically, contaminations with chlorinated POPs were mostly related to pesticides or industrial POPs (such as PCBs). Fluorinated, brominated POPs and POP-like chemicals are now increasingly produced and used[32] including consumer goods. This production and associated discharges of POPs and POP-like chemicals has polluted soils and sediments[33] around the factories but in some cases even rivers and floodplains for several hundred km[34]. As products containing POPs and POP-like chemicals reach the end of life these hazardous compounds end up in the waste stream. Sudan has limited recycling, treatment and destruction capacities hence rely heavily on landfills or dump sites. With several new listed POPs present in consumer products the quantities of POPs/PTS in landfills/dump sites have increased over the last two decades and these sites are joining pesticide and other POPs stockpiles and contaminated sites as reservoirs of POPs. As no environmental risk assessment has been yet made, it is not known which reservoirs (landfills, contaminated sites, contaminated sediments and contaminated soils) contain the largest volume of POPs and which present the largest risk for future releases[4].

2.2. Institutional, policy and regulatory framework

This section describes the present overall institutional, policy and regulatory framework within which the NIP will be implemented. It also covers more detailed baseline information about the POPs issue such as the status of action and implementation activities under related Conventions or regional and sub-regional agreements.

2.2.1. Introduction

Sudan was one of the first African countries to promulgate legislation concerning protection of the environment. Existing legislative acts on the use and conservation of natural resources have been in place since the colonial era and are periodically reviewed and strengthened.

Studies have shown that there are about 150 Acts, local orders, and related regulations addressing environmental issues. Many of these were enacted before independence 1956. Examples include but not limited to: the Diseases of Animal Act 1901, the Calcium Carbide Act, 1917, the Agricultural Pest Prevention Act, 1919, Foodstuff and Necessaries Act, 1926 and the Provincial Forest Ordinance 1932. They include the Wildlife and National Parks Act 1986, the Sudan Forestry Policy (2006) and the Forests and Renewable Natural Resources Act, 2002. However these laws are sectorally fragmented and lack

29 Weber R, Watson A, Forter M, Oliaei F. (2011) Waste Management & Research 29(1): 107-121 and Weber R, Gaus C, Tysklind M, Johnston P, Forter M, Hollert H, Heinisch H, Holoubek I, Lloyd-Smith M, Masunaga S, Moccarelli P, Santillo D, Seike N, Symons R, Torres JPM, Verta M, Varbelow G, Vijgen J, Watson A, Costner P, Wölz J, Wycisk P, Zennegg M. (2008) Env Sci Pollut Res 15, 363-393;

30 Nizzetto L, Macleod M, Borgå Ket al. (2010) Environ. Sci. Technol., 44: 6526–6531 and Qiu, X. & Davis, J. W. (2004). Remediation Journal 14: 55-84;

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

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

33 Förstner U, Salomons W (2010) J Soils Sediments 10: 1440–1452;

34 Weber R, Tysklind M, Laner D, Watson A, Forter M, Vijgen J (2012), The need for inventories of reservoirs of persistent and toxic substances (PTS) in the face of climate change, Organohalogen Compounds Vol. 74, 1186-1189;

comprehensive look to the overall environment. Since 1984 efforts were made to improve these laws by formulating an umbrella law with strong policy orientation that provides a basis for coordinated work.

2.2.2. Legal framework

2.2.2.1. Environment within the Constitution of the Republic of Sudan

Recognizing the importance of environment protection the National Assembly passed the 2005 Interim National Constitution of the Republic of Sudan in which there is a clear commitment towards the environment protection. This constitution signified the end of the long civil war between the south and north by signing the Comprehensive Peace Agreement (CPA).

With respect to the protection of the environment chapter 2 article 11 of the Interim National Constitutions of the Republic of the Sudan states:

“The people of the Sudan shall have the right to a clean and diverse environment; the State and the citizens have the duty to preserve and promote the country's Biodiversity.

The State shall not pursue any policy, or take or permit any action which may adversely affect the existence of any species of animal or vegetative life, their natural or adopted habitat.

The state shall promote, through legislation, sustainable utilization of natural resources and best practices with respect to their management.”

It is worth noting that the previous 1998 constitution was also committed to the protection of environment. Article 13 refers to the role of the State in the protection of environment in its purity and natural balance in pursuance of safety and sustainable development for the benefit of generations. The constitution also in Article 9 refers to natural resources as national heritage and public property regulated by law and "the state shall provide plans and appropriate conditions for the development of the financial and human resources necessary for utilizing such wealth"

2.2.2.2. Environment Protection Act 2001

This Act represents an important development in harmonizing different environmental sectoral laws. It sets environmental standards, requires the introduction of environmental dimension in development plans and requires that Environmental Impact Assessment (EIA) be carried out before implementing any project. The Act also calls for the protection of biodiversity, prohibit pollution, raises environmental awareness and popular participation in setting policies and decision making.

The Pesticides Act (1994)

This is one of the most important legal instruments specifically designed to regulate the management of chemical pesticides. These include insecticides, fungicides, herbicides, rodenticides, acaricides and avicides used for the control of pests in agriculture, public and veterinary health. The main objective of legislation is to regulate the registration, importation, distribution, usage, storage, transportation, disposal and formulation of pesticides and labour protection. According to the provisions of the Act, the National Pesticides Council is empowered with administrative procedures relating to registration of

pesticides, licensing traders, endorsement of recommendations by technical committees regarding risk assessment classification and labelling. The council is composed of 19 members representing different organizations related to pesticides management. The pesticides council is taking the responsibility of old stocks of POP pesticides in addition to waste and contaminated soil and equipment.

2.2.2.3. Environmental Health Act

The main objective of the Environmental Health Act (1975 amended 2005) is to protect human health and environment. Relevant articles are: Article 8 (A, B, C), article 12 (A+B), article 13 (A+B) article 15 and article 16.

The regulations stipulated by the Environmental Health Act 1975 limit hazardous emissions to a minimum level. Section 13 (1) of this Act sets out the following conditions for air pollutions control:

a. Sources of pollution such as industries should be established at an appropriate distance from schools and public institutions.

b. The height of chimney should be reasonable to allow the spread of vapours, fumes, gases, and prevent their concentration.

c. Factories of chemicals, oils, or textiles, which discharge gases, shall be provided with cyclones and filters for the absorption of the gas or to decrease its concentration.

It is obvious that these regulations are not intended to eliminate air pollution, but rather to reduce pollution to a permissible level. The Health Act is technically obsolete, not representing cleaner production and waste prevention concepts. The act is an effective legal instrument in finding technical solutions but needs by-laws and regulations to be added to include the control of POPS releases.

The public health legislation and by-laws are not directly connected to the POPs management. However, the act has been subjected to accelerating changes affecting the roles of the federal government as well as state governments in terms of public health issue.

2.2.2.4. Labour Act (1997)

The main objective of this act is to protect workers in any establishment; it includes some provisions of relevancy to industrial safety such as the number of employees in any factory, their term of employment and the working environment, it also authorize the concerned authority to appoint industrial security inspectors to implement regulations prescribed under this act. The owner of the industrial establishment has to acquaint his employees of the risks associated with their work, and measures to be taken to avoid them, it is also his duty to take precautions and protect his employees from industrial accidents and other related diseases.

2.2.2.5. Road Traffic Act 1983

Section 37(1) and (2) of the act are applied by the concerned authorities to combat air pollution emitted from automobiles exhaust. Regulations that prohibit the importation of automobiles which do not meet the safety standards are lacking, hence the implementation of such measures is unlikely. Economic and social crisis facing the country constitutes a real challenge in implementing the Road Traffic Act.

2.2.2.6. Regulations for Protection of the Environment in the Petroleum Industry

These regulations have been amended twice. The last amendment was in 2011.These regulations were approved by the Petroleum Affairs Board, which is a direct responsibility of the Board according to section (3) of the Petroleum Resources Act 1998.

Pursuant to section (2) of these regulations, any agreement concluded in relation to petroleum operations shall include the following:

a. Taking of measures and procedures necessary for the protection and cause no destruction or mischief of the land layers which contain the petroleum, metals and water during the exercise of the petroleum operations or abandonment of the wells; together with determining and conservation of the resources of the discovered fresh water, during the practice of any petroleum operations.

b. The need to take the precautions and the required procedure against fire or unjustifiable loss of petroleum, metals, water or vegetation cover.

c. The need to take preliminary precautionary measures required to avoid causing environmental pollution during loading and unloading or transportation of petroleum by road, sea, river or air.

d. The need to adopt contingency plan to overcome and control any environmental pollution or damage.

e. The need to follow the process of care and attention as well as the good measures during the exercise of the petroleum operations, to avoid the occurrence of environmental pollution.

f. Submission of an insurance certificate or financial guarantee to cover, restore and compensate the damage in the occurrence of environmental damage.

g. To avoid unjustifiable repetition and severalty in the establishments, equipment and tools concerning the petroleum operations in the same area.

h. To submit a study containing overall evaluation of the environmental impacts likely or definitely may result on exercise of the petroleum operations, the same shall be submitted before the actual commencement of the activity for approval by the competent bodies in accordance with Regulations.

i. To comply with any international environmental agreements to which the Republic of Sudan is a party.

j. To adhere to any law or custom enforce recognized by the Republic of Sudan or the state where the petroleum operations or industry is exercised.

Here the points (f) and (i) have some relevance to POPs.

To enhance the effectiveness of the above mentioned environmental considerations, section (2) of the regulations provides a detailed definition for the petroleum operations:

All the exploration, drilling; exploitation, development, production, and field development, refining, processing, storage, transportation, distribution, import and export and all operations accompanying the petroleum, section (2) again defines the environment in a very broad manner, taking care of all its components:

"The total of natural systems of their basic component such as water, air, soil, flora, and including the socio-cultural systems, in which human beings and other organisms live and obtain their food and perform their activities."

2.2.2.7. Poverty Reduction Strategy

The Interim Poverty Reduction Strategy Paper (IPRSP) initiative is one of the instruments which elaborate a vision and new direction for governance, socio-economic development and poverty reduction efforts. The IPRSP support and complement existing planning and budgeting instruments, including the 3-Year Salvation Economic Program (2012-2014) and the 5-Year Development Plan (2012-2016), by strengthening the prioritization of actions and targeting poverty. Sudan's economic growth pattern has been volatile over the past four decades. In the post-independence period, Sudan had prudent and market-friendly economic policies in a stable international environment. A number of laws that encouraged private sector investment in rain-fed agriculture and the manufacturing sector were enacted. Sudan's growth performance declined from an average of 10.1 percent during 1973-1977 to 1.9 percent in the 1978-1989. After successful stabilization in the mid-1990s, Sudan maintained a strong track record for macroeconomic management that resulted in a low and stable single-digit inflation rates and a steady exchange rate. For over a decade, Sudan has implemented economic policy reforms to maintain economic stability and promote growth and poverty reduction. Since 1999, these reforms have been implemented under successive International Monetary Fund (IMF) staff monitored programs (SMP). For over a decade, Sudan has maintained close cooperation with IMF with good performance under successive SMPs as well as making payments in excess of its obligations to the IMF. The Sudanese Government considered the program monitored by the SMP as part of its strategy for macroeconomic stability and sustained economic growth and poverty reduction and a logical step to a full fund supported program. The total stock of public and publicly guaranteed external debt is estimated at US$38.0 billion at end of 2010, consisting of US$16.1 billion of principal (debt disbursed and outstanding) and US$21.9 billion interest arrears and penalty interest. The rise is the stock of debt has been due to the relentless accumulation penalty interest and interest arrears that consisted of 57.6 percent of the stock of debt at the end of 2010.

2.2.3. Relevant international commitment obligations

As a member of the United Nations Sudan has committed itself to a range of Multilateral Environmental Agreements (MEAs) and other international commitments, in order to improve the efforts to protect the environment and finally human health in the country and globally. Due to the specific situation of Sudan, climate changes, as well as desertification and biodiversity loss are high on its agenda and there is a pressing need to implement activities related.

Therefore, coordination has been maintained in the process of implementing the UN Conventions on desertification, climate change and biodiversity. That was manifested by:

- appointment of a national coordinator for UNFCCC;

- authorizing and recognizing the NDDU, institutionally positioned under the Land Use and Desertification Control Administration, which comes under the Federal Ministry of Agriculture, by ministerial resolution, as the sole focal point and coordinating body for the UNCCD;

The Administration has prepared a national program to combat desertification as one of its main tasks in the implementation of the Desertification Convention. In addition to that the Forest Natural Resources Act 2002 obliged the agricultural schemes to allocate percentage of an area (10% in the rain fed and 5% in the irrigated agriculture) for trees plantations.

Moreover, the Government of Sudan has adopted national strategies, legislation and programs to strengthen biodiversity conservation and natural resources management, such as the Wildlife and Nature Reserves Conservation Act 1986, Forestry Act 2002, Environmental Protection Act 2001 and the 10-year National Comprehensive Strategy (NCS, 1992-2002). It also participates in international agreements on biodiversity conservation and sustainable development, including World Heritage; Man and Biosphere Reserves (MAB); Convention on Wetland of International Importance (Ramsar); Convention in Trade of Threatened and Endangered Species (CITES); and Protection of the Red Sea and Gulf of Aden (PERSGA).

The efforts exerted in environmental management included the preparation of the National Plan for Environmental Management (NPEM)[35] by the HCENR in cooperation with the federal line ministries and the Ministry of Environment, Wildlife Conservation and Tourism of the Government of South Sudan.

The approach is based on establishing a national forum composed of national environmental and natural resources institutions for focusing on national and regional environmental issues. The discussion on these issues was led to the preparation of the Environmental Management Plan for post conflict Sudan. The plan reflected the shared vision of all partners and pinpointed the priority actions.

2.2.3.1. Stockholm Convention

The Republic of Sudan ratified the Stockholm Convention on 29 August 2006 and endorsed its NIP on 4 September 2007. The Government of Sudan nominated the Higher Council for Environment and Natural Resources (HCENR) of the Ministry of Environment and Physical Development as the National Focal Point For the Stockholm Convention on POPs in Sudan and as Executing Agency for the initial Enabling Activities for the original NIP development.

Under the SAICM Quick Start Programme Trust Fund, the Sudan's HCENR commenced the implementation of a Project to develop a sustainable integrated national programme for the sound management of chemicals (2009-2011). The project includes: i) strengthening the coordination mechanisms and formation of permanent intersectoral central body for chemical management; ii) development and strengthening the legal framework , to enable the government, producers, traders and user of chemicals to operate safely and effectively ; iii) conducting inventories of import , export, use and obsolete and stockpiles of chemicals; iv) assessing the national chemical management system and updating the national chemicals safety profile to identify and define national priorities in chemicals management, and v)establishing a national information system and information exchange to enhance the coordination and integrated approach for the dissemination of information on chemical risks, hazards and safe management .

35 The plan was sponsored by the Nile Trans-boundary Environment Action Program (NTEAP), United Nations Environment Program (UNEP) and the European Commission (EU);

The Sudan is currently participating in the full-sized GEF UNIDO/UNEP regional project ‘‘Capacity Strengthening and Technical Assistance for the Implementation of the Stockholm Convention national Implementation plans in African Least Developed Countries (LDCs) of the Common Market for Eastern and Southern Africa (COMESA) Sub-region’’. The project addresses the legislative and regulatory framework , enforcement and administrative capacities, BAT/BEP for industrial production processes reductions to POPs exposures, identification of contaminated land and the dissemination and sharing of experiences and good practices for the sustainable, effective and comprehensive implementation of the NIPs and related chemicals management objectives in the COMESA region. The project commenced in September 2010 and is expected to be fully implemented by August 2015.

2.2.3.2. Basel Convention

Sudan is a party to the Basil Convention since 9/4/2006. The Higher Council for Environment and Natural Resources (HCENR) of the Ministry of Environment and Physical Development is the National Focal Point for the Basel Convention. Sudan does not import or export any waste except the export of limited quantities of used batteries. Sudan has no facilities for any waste disposal or ship dismantling.

2.2.3.3. Rotterdam Convention

Sudan is a party to the Rotterdam Convention since 2004. The Plant Protection Directorate of the Ministry of Agriculture and Irrigation is the Designated National Authority (DNA) for the Convention. Sudan fulfilled all its obligations regarding the import responses for pesticide category but is facing problems with regard to industrial chemicals. Sudan is not a PIC chemicals exporter and therefore, has no obligation for export notification. The country suffers from unreported pesticide poisoning cases and needs capacity to monitor and document human and environmental poisoning episodes.

2.2.3.4. Climate Change Convention

Sudan ratified the Climate Change Convention in 1993 and the Kyoto Protocol in 2005.

Two national communication reports have been prepared and submitted to the UNFCCC in 2003 and 2013 respectively, in response to Sudan’s obligations under the Convention.

Sudan conducted number of research and studies in the areas of greenhouse gases inventory and mitigation, assessment of the vulnerability and adaptation of the agriculture, water and health sectors to the impacts of climate change, technology needs assessment, coastal zones vulnerability to climate change, climate scenarios and future projections of changes in temperature and rainfall, adequacy of the current programmes on research and systematic observations, etc.

Sudan prepared a National Adaptation Programme of Action (NAPA), with aim of communicating the urgent and immediate needs of the most vulnerable areas for support through the Least Developed Countries Fund. Currently some of the needs specified in the NAPA are being implemented in 6 states.

Sudan is currently finalizing a National Adaptation Plan with comprehensive coverage of all states, preparing a framework for National Appropriate Mitigation Actions and developing project proposal for a low carbon development strategy.

2.2.3.5. Other MEAs ratified

Other MEAs ratified by the Sudan government includes, but not limited to, the Vienna Convention and the Montreal Protocol on Ozone Depleting Substances. The government succeeded in phasing out the ozone depleting substances and has initiated programs to manage and phase out all ozone depleting substances.

Sudan has ratified and committed also to other international Conventions (see table 5 below). However, there is a lack a coordination mechanism to implement these Conventions in a harmonized manner and building on the synergism among them. Therefore, the implementation of the Stockholm Convention aims at building upon the synergism among MEAs.

Table 5 -MEAs signed by Sudan

No.	Title	Year of ratification/signing
1	The Vienna Convention for the Protection of the Ozone Layer	29 April 1993
2	Montreal Protocol on Substances that Deplete the Ozone Layer	April 1993
3	United Nations (UN) Framework Convention on Climate Change	November 1993
4	Kyoto Protocol	16 April 2005
5	The London Convention on Prevention of Pollution by Dumping of Wastes and Other Matter 1972	
6	Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade	2004
7	The SC on Persistent Organic Pollutants (POPs)	5 February 2006
8	The Ramsar Convention on Wetlands of International Importance especially as Waterfowl Habitat	17/May/2005
10	UN Convention on Biological Diversity	1995
11	Convention on International Trade in Endangered Species of Wild Fauna and Flora	1982
12	UN Convention to Combat Desertification in those Countries experiencing serious drought and/or desertification, particularly in Africa	15 October 1994

13	Basel Convention	9 April 2006

2.2.4. Sustainable development and sustainable consumption and production agenda

Sudan has committed towards environmental protection since the mid-1970s. This commitment was triggered by environmental disasters, namely, the desertification and drought which stricken the African Sahelian States including Sudan during the years 1968-1973. The global awareness about the state of environment and the need for regional and national cooperation to eliminate or, at least reduce the most pressing environment problems identified by the Stockholm Conference on Human Environment 1972, the Nairobi Declaration 1982 and the Proposed Legal Principles for Environmental Protection and Sustainable Development adopted by the World Commission on Environment and Development Experts Group on Environmental Law (WCED) and the successive relevant regional and international conferences had contributed positively in upgrading the level of national commitment towards the protection of the environment and human health and therefore for sustainability and sustainable development.

However, Sudan has not developed yet an action plan for sustainable development and for sustainable consumption and production (SCP). Therefore, it is important that sustainable development and SCP are integrated in other national activity plans and strategies and in implementation plans of MEAs such as the Stockholm Convention NIP.

Sudan's main objectives and priorities for sustainable development were spelt out in the National Comprehensive Strategy (NCS 1992-2002) which provided policy directions to all economic and social sectors. The NCS incorporates the country's environmental strategy, which states clearly that environmental issues must be embodied in all development projects including Sugar Industry. The NCS has served as a key reference document and basis for sectoral policies and measures. Among the directives of the NCS is the concern for poverty alleviation, popular participation and call for the incorporation of community based origination and indigenous knowledge in the development process.

In the field of environment and natural resources the strategy emphasizes the protection and improvement of environment that would lead to a balanced development. The National Comprehensive Strategy of the country devotes considerable attention to biodiversity conservation and encourages the private sector to invest in the conservation of natural resources. The establishment of additional protected areas, public awareness, involving local communities in conservation matters and strengthening cooperation with neighbouring countries in the field of wildlife conservation are also highlighted in the strategy.

The policies to reach major objectives of sustainable development and SCP involve:

i. Development projects should be planned on the basis of their continuous productivity and renewal making use of local technology or imported technology suitable for local environment and life-style of the people.

ii. The environmental impact for each project should be estimated in an environmental impact assessment (EIA) study and this should be supervised by the authority approving the project.

iii. Evaluation of present practices negatively affecting the environment and the existing projects with the intention of rectifying them and fending against future negative side-effects.

iv. Enforcement of HCENR as the central body for environmental administration for the protection of environment with adequate resources and branches at the state and province levels to draw policies, propose legislation, supervise and follow-up implementation of governmental decisions.

v. Promulgation the necessary legislation, embodying strong punishment, to guarantee environmental protection.

vi. A shift towards more sustainable production is needed in order to promote social and economic development. This is closely linked to the appropriate selection and use of chemicals and a move to Green/Sustainable Chemistry. The substitution of POPs and POPs-like chemicals can be one important element for this shift.

vii. Also a shift to more sustainable consumption is needed. This mean an understanding of the policy makers and the broad population on the concept of sustainable products, the support and effort of purchasing such products, the reduction of unnecessary items and the support of waste and recycling schemes at the end of life.

The Sustainable Development Goals by 2030 address inclusive and sustainable industrialization. The sound management of chemicals and waste contribute to the resource efficiency and reducing pollution and waste, in the same time being a critical engine for social and economic development, prosperity and human wellbeing. The sound management of chemicals throughout their life cycle and of hazardous waste in ways that lead to minimization of significant adverse effects on human health and the environment should be achieved and would significantly contribute to social and economic welfare.

2.2.5. Institutional framework

The issue of POPs in Sudan has gained considerable importance in recent years. Awareness raising on POPs has been significantly increased since the ratification of the convention. This is mainly attributed to the efforts exerted by the HCENR through awareness raising programs and projects related to the environmental impacts of chemicals such as SAICM activities.

Sudan is aware that POPs are only a part of the chemical management challenge. Therefore, HCENR is aiming to coordinate different activities on chemical management (POPs, mercury, ozone depleting substances, climate change including short-lived climate pollutants). Clear links exist in the waste management sector with an emphasis on resource recovery and recycling, in the legislative frame of chemical management and regulation of industrial emissions, as well as in the implementation of BAT/BEP measures (e.g. there is a large overlap of reduction of unintentional POPs and mercury in many industrial sectors).

Environmental Education has been introduced in the curricula of several universities. Some of them created environmental colleges or at least environmental departments and the University of Khartoum established the Institute of Environmental Studies for post graduate students. Certain line ministries and agencies have responsibilities, in one way or another, to manage chemicals or address their impacts on

health and the environment in Sudan. The principal ministries involved in different aspects of the management of chemicals (including POPs) are as follows:

1. Higher Council for Environment and Natural Resources (HCENR)

Under the auspices of the Minister of Environment, Forestry and Physical development with primary role to act as the technical arm of the Ministry of Environment, Forestry and Physical Development, the functions of HCENR at the present are the long term planning and co-ordination at the national level. The HCNER has the responsibility of drawing and coordinating national policies and plans as well as proposing legislation for environmental protection and conservation of natural resources. It has a secretariat which functions in an advisory and liaison capacity to the Ministry of Environment, Forestry and Physical Development under whose auspices it falls at the present. The secretariat also acts as Sudan focal point for regional and international environmental concerns. In this context, HCENR is entrusted with the task of handling the POPs issues by the provisions of the Environmental Protection Act 2001. HCENR is shouldered with the responsibility of monitoring the management and phase out of POPs leaving the operational responsibility for sector authorities.

2. Ministry of Agriculture/Division of Plant Protection (DPP) and the National Pesticide Council

Both are mandated to spearhead the control/management of crop pests and diseases. The division:

a) ensures environmental sustainability through application of environmental friendly devices such as integrated pest management;

b) registers and controls pesticides in use in the country, controls migratory pests;

c) gives a competence assurance certificate to any person who wants to engage in pesticides business after making sure that enabling conditions are satisfied;

d) makes sure that any pesticide locally manufactured or imported and stocked and ready for distribution and sale conforms to the requirements of Sudanese Standards and is registered for use in the country as pesticide; and ensures that the disposal of any adulterated pesticide is done according to the agency's directives.

3. Ministry of Health

The Ministry is vested with the power of registering and controlling the administration of pharmaceuticals, medical appliances, and pesticides for public health in the country. It also rules over the issue of disease vector control like malaria and other vector borne diseases.

The Ministry through its directorates and centres is involved in chemical safety. The General Directorate of Occupational Health has a unit for chemical safety and keeps a register of hazardous chemicals. Occupational Health Department “Chemical Safety Unit” supports the safe handling of chemicals throughout the whole process (importation, transportation, storage, use and waste management).

The General Directorate of Environmental Health supervises hazardous, materials and hazardous wastes generated by health establishments and license clinical waste disposal.

The Directorate of Food Control sets limits for food additives and food contaminants inspects and analyses imported and locally produced foods and those on the market for safety and investigate food poisoning outbreaks.

The Directorate of Central Laboratories does laboratory analyses for water, food and biological fluids to help implement various legislations of the ministry and other agencies.

Moreover, the Ministry regulates matters related to control of poisonous and deleterious substances, matters related to regulations of production, import, use or handling of chemical substances which may damage human health and also, matters related to regulations of household pesticides containing hazardous substances.

4. Ministry of Industry (MOI)

Also the Ministry of Industry (MOI) has an important and increasing role to play in particular when considering that several of the new listed POPs are industrial chemicals. Therefore, a close cooperation with industries using these chemicals or affected by these chemicals due to materials used or recycled in these industries is required. The MOI mandates:

a) Analysis of industrial products for ingredients and standards;

b) Defining places and methods of hazardous industrial waste disposal together with Ministries of Health and Environment;

c) Ensuring the enforcement of the law concerning the evaluation of Industrial chemical substances and regulations of their manufacture, etc;

d) Conducting researches related to the risk assessment of Industrial chemical substances.

5. Ministry of Electricity and Dams (MED)

The National Electricity Corporation has been unbundled in 2010 into three companies. The Sudanese Thermal Power Generation Company is responsible of managing the power stations. Power stations are responsible for emitting excessive amounts of pollution into the atmosphere including unintentionally POPs.

The current uses of polychlorinated biphenyls (PCBs) are mainly in electric transformers and capacitors imported by the Ministry of Water Resources and Electricity. PCBs management in terms of uses, disposal and/or elimination is handled by MED.

6. Customs General Directorate

It makes sure that all imported chemicals comply with specifications and that restricted chemicals are not permitted.

7. Ministry of Justice

The Ministry represents the Federal Government in criminal cases falling under the jurisdiction of the Federal Courts including offences committed against legal instruments on chemical management.

2.3. Assessment of the POPs situation in the country

Assessment of current POPs management in Sudan is based on updated and in some case preliminary inventories of: Pesticides, PCB, POP-PBDEs, PFOS and related substances and unintentional POPs (PCDD/PCDF, PCB, HCB and PeCBz). These are described in this section. The section also presents information on current POPs stockpiles, contaminated areas and waste, data on remediation of contaminated areas, POPs levels in different environmental media, prediction of future POPs production, use and release.

2.3.1. Assessment of POPs Pesticides (Annex A, Part I chemicals)

2.3.1.1. General

In many parts of the world poorly stored obsolete POPs pesticides stocks and other hazardous pesticides in warehouses, dump sites, landfills, and other storages await clean-up and final disposal. There are approximately 50,000 tonnes of POPs pesticides in Africa with an estimated cost for management and destruction of 250 to 300 million US$. The challenges of pesticide stockpile management in developing countries can be seen in the African Stockpiles Programme. According to the World Bank's report from August 2013, 3,310 tones have been removed from 897 sites under the Africa Stockpiles Programme (ASP) since 2005[36,37]. Against the background of the estimated 50,000 tonnes of stocks, this shows there is still a long journey ahead. The World Bank has so far issued only an Interim Implementation, Completion and Results Report, in which outcomes were rated as moderately unsatisfactory.[36,37] Sudan has not managed obsolete pesticides in this frame yet.

The chemicals in this category of POPs include:

- POPs pesticides listed in the original "dirty dozen": aldrin, chlordane, dieldrin, endrin, heptachlor, hexachlorobenzene (HCB), mirex and toxaphene.
- Newly listed POPs pesticides: Chlordecone, technical endosulfan and its related isomers, lindane (gamma-HCH), alpha-HCH, beta-HCH and pentachlorobenzene (PeCBz).

They are listed in Annex A of the SC along with the other POPs which are chemicals to be eliminated. However, the convention has noted specific exemptions such as: (a) use of lindane as human health pharmaceutical for control of head lice and scabies as second line treatment; and (b) technical endosulfan production for registered Parties and use in crop-pest complexes as listed in accordance with the provisions of part VI of this Annex A of the Convention.

The main characteristics of the chemicals in this category of POPs are:

1. Old POPs:

36 World Bank (2013). Obsolete Pesticide Stockpiles: An Unwanted Legacy of the African Landscape, Washington 5 August.
37 World Bank (2013) Interim Implementation Completion and Results Report ICR2682, Africa Stockpiles Program – Project 1

- **Aldrin** is an organochlorine insecticide that was widely used until the 1970s, when it was banned in most countries. Before the ban, it was heavily used as a pesticide to treat seed and soil. Aldrin and related "cyclodiene" pesticides became notorious as persistent organic pollutants.

- **Chlordane**, or chlordane, is an organochlorine pesticide. Chlordane was a manufactured chemical, commonly used in 1948-1988 as an insecticide for crops like corn and citrus and on lawns and domestic gardens as well as a method of termite control.

- **Dieldrin** is a chlorinated hydrocarbon originally produced as an insecticide. Dieldrin is closely related to aldrin, which reacts further to form dieldrin. Originally developed in the 1940s as an alternative to DDT, dieldrin proved to be a highly effective insecticide and was very widely used during the 1950s to early 1970s.

- **Endrin** is an organochloride that was primarily used as an insecticide. It is also a rodenticide.

- **Heptachlor** is an organochlorine compound that was used as an insecticide.

- **Hexachlorobenzene (HCB)** It is a fungicide formerly used as a seed treatment, especially on wheat to control the fungal disease bunt. HCB is also an unintentionally formed POPs.

- **Mirex** is a chlorinated hydrocarbon that was commercialized as an insecticide. This white crystalline odorless solid is a derivative of cyclopentadiene. It was popularized to control fire ants.

- **Toxaphene** is a mixture of approximately 200 organic compounds formerly used as an insecticide.

2. New listed POPs pesticides:

- **Technical Endosulfan and its related isomers** occurs as two isomers: alpha- and beta-endosulfan. They are both biologically active. Technical endosulfan (CAS No: 115-29-7) is a mixture of the two isomers along with small amounts of impurities. Endosulfan is an insecticide that has been used since the 1950s to control crop pests, tsetse flies and ectoparasites of cattle and as a wood preservative. Endosulfan is persistent in the atmosphere, sediments and water. Endosulfan bio accumulates and has the potential for long-range transport. Endosulfan is toxic to humans and has been shown to have adverse effects on a wide range of aquatic and terrestrial organisms. Exposure to endosulfan has been linked to congenital physical disorders, mental retardations and deaths in farm workers and villagers in developing countries in Africa, Asia and Latin America. Endosulfan sulfate shows toxicity similar to that of endosulfan.

- **Lindane** is the common name for the gamma isomer of hexachlorocyclohexane, which has been used as an insecticide and for pharmaceutical treatment for lice and scabies. Lindane has been used as a broad-spectrum insecticide, which acts for both agricultural and non-agricultural purposes. Lindane has been used for seed and soil treatment, foliar applications, tree and wood treatment and against ectoparasites in both veterinary and human applications. It is estimated that global lindane usage from 1950 to 2000 for agricultural, livestock, forestry, human health and other purposes amounts to around 600,000 tonnes (with related 4 to 7 million tonnes of waste isomers[38]). In Africa only 28,560 tonnes were produced from one factory[38]. Lindane is a volatile compound which can be found in

remote regions where it is not used, such as the Arctic, and therefore has potential of long-range transport. It degrades very slowly and is more water-soluble and volatile than most other listed POPs. In 1998, the Food and Agriculture Organization Inventory of Obsolete, Unwanted and/or Banned Pesticides found a total of 2,785 tonnes of technical-grade HCH, 304 tonnes of lindane, and 45 tonnes of unspecified HCH material scattered in dumpsites in Africa and the Near East.

- **Alpha hexachlorocyclohexane (alpha-HCH)** is the only choral isomer of the eight isomers of 1,2,3,4,5,6-HCH. Alpha-HCH by itself is not intentionally produced or commercialized but is the main waste by-product (70% of all waste isomers) of gamma-HCH (lindane). Alpha-HCH is the predominant HCH isomer found in ambient air and in ocean water. The physic-chemical properties in combination with the stability of alpha-HCH allow it to undergo long range transport in the atmosphere. Alpha-HCH was included in the technical HCH but after replacement by lindane (> 99% gamma-HCH) was generated as waste at productions. About 4 to 7 million tonnes of HCH-wastes are disposed around (former) lindane production facilities with alpha-HCH as major isomer[38].

- **Beta hexachlorocyclohexane (beta-HCH)** is one of the five stable isomers of technical HCH, an organochlorine pesticide formerly used in agriculture. Beta-HCH is more soluble in water and octanol compared to other HCH-isomers. Alpha-HCH by itself is not intentionally produced or commercialized but is the main waste by-product (approx. 10% of waste isomers) of gamma-HCH (lindane). The physic-chemical properties in combination with the stability of beta-HCH allow it to undergo long range transport in the atmosphere. Beta-HCH was included in the technical HCH but after replacement by lindane (> 99% gamma-HCH) was generated as waste at productions. About 4 to 7 million tonnes of HCH-wastes are disposed around (former) lindane production facilities with beta-HCH approx. 10% of these waste[38].

- **Chlordecone** is a synthetic chlorinated organic compound which has mainly been used as an agricultural insecticide, miticide and fungicide. Chlordecone is chemically very similar to mirex, which is already listed under the Stockholm Convention. Chlordecone is no longer produced or used since approx 30 years. It has been mainly produced in the US and France and has been used for the control of the banana root borer. It has also been used as a fly larvicide, as a fungicide against apple scab and powdery mildew, to control the Colorado potato beetle, rust mite on non-bearing citrus, and potato and tobacco wireworm on gladioli and other plants. It is regarded as an effective insecticide against leaf-cutting insects, but less effective against sucking insects. Chlordecone has also been used in household products such as ant and roach traps.

- **Pentachlorobenzene (PeCBz)** PeCBz has been used in the past as a pesticide, flame retardant, and together with PCBs in dielectric fluids. PeCB has been used as a chemical intermediate in the manufacture of pentachloronitrobenzene (quintozene). PeCBz is and unintentional POPs found as an impurity in a range of chlorinated organic including e.g. certain pesticides and dyestuff.

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

2.3.1.2. History of POPs pesticides in Sudan

Cotton cultivation in Gezira started in 1911 on a small-scale of 250 feddans (F= 4200 m²). The area increased to ca. 2,000,000 F. The annual cropping structure is composed of wheat (ca. from 150,000 F to >500,000 F), cotton (from 32,000 F to 500,000 F), sorghum (around 500,000 F), groundnuts (peanuts ca. 80,000 F), and vegetables (approx. 50,000 F).

For cotton, as the main cash crop (total area: from 1,199,771 F to ca. 100,000 F in 2013), the pesticide application is directed against the pest complex. However, the relative importance of each pest changed over the years.

Large-scale insecticide spraying started in the scheme of 1945 to control cotton pests. OCs were the first to be used (e.g. DDT). By 1960/61 season, dimethoate (OP) was introduced. Carbamates (viz. carbaryl = Sevin®) were applied starting in 1970/71. Pyrethroids were introduced commercially in 1981/82. Since 1945, a wide variety of insecticides were introduced; many of them continued in use either alone or in mixtures. Others, like DDT and dieldrin were banned (1981) or severely restricted.

The reliable data for the types and quantities of insecticides used in Sudan, the Gezira scheme is available starting from 1966. The last time the chlorinated hydrocarbons (other than endosulfan and lindane) appeared in the list was the season of 1980/81.

During the period from 1945 to 1956, ground equipment, i.e. tractor-mounted sprayers and Land Rovers, were used for treating the crop with insecticides. Spraying by fixed-wing aircraft was introduced in 1950/51 season; by 1966/67 season all the insecticide spraying on cotton and wheat, in the Gezira and other schemes, was carried out by aerial spraying contractors. Still the herbicides are applied by tractors.

In addition to the Gezira Scheme, which is the largest agricultural scheme in the world under one administration, there are several other schemes or corporation that uses pesticides. These cotton producing schemes are:

- The Rahad Agricultural Corporation (RAC);
- New Halfa Agric. Corporation;
- Elsuki Agric. Corporation;
- The previous Blue Nile and White Nile Corporations.

Recently (in the last seven years), several other cotton producing private companies were established in Gadarif and Damazin areas (rain-fed); these companies have, for the first time, introduced the use of insecticides and herbicides to the traditional rain-fed agriculture.

The previous Nuba Mountains Corporation (rain-fed) used to apply some POPs pesticides in what is known as the Modernized Sector. Moreover, there are yearly campaigns, conducted by for controlling the cotton stainer bug (Dysdercus), the andat (Agonoscellus), rats, mice, birds (Quelea) in addition to the desert and migratory locust control programs.

Dar Fur state was not a major recipient of pesticides. The rest of Kordofan State concentrates mainly on controlling desert and migratory locust to protect the hashab trees (the Gum Arabic producing tree), from these devastating pests. DLCO-EA is the body responsible for coordination between the east African countries.

Other major users of pesticides in Sudan are: the Sugar Company (>200,000 F) and Kenana Sugar Company (KSC; ca. 100,000 F). This industry was the major user of POPs pesticide up to the early 1990's as a result of heavy termite infestation. Aldrin, dieldrin, heptachlor and chlordane were intensively applied in these areas. They continued using chlordane, heptachlor and aldrin even after being severely restricted in cotton in 1981. Now these OCPs are substituted by clorpyrifos and imidacloprid.

According to the updated inventory, in Sudan DDT was registered but officially was never used. The chemical is illegally commercialized through the eastern and western states. Moreover, Darfue State was using it up to the year 2000. According to the market people not less than 100 tonnes/yr is illegally commercialized, packed in small sacks (10 kg/sac), with a price around 10 Sudanese pounds/kg.

2.3.1.3. Production

Currently, Sudan does not produce pesticides. In 1963, Shell Chemicals (S.I.C.C)–East Africa (EA) established a formulation plant to produce insecticides for the agricultural schemes at Marinjan, Wad Medani. The plant was established in an area of 100 x 100m. The blending capacity was 7,000 I.G. per shift (1.5 - 2.3 million Gallons within 180 days). The staff operating this plant was composed of 13 individuals, including the plant manager and the three watchmen.

The plant started in 1964 with production of large quantities of OCs, i.e. endrin (not registered), DDT, dieldrin and toxaphene. These insecticides were used for cotton pests control in the irrigated and rain-fed sectors. The products were of high quality with competitive prices and were distributed via Sudan Railways or trucks.

In 1983, the plant ownership was transferred to Shell-Sudan. The plant faced some problems (administrative and economical) and stopped the production completely early 1990s.

The formulation plant was designed to produce OCs, OPs and pyrethroids and their mixtures in both EC and UL formulations. In addition to the above mentioned OCs, the plant was producing the following ULs: Azodrin 40%, Fastac/Birlane 0.65/16.8, Azodrin/DDT 13/20, Fastac/Dimethoate 0.65/18, Ripcord/Bidrin, and Bidrin 25%. The ECs produced were: DDT 25%, Azodrin 55.2%, Dimethoate 32%, Endosulfan 35%, Bidrin 24%, and Azodrin/Endosulfan 11.25 / 35, Ripcord 40%, Fastac 10%, Birlane 50% and Birlane 24%.

During the period 1971/72 – 1980/81 (the Package Deal Period) the plant was providing Shell with all its requirements of pesticides for the area allotted to Shell for cotton pest's control. In addition, in some seasons, the plant was formulating for both Ciba – Geigy and Rhone-Poulenc companies.

The plant was also producing other products, e.g. Shell domestic spray, Shell sol KA 75/25, Shell sol KA 50/50, Teepol G.D. 33 and 53 (liquid detergent), Vapona 90% Fogging solution, Vapona 48% EC and 50 EC, Vapona 15% UL, cides, concentrate for Shelltox aerosols, Donax B (brake fluid). Off-season brake fluid,

liquid soap, domestic pesticides and industrial solvents were manufactured in 1973-1982 at an average volume of 410,000 gallons /season.

An investigation revealed contamination of soil and underground water with POPs pesticides and other pesticides produced and formulated at this plant. The plant incinerator (dismantled and scrapped), according to a report by Himora and Suliman (1995), was previously used to dispose of >100 tonnes of obsolete pesticides and toxic waste, mostly from SGB and about 50 tonnes from Ciba-Geigy. The operation was properly performed according to the authorities, Ciba –Geigy experts and WHO. The plant was also reusing the drums of the imported pesticides for four extra rounds; this practice minimized the cost of containers and insured the safe-use of such containers. The damaged containers were subjected to shredding inside the plant to make them unsuitable for use.

Obsolete pesticide stocks, particularly those in leaking and stored in deteriorating containers, require immediate containment and disposal. Only environmentally sound disposal methods that are safe, affordable and generally applicable under circumstances prevailing in Sudan should be applied. There are several methods that must not be used, e.g. open burning and burying, because they are likely to pose severe pollution threats to public health and the environment. With regard to the available disposal options, a distinction must be made between small and large quantities of product to be disposed of. Disposal options for large quantities are more limited because safety requirements are higher. For some products, certain disposal methods may be considered acceptable for small quantities, but not for large quantities. Whether quantity is defined as large or small depends on the toxicity of the product.

As regarding new POPs pesticides, these were never produced in Sudan.

2.3.1.4. Use

The commonly used pesticide formulations in Sudan are emulsifiable concentrates (EC) and ultra-low volume (UL), in addition to wettable powders (WP), especially for herbicides. UL formulations were first introduced commercially in 1975/76. All recently developed formulations are now available in Sudan, e.g. WML, WDP, WSP, GR, D, DP, WSC, OS, pellets, etc.

The chemicals previously used for cotton and sorghum seed treatment were Aldrex-T and Dieldrex-B, i.e. aldrin plus thiram and dieldrin plus thiram. Agrosan was also stopped by the Pests and Diseases Committee because of its Hg-content. These insecticides and fungicides mixtures have been substituted by others, especially for cotton-seed treatment against the bacterial black-arm disease; several substitutes are now available.

Rats, mice and birds control is the responsibility of PPD and others (e.g. SGB). The campaigns previously used to concentrate mainly on applying poisoned-baits that contain endrin; however, currently zinc phosphide is the main active ingredient used in baits. Anti-coagulants are also commonly used. Birds are controlled by destruction of their nests and spraying with fenitrothion.

Concerning the new POPs pesticides, the inventory identified the followings:

- As a broad-spectrum insecticide, endosulfan is currently used to control a wide range of pests on a variety of crops including coffee, cotton, rice, sorghum and soy and is one of the oldest chemical

registered in Sudan. This insecticide is used alone and in mixtures for controlling cotton pests either the pest alone or complex. Mixing the endosulfan with other (pyrethroids, or OPs) proved that endosulfan has a potentiating effect making the other chemical more toxic. Endosulfan is forming the highest percentage of the imported pesticides of the Sudan. It seems that its cancellation might take time because of lack of suitable alternatives, in addition, its application is usually by professional contractors for cotton spraying and not recommended for other crops. However, this does not mean that the farmers of the other crops cannot find it in the market with affordable prices, illegally commercialized from government stores.

- Alfa- and beta-HCH were never registered and used in Sudan. However there is an option that technical HCH might have been used.

- Lindane is used currently for controlling ectoparasites (such as ticks) of livestock, and onion farmers use the same formulation to control thrips and cutworms. The inventory showed that in the northern state, where faba beans are produced, farmers are using lindane to protect their products from store pests. The inventory also showed that lindane it is illegally commercialized through the eastern borders in 10 kg sacs. Hundreds of tonnes are used in Gadarif and the Northern State. The chemical is very cheap (10 Sudanese pounds/kg; 2 US$) compared to the other pesticides. According to the inventory farmers confessed that they can easily get it and retailers have not denied this statement.

- Chlordecone and PeCBz were never registered and used in Sudan.

2.3.1.5. Import

The imports of the old POPs pesticides stopped by 1980/81; however, imports for public health, veterinary use and sugarcane plantations continued up to early 1990s. Imports started as early as in 1950/51. However reliable data is not available whether in the schemes or the central Bank.

Toxaphene was not introduced as toxaphene alone in 1966/67; it was introduced as Torbidan® (methyl parathion +toxaphene +DDT) or as Heliotox (DDT + toxaphene). None of the other compounds of Annex A of SC appeared in the list of products purchased from 1966/67 to 1980/81. Endrin (not registered) was withdrawn from the Sudanese market as early as mid-1960's because of its high acute mammalian toxicity. Aldrin and dieldrin were mostly used for the preparation of seed dressing of cotton mainly at 3 g /kg seed (Aldrex-T® and Dieldrex-B®), and sometimes for rat control campaign and locust control. Shell Company was the main supplier. Data regarding quantities used is not available whether in Seed Propagation of SGB, the previous National Seed Propagation Department of Ministry of Agriculture and Forests or The Bank of Sudan. Shell Company (Agrochemicals) is no longer working in Sudan. The previous agents claimed that they had no data about the sales. The last Plant Manager witnessed the destruction (burning) of all documents based on orders from the HQ (personal communication).

Aldrin and dieldrin, in addition to heptachlor and chlordane, were the major recommended insecticides for controlling termites and white grubs in sugarcane plantations in Kenana, Assalaya, Sinnar, Ginaid, and New Halfa. These are currently substituted by chlorpyrifos (Dursban®), Regent® and Gaucho® (imidacloprid). The total area for these plantations does not exceed 300,000 F of which ca. 20% will be

treated every year during the establishment of the new crop. Mirex is not registered in Sudan. HCB is also not used in Sudan; actually it is not registered.

Regarding new POPs pesticides, endosulfan imports have the highest percentage of imported pesticides of Sudan. The data on endosulfan imports starting with 1966/67 season are presented in the Table 6 below. It can be seen that between 1966 and 2012, **9,329,599 L** were imported in Sudan, while 685,600 L during 2011 (when endosulfan was listed in SC) and 2012 (when endosulfan amendment entered into force).

Table 6 - Endosulfan imports from 1966 to 2012

SEASON	TRADE NAME	QUANTITY (L)`
1966-1974	Endosulfan/Thiodan/Endosulfan 35%/Endosulfan UL	2,146,500
1974/75	Endosulfan/Dimethoate	201,235
1975/76	Endosulan 35%/ dimethoate UL	129,735
1976/77	Endosulfan 35%/Endosulfan 50%/ Endosulfan/Dimethoate UL	59,830
1977/78	Endosulfan 35% e.c./ Endosulfan 50% e.c./ Endosulfan/Dimethoate UL	142,186
1978/79	Endosulfan/Dimethoate UL	49,000
1979/80	Endosulfan 50%/Endosulfan UL	447,730
1980/81	Endosulfan	83,885
1981/82	Endophos (triazophos + endosulfan)/ Endosulfan 50% e.c./ Endosulfan/ dimethoate UL	187,950
1982/83	Thimul/Dimethoate UL/ Thimul 50% e.c./ Endosulfan 50%e.c./ Endophod e.c.	399,310
1983/84	Thimul /Dimethoate UL/Thimul 50%/Endophos	368,695
1984/85	Endophos 16/31 e.c./ Endosulfan 50% e.c./ Thimul /Dimethoate	306,628
1985/86	Thimul/Dimethoate 50/20 UL/ Thimul 50% e.c.	350,550
1986/87-1999	Not found	Not found
2000	Thiodan 50% UL	97,810

2001	Thimul 50% EC/ Thiodan 50% UL/ Thimul /D UL/ Callisulfan D UL/ Callisulfan K UL/ Callisulfan D UL	961,300
2002	Thimul 50EC/ Thiodan 50% UL/ Thiodan/D/ Thimul/D UL	202,790
2003	Thiodan 50 % UL/ Thiodan D UL/ Thimul/D UL/ Endosulfan 50%EC/ Endomight Super 50%	468,950
2005	Callisulfan D/ Thimul D/ Thiodan D/ Endosulfan 50%/ Callisulfan K/ Callisulfan 50% EC/ Endotaf/ Endomight/Akodan/Callisulfan/Thiodan 50EC/Endocel	720,800
2006	Endosulfan 50% EC/ Callisulfan 50%EC/ Akodan/Endomight/Thiodan 50%EC/ Endocel/Callisulfan D/Thimul D/ Thiodan D	360,200
2007	Thimul D/ Endosulfan 50% EC/ Endomight	73,800
2008	Callisulfan D/Thimul D/Thiodan D/ Callisulfan 50%EC/Akodan/Endomight/ Thiodan 50 EC/Endocel/Thimul 50EC	456,000
2009	Callisulfan D/Thimul D/Thiodan D/ Endomight/Thiodan 50% EC/Endocel/ Endosulfan/Dimethoate UL/Endosulfan EC	162,400
2010	Callisulfan 50EC/Endotaf/Akodan/ Endomight/Endocel	351,400
2011	Endomight 50%EC/Callisulfan D 50/20 UL/Callisulfan 50EC/ Endomoght Super 50% EC/ Endomight Super 50% EC/ Akodan 500EC	423,000
2012	Endomoght Super 50% EC	262,600
OVERALL UP TO 2012		**9,329,599 L**

Source: Pesticides Inventory Report

Lindane is still imported and used for tick control.

2.3.1.6. Export

Sudan does not export any pesticides, including old and new listed POPs pesticides.

2.3.1.7. Registration

See section *2.3.16. Details of any relevant system for the assessment and regulation of chemicals already in the market.*

2.3.1.8. Release

Due to the bad storage conditions of POPs pesticides released from the storages by air emission and due to unsound storage condition these releases are non-avoidable.

Endosulfan is still used in the country in high volumes. Therefore, endosulfan is directly released to the environment by applications in farming activities.

See also section *2.3.9. Existing programmes for monitoring releases and environmental and human health impacts, including findings*.

2.3.1.9. Future use of POPs pesticides

The use of endosulfan will continue in future for some applications until alternatives are assessed and introduced in Sudan. Therefore, there is a pressing need for the assessment of alternatives for endosulfan in different application areas.

Lindane is also used for cattle ectoparasite treatment. A range of alternatives are available and can be used. Therefore, the use of lindane will not be necessary in future. Since lindane is still available in the marked without registration of imports it is most likely that it is imported without appropriate labelling or smuggled into the country. The illegal import of lindane will be addressed within the action plan.

See also section *2.3.8. Summary of future production, use, and releases of POPs – requirements for exemptions*.

2.3.1.10. Use of alternatives to POPs pesticide

All POPs pesticides have already been substituted, with the exemptions of endosulfan and to some extent lindane. The alternatives to lindane are known and already applied. For the use of alternatives to endosulfan in some applications still more assessment and practical experiences are needed. This needs therefore being addressed in the action plan.

Regarding alternatives, several conventional insecticides and non-conventional substitutes were tested and registered, e.g. OPs, carbamates, pyrethroids, formamidines, neonicotinoids, IGRs, chitin synthesis inhibitors (CSI), botanicals etc.

Integrated Pest Management (IPM) Programs started in 1979 by funding of the Netherlands Government to the Entomology Section of Agricultural Research Corporation (ARC) in cotton Production. The program continued for five years, and established some valuable procedures, methodologies and techniques that resulted in the reduction of the pest populations and, hence, the number of sprays per season decreased (from 9 sprays/season to <4 sprays/season). The next phase (another 5 years) was focused on IPM in vegetables production. Vegetable growing farmers were trained in the irrigated schemes in IPM and safe use of pesticides (i.e. farmers Field Schools, FFS; Figure 2 to 4). The organizations of farmer field schools have challenges today due to the lack of funding and need to be addressed in NIP update.

This measure resulted in reducing the number of sprays from an average of 9 sprays/ cotton season to < 4 sprays. One of the most important recommendations of that program, which significantly reduced the number of sprays, was to delay the first or the first two sprays early in the season to help in establishing

the populations of natural enemies. Another measure, although was not based on solid data, was to increase the economic threshold level (ETL) or the action threshold (AT).

Figure 2 - Workshop on the review of FFS&RWS Curricula for Master Trainers organized by FAO & ARC

Research on natural products (botanical) as pesticides is becoming very popular among researchers and graduate students. For the last 10 years, several plants have been screened, active ingredients have been isolated/extracted, tested in the laboratory and the field; risk assessment studies are in progress; formulation studies have also been carried on in the Department of Pesticides and Toxicology and the Department of Applied Chemistry, and the BNNICD, University of Gezira, Wad Medani, Sudan.

Figure 3 - Field testing of pesticides on natural products (botanical)

Studies on susceptibilities/resistance of all major pest species of several crops were conducted. Rate of resistance development against insecticides from different chemical groups were investigated and

regimes for delaying or breaking the resistance were suggested and tested. Breeding for crop resistance programs against specific insect and diseases resulted in field crops (especially cotton, sorghum and wheat), and some horticultural crops (viz. tomato) that proved to have resistance to some of the major insect pests and plant diseases. It further reduced the number of sprays/season in addition to the other advantages (economical, health and environmental).

Figure 4 - Farmers Field Schools in the Gezira

Improving the application techniques by introducing the new technology is expected to improve the performance of different formulations of pesticides of the available recommended insecticide.

2.3.1.11. Storage

The storage facility of POPs and other pesticides is not appropriate in Sudan (see *2.3.7.*). By implementing SC, due to the lack of funding, the situation has not improved. Many of the stores are broken and their location is close to irrigation channels. The stores are not protected against flooding and pesticides are leaking into the environment. There is a need for improvement.

For details see section *2.3.7. Information on the state of knowledge on stockpiles, contaminated sites and wastes, identification, likely numbers, relevant regulations, guidance, remediation measures, and data on releases from sites*.

2.3.1.12. Management

See section *2.3.7. Information on the state of knowledge on stockpiles, contaminated sites and wastes, identification, likely numbers, relevant regulations, guidance, remediation measures, and data on releases from sites*.

The Stockholm Convention implementation has not lead to the environmentally sound management of POPs stockpiles due to the lack of funding.

2.3.1.13. Disposal

There is a lack of destruction capacity in Sudan. Therefore, up to now POPs pesticide stocks have not been destroyed. In several cases the stocks have been buried. In some other cases the stocks "disappeared" resulting in further contamination. Considering this situation there is a pressing need for disposal/destruction project for managing the pesticide stockpiles and pesticide contaminated soils in an environmentally sound manner in Sudan.

See also section *2.3.7. Information on the state of knowledge on stockpiles, contaminated sites and wastes, identification, likely numbers, relevant regulations, guidance, remediation measures, and data on releases from sites*.

2.3.1.14. Potential Impacts of POPs pesticides and socio economic considerations

Pesticides are inherently toxic to living organisms including humans[39,40]. Hence, the use of pesticides in agriculture (and homes/gardens) is likely to have negative impacts on human health and the environment. Humans are primarily exposed to residues in food and drinking water[41,42], via occupational, by-standard, and residential exposure[43]. The environment is exposed to pesticides primarily by reaching non-target organisms via wind drift, leaching, and runoff[44,45].

Poisoning by pesticides has resulted in death of farmers in Sudan (endosulfan caused fatalities have been reported). Therefore, the assessment of alternatives to endosulfan and its phase out is a high priority. Alternatives pest control, such as IPM, is another priority in implementing SC.

2.3.2. Assessment of PCB (Annex A, Part II chemicals)

2.3.2.1. General

Polychlorinated biphenyls (PCBs) are a group of organic compounds bearing chlorinated hydrocarbon. The chemical formula for PCB is C12H (10-n) Cln where n is the number of Chlorine atoms, ranged from 1 to 10. Polychlorinated Biphenyl's compounds are composite chemicals. At room temperature, most PCBs are liquids, viscous or waxy, PCBs are odourless, tasteless, clear to pale yellow and may exist in a form of liquid or solid, there is no natural source of it but they are manmade as an industrial products under different commercial names, most famous are (Aroclor and Askarel).

---

39 Bassil KL, Vakil, C., Sanborn M., Cole DC, Kaur JS, Kerr KJ, (2007) Cancer health effects of pesticides: systematic review. Canadian Family Physician 53, 1704-1711.

40 Sanborn M, Cole D, Kerr K, Vakil C, Sanin LH, Bassil, K., 2004. Systematic Review of Pesticide Human Health Effects. The Ontario College of Family Physicians, Toronto, Ontario, p. 188.

41 Fantke P, Friedrich R, Jolliet O (2012) Health impact and damage cost assessment of pesticides in Europe. Environment International 49, 9-17.

42 Hamilton D, Crossley S (2004) Pesticide Residues in Food and Drinking Water: Human Exposure and Risks. John Wiley and Sons, Inc., Chichester.

43 Vida P, Moretto A (2007) Pesticide exposure pathways among children of agricultural workers. Journal of Public Health 15, 289-299.

44 tenersen J (2004) Chemical Pesticides: Mode of Action and Toxicology. CRC Press, Taylor and Francis Group, Boca Raton, Florida.

45 Coats JR, Yamamoto H (2003) Environmental Fate and Effects of Pesticides. American Chemical Society, Washington, D.C.

PCBs are chemically inert being extremely resistant to oxidation and hardly burnt, (can only be incinerated at a temperature above 1100oC in BAT hazardous waste incinerators, specialized cement kilns or similar facilities. Non-combustion technologies are also available to destruct PCBs.

PCBs are insoluble in water, but well dissolved in oil and chlorinated benzene. They have low vapour pressure at room temperature. They are resistant to heat and have high dielectric constant. Due to their above mentioned properties, PCBs are widely applied in many fields such as electrical insulating fluids, hydraulic fluids, lubricating fluids and carbonless copy paper.

The "Guideline for Identification of PCBs, and Materials Containing PCBs (UNEP 1999)" provides directions for identifying PCBs containing transformers and capacitors which are owned by the Ministry of Electricity and provides the list of manufacturers and dates of manufacture and dates of installing in the distribution grids and also the recent locations and owners.

Some equipment requires retro-filling/ oil change to ensure its operation. PCBs concentration is decreased after each time of oil retro-filling leading to dispersion of PCB. The following table shows the dilution of PCBs. Original oil of 1000 ppm PCBs, which is higher than any detected results so far has been used a ratio of 30% for oil reuse, which is highest rate of oil reused/ remained in industrial equipment, has been used to calculate the dilution of PCBs by oil retro-filling with new PCB free oil.

Table 7 - Estimation of PCBs dilution from equipment maintenance

Times of oil retro-filling	Quantity of oil used (kg)	PCBs concentration in oil (kg)	PCBs quantity in oil (kg)	PCBs concentration reusing 30% of oil (kg)
0	100	1000	0.1	0.03
1	100	300	0.03	0.009
2	**100**	**90**	**0.009**	**0.0027**
3	100	27	0.0027	0.00081
4	100	8.1	0.00081	0.000243
5	100	2.4	0.000243	0.0000729

Source: PCBs Inventory Report

According to this table, the PCBs concentration will be less than 50 ppm at the third time of oil retro-filling (in the green row). However it is not allowed to dilute PCBs and other POPs. This is one reason to take care that such dilution does not take place. By such dilution a much larger number of transformers get contaminated with PCBs. If the PCB contamination limit is possibly reduced in future to e.g. 20 ppm or 5 ppm then the utility sector would have a much larger amount of transformers considered as PCB contaminated. This could drastically increase the treatment cost due to the higher volumes of transformers and oils to treat.

In the preliminary PCBs inventory only transformers in the electric utility sector including distribution networks were addressed. Other target industries including industrial facilities (cement industry, metal industry etc.), railroad systems, underground mining operations, residential/commercial buildings,

research laboratories, waste water discharge facilities, automobile service stations etc. were not addressed.

Also, the inventory had not addressed the capacitors. Capacitors are present in power generation, power transmission and power distribution. Therefore all three sectors need to develop an inventory of capacitors and a plan on how to manage it. Capacitors are also used in industries such as cement industry, metal industries, and other heavy industries and even in the food processing industry. A PCBs inventory need therefore also assess these industries

The preliminary inventory also had not addressed PCBs in open application. While there has probably been only a small use of PCBs in open applications it is important to have an assessment of potential former open PCBs use in Sudan.

The main industry sectors using PCBs and subject to regulations are the electric utilities, owned and managed by the Ministry of Electricity. The installed transformers in other government departments like hospitals, schools; and other miscellaneous industry sectors is also owned, supervised and regular maintained by the electricity staff. Locations, capacities and year of installation are included in this report. Other industry sectors such as; iron and steel manufacturing; and mining, cement industries, and mineral manufacturing were newly established in Sudan, most of them after the year 1980. The data concerning the capacitors was also very limited. It was assumed that, only the capacitors located in the old transmission and distribution sub-stations are suspected to be contaminated by PCBs.

2.3.2.2. Import

Sudan has never produced PCBs but imported equipment and oils that are suspected of being PCBs-contaminated.

2.3.2.3. Export

In the last 10 years of Stockholm Convention no known export of PCB took place for disposal.

2.3.2.4. Use

According to the inventory report the total number of PCBs containing transformers in Sudan is estimated at 255 units, with capacities ranging between 25 KVA to 2500 KVA (Table 8). The highest number of PCBs containing transformers was found to be in the Khartoum region, namely 187 units and the region having the lowest PCBs containing transformer units is Darfur, with 7 units.

According to the preliminary inventory of transformers in Table 8 below about 151.78 tonnes of PCBs contaminated fluid is still in use in Khartoum Grid and 61.95 tonnes of contaminated fluid is still in use in the States. This is however only a preliminary inventory.

Table 8 - Locations and capacities of transformers in Sudan (manufactured before 1990 and in use)

State	25 KVA	50 KVA	100 KVA	200 KVA	250 KVA	300 KVA	400 KVA	500 KVA	630 KVA	750 KVA	1000 KVA	1250 KVA	1600 KVA	2500 KVA	Total No.
Khartoum	**0**	**17**	**16**	**23**	**0**	**19**	**1**	**42**	**1**	**16**	**47**	**1**	**4**	**0**	**187**

North & East Sudan	**1**	**4**	**6**	**10**	**1**	**5**	**1**	**8**	**1**	**1**	**9**	**1**	**0**	**0**	**48**
Darfur	**0**	**1**	**3**	**2**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**7**
Kurdufan	**N.D**	**N.D**	**N.D**	**N.D**	**N.D**	**N.D**	**N.D**	**N.D**	**N.D**	**N.D**	**N.D**	**N.D**	**N.D**	**N.D**	**N.D**
Middle of Sudan	**0**	**0**	**0**	**4**	**0**	**3**	**1**	**2**	**0**	**2**	**1**	**0**	**0**	**0**	**13**
Total	**1**	**22**	**25**	**39**	**1**	**28**	**3**	**52**	**2**	**19**	**57**	**2**	**4**	**0**	**255**

Source: PCBs Inventory Report

Condensers have not been addressed in the preliminary inventories in 2004 and also the updated inventory in 2013. Also PCB in hydraulic oils has not been addressed in these inventories.

Open PCB applications (sealants in buildings, paints and floorings) have also not been addressed in these two inventory activities.

2.3.2.5. Registration and Control

The largest share of transformers in Sudan belong either to the Ministry of Electricity & Water Resources which is responsible for the governmental generation, transmission and distribution companies. In these sectors there is some awareness and control. However as can be seen with the missing PCB stocks from the first inventory (see below 2.3.2.6) the control of these sectors needs to be improved (Action Plan).

Other industrial sectors like cement industry, metal industry, sugar industry or other energy intensive sectors have not been included in the PCB inventory yet. Therefore in these sectors neither registration nor control of transformers and waste oils (Action Plan) have been performed.

2.3.2.6. Release, Contaminated Sites and Storage

See section *2.3.7. Information on the state of knowledge on stockpiles, contaminated sites and wastes, identification, likely numbers, relevant regulations, guidance, remediation measures, and data on releases from sites.*

2.3.2.7. Potential impacts of PCBs and socio-economic considerations

PCBs (and DDT) have been detected globally in human milk. A recent study in human milk in Ghana revealed that levels might even have increased in African countries over the years. Estimated hazard quotient (HQ) showed that the mothers had HQ values exceeding the threshold of 1 for PCBs, indicating potential health risk for their children.[46] Furthermore PCB has recently been classified as class 1

46 Asante KA, Adu-Kumi S, Nakahiro K, Takahashi S, Isobe T, Sudaryanto A, Devanathan G, Clarke E, Ansa-Asare OD, Dapaah-Siakwan S, Tanabe S. (2011) Human exposure to PCBs, PBDEs and HBCDs in Ghana: Temporal variation, sources of exposure and estimation of daily intakes by infants. Environ Int. 37, 921-928.

carcinogen[47]. The human exposure and associated toxicity together with the lack of environmentally sound management of PCBs in Sudan poses a risk for the population and the environment.

It has recently been reported that flood plains of rivers with industrial inputs in UK[48] and Germany have elevated levels of PCB and PCDD/F with related higher exposure for cattle and exceedance of food limits. Since Sudan and several other African countries are dependent on the Nile a similar pollution would be a threat for the food safety of the countries depending on these river areas and irrigation schemes. Therefore, environmentally sound management of PCBs in countries along the Nile should avoid to contaminate soil and sediments. In addition to the contamination of food for local consumption, the food export can also be impacted. Since for food export regulation limits exist these food items are in particular sensitive. It is worth noting that the Dall Group has started organic farming with export. The continuous contamination of the environment by release of PCB, other POPs and POPs-like[15] chemicals increases the risk of environmental contamination with related long term risk for feed and food.

Particular vulnerable groups for PCB exposure are those who are responsible for the physical end of life management of PCB containing equipment[49]. High occupational exposure can result from dismantling of PCB containing transformers and other PCB containing equipment and waste oils. Since the last 10 years no measurable step in the management of PCBs have been achieved and even some of former inventoried oil has been lost, a pressing need exists considering the associated threats.

See also section *2.3.14. Identification of impacted populations or environments, estimated scale and magnitude of threats to public health and environmental quality, and social implications for workers and local communities.*

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

2.3.3.1. General

The brominated flame retardants (BFRs), Hexabromobiphenyl (HBB) and certain congeners/homologues of c-PentaBDE and c-OctaBDE, two commercial polybrominated diphenyl ether mixtures including tetraBDE, pentaBDE, hexaBDE and heptaBDE (POP-PBDEs) were added to Annex A of SC in 2009, due to their toxic properties, persistence, and bioaccumulation. They are also transported through air, water and migratory species, across international boundaries and deposited far from their source of release and accumulate in terrestrial and aquatic ecosystems.

Polybrominated diphenyl ethers (PBDEs); are a group of industrial aromatic organobromine chemicals that have been used since the 1970s as additive flame retardants in a wide range of consumer products.

47 Lauby-Secretan B, Loomis D, Grosse Y, El Ghissassi F, Bouvard V, Benbrahim-Tallaa L, Guha L, Baan R, Mattock H, Straif K (2013) Carcinogenicity of polychlorinated biphenyls and polybrominated biphenyls. Lancet Oncol. 14(4), 287-278.
48 Lake IR, Foxall CD, Fernandes A, Lewis M, White O, Mortimer D, Dowding A, Rose M5. (2014) The effects of river flooding on dioxin and PCBs in beef. Sci Total Environ. 2014 Feb 13. pii: S0048-9697(14)00098-9. doi: 10.1016/j.scitotenv.2014.01.080..
49 Pedersen EB, Jacobsen P, Jensen AA, Brauer C, Gunnarsen L, Meyer HW, Ebbehøj NE, Bonde JP (2013) Risk of disease following occupational exposure to Polychlorinated Biphenyls.

PBDEs were produced with three different degrees of bromination, and marketed as commercial PentaBDE (c-PentaBDE), commercial OctaBDE (c-OctaBDE) and commercial DecaBDE (c-DecaBDE)[50].

OctaBDE, nonaBDE, and decaBDE homologues are not listed as POPs in the Convention. These highly brominated PBDEs, however, can be degraded to POP-PBDEs by debromination and its debromination in different life cycle phases can form POP-PBDEs (in production and product, in thermal and environment processes and even in biota) thus representing an important reservoir of POP-PBDEs [51,52,53]. Other toxicological relevant degradation products are polybrominated dibenzofurans and, depending on conditions, polybrominated dibenzo-p-dioxins. Furthermore DecaBDE is currently evaluated by the POP Reviewing Committee[54] and it has been concluded that it meet Annex D criteria[55].

C-OctaBDE was produced in several industrialized countries, however the production stopped in the EU, United States and the Pacific Region around 2004. An approximate distribution of global c-PentaBDE is as follows: 36% was used in transport, 60% in furniture and a 4% residual in other articles. The main user was the US (ca. 85%). C-OctaBDE was used in acrylonitrile-butadiene-styrene (ABS) polymers, accounting for about 95% of c-OctaBDE supplied in the EU. The treated ABS was mainly used for housings/casings of electrical and electronic equipment (EEE), particularly for cathode ray tube (CRT) housings and office equipment such as copying machines and business printers. Other minor uses were high impact polystyrene (HIPS), polybutylene terephthalate (PBT), and polyamide polymers. Although the majority of these polymers were used in electronics, there was also some use in the transport sector. Other minor uses found in literature include nylon, low density polyethylene, polycarbonate, phenol formaldehyde resins, unsaturated polyesters, adhesives and coatings.[50]

The average content of c-PentaBDE in PUR foam is reported to be around 3-5% (wt %) for upholstery, cushions, mattresses, and carpet padding. PUR foam in the transport sector might have been used in lower concentrations for applications like seats or arms/head rests at 0.5-1 wt %.

Sudan as one of the countries that signed and ratified SC, for which the amendments have entered into force, need to meet the obligations under the Convention that lead to the elimination of the listed POP-PBDEs. Due to the complexity and the volume of the stocks and wastes containing these chemicals the inventories and elimination of them may represent a major challenge. To develop effective strategies that could lead to the elimination of the listed BFRs, there was a need for a sound understanding of the situation in Sudan concerning these chemicals. The required information was obtained through

50 Stockholm Convention (2012) Guidance for the Inventory of commercial Pentabromodiphenyl ether (c-PentaBDE), commercial Octabromodiphenyl ether (c-OctaBDE) and Hexabromobiphenyls (HBB) under the Stockholm Convention on Persistent Organic Pollutants; Draft;

51 UNEP (2010) Debromination of brominated flame retardants. 6th POP Reviewing Committee meeting Geneva 11-15. October 2010 (UNEP/POPS/POPRC.6/INF/20)

52 UNEP (2010). Technical Review of the Implications of Recycling Commercial Pentabromodiphenyl Ether and Commercial Octabromodiphenyl Ether. 6th POP Reviewing Committee meeting Geneva 11-15. October 2010 (UNEP/POPS/POPRC.6/2)

53 UNEP (2010) Supporting Document for Technical review of the implications of recycling commercial penta and octabromodiphenyl ethers. 6th POP Reviewing Committee meeting Geneva 11-15. October 2010 (UNEP/POPS/POPRC.6/INF/6).

54 UNEP (2013) Proposal to list decabromodiphenyl ether (commercial mixture, c-decaBDE) in Annexes A, B and/or C to the Stockholm Convention on Persistent Organic Pollutants. 6 June 2013.

55 UNEP (2013) Report of the Persistent Organic Pollutants Review Committee on the work of its ninth meeting. UNEP/POPS/POPRC.9/13

inventories of the listed BFRs. The inventory covered the major articles that can contain POP-PBDEs, namely the electrical and electronic equipment, the transport sector and furniture and insulation materials for buildings. It focuses mainly on identifying the relevant use categories and life cycle stages of these items. Other categories of former of POP-PBDE use were not addressed in this inventory since they are considered of less relevance for Sudan[50] and would need monitoring for a useful assessment. HBB was not addressed either as the small production volume (approximately 6000 tonnes) was largely used in the US in the 1970s. Since applications were in the same sectors (Plastic of electronics, PUR foams in transport) the possibly remaining HBB in products will be managed together with the POP-PBDE material flows.

The evaluation of available and relevant national data on the selected sectors was conducted by using the tiered approach suggested by the UNEP PBDE Inventory Guidance document[50] with the collected available data and by extrapolating the data to fill gaps. According to the inventory the POP-PBDEs have never been produced in Sudan and most probably articles containing POP-PBDEs have not been produced as well.

The major challenge is the end of life management. In Sudan no national policy or strategy on end-of-life management of WEEE or end of life vehicles has been established yet.

The Sudanese PBDE inventory concludes that more intensive effort must be made in order to trace the presence of POPs-PBDEs containing products still in use, and that have been recycled, stockpiled, or land fill. Intensive collaboration among stakeholders is necessary to bridge the gap in the information required for quantitative estimation of POPs-PBDEs.

2.3.3.2. Import

POP-PBDEs have been imported via products, in particular in electrical and electronic equipment (EEE) and in vehicles. Since POP-PBDE production stopped around 2004, the import of POP-PBDE containing equipment was made largely in the past.

A. Import of POP-PBDEs containing EEE equipment

Sudan has been undergoing rapid ICT transformation in recent years, importing computers, mobile phones, and TV sets from developed countries. These appliances together with other electrical and electronic equipment (EEE) are also contributing to the ever growing amount of waste of electrical and electronic equipment (WEEE) or e-waste for short, when they reach their end of life.

Most of EEE is imported into Sudan, but there are also six assembling companies for TVs with total production capacity of 600,000 units per year. However, these TVs assembly companies were not included in the inventory because, according to the information provided by the Ministry of Industry, five of the six companies produce LCD units and have started production between 2009 and 2011 after the use of POPs-PBDE have been stopped (2004). There was only one company that had assembled CRTs in the early 2000s, but stopped shortly after it started and there was no statistics for the amount it had produced.

According to the Customs officials used EEE are not allowed to enter the country, and there is no export of e-waste from the country.

For the estimation of CRTs in stock (used and stored in households and consumer level) the available import statistics of TVs and PCs have been used. Import statistics were available from 2000 to 2012. Until 2007 largely CRT monitors have been produced. In 2007 the flat screen sales surpassed the sales of CRTs (Wikipedia 2013**). Therefore for this first inventory, TVs and PCs import data from 2000 to 2007 have been used (see Table 9). Table 9 shows the total amount of imported computers and television sets during the years 2000 and 2012 with total numbers of 959,542 for computers and 2,148,736 for television sets.

Table 9 - Imported TVs and PCs

Year	2000	2001	2002	2003	2004	2005	2006
Computer	45,453	64,157	65,196	87,270	79,031	81,801	88,034
TV sets	84,527	98,588	633,610	153,643	140,648	108,166	208,342

Table 9 (cont.) - Imported TVs and PCs

Year	2007	2008	2009	2010	2011	2012	Total
Computer	115,284	70,837	41,411	86,350	79,587	55,131	959,542
TV sets	229,862	166,486	66,196	99,406	57,771	101,491	2,148,736

Source: General Customs Administration (2013)

B. POPs-PBDEs in transport sector

The total number and percentage of imported cars, buses and trucks for the period 1995-2011 was 366,619 (54.05%), 90,918 (13.40%) and 220,808 (32.55%), respectively with a total of 678,345 (100%) vehicles. Total number and percentage of registered in use cars, buses and trucks for the period 1990-2012 were 1,099,798 (72.26%), 189,134 (12.43%) and 233,052 (15.31%), respectively with a total of 1,521,984 (100.00%).

The estimated amount of c-PentaBDE (tetraBDE, pentaBDE, hexaBDE and heptaBDE) in imported vehicles during the period 1995-2009 was found to be 4.6 tonnes (1.52 tonnes tetraBDE, 2.67 tonnes pentaBDE, 0.37 tonnes hexaBDE and 0.23 tonnes heptaBDE) out of which 1.9 tonnes in cars (0.62 tonnes tetraBDE, 1.09 tonnes pentaBDE, 0.15 tonnes hexaBDE, and 0.01 tonnes heptaBDE), 1.54 tonnes in buses (0.51 tonnes tetraBDE, 0.89 tonnes pentaBDE, 0.12 tonnes hexaBDE and 0.08 h tonnes heptaBDE) and 1.19 tonnes in trucks (0.39 tonnes tetraBDE, 0.69 tonnes pentaBDE, 0.10 tonnes hexaBDE and 0.01 tonnes heptaBDE).

2.3.3.3. Export

A. POPs-BDEs in EEE equipment

According to the customs officials no export of any e-waste is allowed.

B. POPs-BDEs in transport sector

Sudan has not produced and/or exported vehicles before 2005.

2.3.3.4. PBDE in use and stocks

The largest share of POP-PBDEs is present in polymers in EEE and vehicles. Other applications are considered of minor relevance. In addition, PBDE are contaminating by recycling other plastic products even children toys or coffee cups. As PBDE contamination from recycling cannot be estimated in the country, it needs further consideration.

It should also be mentioned that DecaBDE, not listed as POP-PBDE but assessed by POP Reviewing Committee, is likely present in much higher volumes in polymers in Sudan compared to POP-PBDEs. These large volumes of DecaBDE will partly degrade to POP-PBDEs over time[51].

A. POP-PBDEs in EEE equipment

In order to estimate the total amount of POP-PBDEs in the preliminary inventory it was assumed that the imported CRTs in the period 2000 to 2007 are still in stock (used or stored at household or consumer level). This calculation has not considered the amount which has been disposed to waste. Since electronics such as TVs are used for long time in Sudan, most of EEE can be assumed to be still in use. On the other hand, the calculation has not considered the EEEs which have been imported before 2000. While a large share of these is not used anymore, but kept at households and consumer level, it needs to be considered in a more detailed inventory.

With these two major simplifications, for the 2012 inventory the total CRTs units in stock (used or stored in households or institutions) were estimated to be 2,051,333 (51,294 tonnes), out of which 626,226 units (15,666 tonnes) of PCs and 1,425,107 units (35,628 tonnes) of TV sets.

The total amount of the polymer fraction for the CRTs casings in stock at the level of 2012 is estimated to be 15,385 tonnes (4,697 tonnes for PCs and 10,688 tonnes for TV sets).

The total amount of c-OctaBDE within this CRTs casings stock (2012) is estimated between 13,385 kg to 39,078 kg (between 4,086 kg to 11,930 kg in CRT-PC casings, and between 9,299 kg to 27,148 kg in CRT-TV casings).

The POP-PBDE congeners in this total amount of c-OctaBDE for CRTs in stock (2012) are estimated for heptaBDE to 5,756 kg to 16,804 kg and for hexaBDE between 1,472 kg to 4,299 kg.

B. POP-PBDEs in transport sector

Since POP-PBDEs were produced and used (mainly) in the period from approximately 1975 to 2004, vehicles produced in this period were considered for this POP-PBDE inventory following the POP-PBDE Inventory Guidance approach.

Concerning the polymer fraction, only PUR foam was considered since there is no impact factor given on PBDEs in plastic in transport (e.g. dash board in the cars/vehicles). Also, as it was not possible to determine which car PUR foam contains PBDEs, all PUR foam from cars produced before 2005 need to be considered.

Therefore, the total amount of PUR foam from the registered in use possibly impacted vehicles (cars, trucks, busses produced before 2004) was estimated at 85,909 tonnes, out of which 43,639 tonnes of PUR foam in cars, 23,081 tonnes of PUR foam in buses and 6,205 tonnes of PUR foam in trucks.

The level of PBDE contamination of these PUR foam impacted vehicles is not known. The inventory guidance considers that of the cars produced before 2005 approx. 5% from different regions might be impacted with PBDEs while 50% from the U.S. might be impacted with PBDEs (UNEP 2012a). Further assessment (e.g. by XRF screening) is necessary to conclude on the contamination level and on options of separation and management is necessary.

With regard to the amount of PBDEs in vehicles, it was estimated based on the number of imported and registered vehicles in operation. Cars, buses and trucks were considered in the inventory.

To estimate the amount of POPs-PBDEs in vehicles, it was considered that the amount of c-Penta BDE used to treat one bus was 640g and one car or truck was 160 g, respectively, with an impact factor of 0.05 for the region of import.

The estimated amount of c-PentaBDE (tetraBDE, pentaBDE, hexaBDE and heptaBDE) in impacted registered in use vehicles for the period 1990-2009 was found to be 36.46 tonnes (11.16 tonnes tetraBDE, 19.62 tonnes pentaBDE, 2.71 tonnes hexaBDE and 0.17 tonnes heptaBDE), out of which 21.82 tonnes in cars (7.20 tonnes tetraBDE, 12.66 tonnes pentaBDE, 1.75 tonnes hexaBDE, and 0.11 tonnes heptaBDE), 11.540 tonnes in buses (3.81 tonnes tetraBDE, 6.69 tonnes pentaBDE, 0.92 tonnes hexaBDE and 0.58 tonnes heptaBDE)and 3.10 tonnes in trucks (1.02 tonnes tetraBDE, 1.80 tonnes pentaBDE, 0.25 tonnes hexaBDE and 0.02 tonnes heptaBDE).

The estimated number of damaged impacted vehicles that reached the end of life was approx. 100,000 vehicles. The estimated amount of c-PentaBDE in damaged impacted vehicles that reached the end of life was estimated to be 1.1 tonnes (0.36 tonnes tetraBDE,0.64 tonnes pentaBDE, 0.09 tonnes hexaBDE and 0.005 tonnes heptaBDE), out of which 0.58 tonnes in cars (0.2 tonnes tetraBDE, 0.34 tonnes pentaBDE, 0.046 tonnes hexaBDE and 0.003 tonnes heptaBDE), 0.40 tonnes in buses (0.13 tonnes tetraBDE, 0.23 tonnes pentaBDE, 0.032 tonnes hexaBDE and 0.002 tonnes heptaBDE) and 0.12 tonnes in trucks (0.04 tonnes tetraBDE, 0.07 tonnes pentaBDE, 0.01 tonnes hexaBDE and 0.001 tonnes heptaBDE).

Time projection of end-of life vehicles is difficult. It is assumed that the average vehicle life span in Sudan is approximately 30 years. This would mean that imported vehicles from the year 1995 will, in average,

reach the end of life in 2025. For the NIP implementation a detailed study on time projection for end-of-life vehicles should be established.

C. Furniture and insulation materials for buildings

The collected data from the Customs Administration on furniture, seats, insulation materials and insulated items were not used for the estimation of POP-PBDEs because no flammability standards exist for these articles in Sudan and it is therefore considered that PBDE were not used in furniture.

Even the data collected from the Ministry of Industry record 2012 as the production year of the locally manufactured articles (mattresses), most of them started production after 2004.

These and other products need to be checked with the XRF device (from the custom authority) for bromine content as an indicator for PBDEs. If these are bromine negative then it can be concluded that they do not contain PBDEs or HBCD (and other BFRs).

2.3.3.5. Use of PBDE alternatives

Currently it is not known what flame retardants are used in Sudan (e.g. in textile industry, polymer production or construction). Also it is not known what alternative flame retardants are imported in products such as polymers or textiles. It is suspected that partly DecaBDE is used/present in these articles and processes which is currently assessed from the POP Reviewing Committee and meeting Annex D[55]. Also Hexabromocyclododecane (HBCD) listed in 2013 to the Convention might still be used. There is an urgent need to assess what alternatives are used in Sudan and what alternatives are imported in articles to Sudan.

2.3.3.6. Control and management of PBDE-containing articles and wastes

Currently there is no particular control and management of the major PBDE-containing material flows – plastic in EEE/WEEE and polymers in end of life vehicles. The management of WEEE is still in its infancy in Sudan. The current inventory activity was one of the first activities on WEEE assessment in the country. The WEEE inventory for TV sets and CRTs has become a basis for the management and control of EEE/WEEE in Sudan. It has therefore been listed as a key issue in the action plan of updated NIP and need to be extended to all EEE/WEEE.

Preparing the transport sector inventory in Sudan and has led to recognizing the need of management of end of life vehicles. There is a lack of national policy or strategy on end-of-life management in the country. It is also not known if and to which extent polymers from the end-of-life management of vehicles were recycled. Laws and regulations for end of life vehicles and their management have not been established yet. All the damaged vehicles are sold as scrap which can be used as sources for spare parts or steel recycling industries. The end of life management of vehicles is largely uncontrolled and mainly driven by recovery of metals and spare parts. Polymers are not recycled, recovered and managed in an environmentally sound manner but just burned in open, dumped or otherwise thrown away in the wider environment around road sides or car repair shops,etc resulting in environmental contamination and associated risk for human exposure.

Therefore there is an urgent need for establishing environmentally sound management of articles and materials at the end of life in Sudan as part of the action plan.

See also section *2.3.7. Information on the state of knowledge on stockpiles, contaminated sites and wastes, identification, likely numbers, relevant regulations, guidance, remediation measures, and data on releases from sites.*

2.3.3.7. Storages, release and contaminated sites

Currently there is lack of specific storage for polymers from WEEE or end of life vehicles. There is also a lack of specific collection points or storages for EEE/WEEE or end of life vehicles. Therefore, storages for PBDE containing materials should be established along with proper management of WEEE and end of life vehicles. It should be integrated in an overall management of polymers in Sudan. Currently a large part of these polymers are finally burned in the open either directly or at dump sites, where continuous open burning and smouldering take place. The SC BAT/BEP guidance[56] and the PBDE BAT/BEP guidance[57] warns about the content of shredder residues which are dioxin precursors and may result in the formation of PCDD/F or other dioxin-like compounds when burnt. These include PCB-containing capacitors, PCB contaminated waste oils or chlorophenols and chlorobenzenes. Polymers containing PBDEs and other brominated flame retardants have the risk of formation of polybrominated dibenzofurans and dibenzo-p-dioxins (PBDD/F)[56,57].

Releases of PCDD/F, PBDE and PBDD/F have not been monitored in Sudan due to the lack of monitoring capacity. However, considering that part of the PBDE (and PCB) containing waste is burned in the open, releases of these pollutants can be expected from this practice. Dumping of PBDE containing materials results in the contamination of the area. Since landfill/dump fires are frequently occuring at landfills/dumpsites releases of PBDE, PCDD/F and PBDD/F can be expected.

These releases can result in contaminated sites. However, currently there are no limit values in soil which would define a contaminated site. In areas in China at E-waste recycling sites the animals (duck/egg, chicken/egg and fish) are contaminated at levels exceeding the acceptable human intake[58]. The soil levels of Dioxins at areas where WEEE is burned in the open can exceed international limits for dioxins in soil[59]. Open burning of polymer and shredder waste from end of life vehicles will release PBDE and other pollutants.

Therefore, for the areas of open burning of polymers from WEEE and other end of life vehicle or other materials containing PBDE, further assessment on the contamination level is needed for a wide range of

---

[56] Stockholm Convention (2007). Guidelines On Best Available Techniques And Provisional Guidance On Best Environmental Practices Relevant To Article 5 And Annex C Of The Stockholm Convention On Persistent Organic Pollutants - Adopted at COP 3, May 2007. Geneva, Switzerland

[57] Stockholm Convention (2012) Guidance on best available techniques and best environmental practices for the recycling and disposal of articles containing polybrominated diphenyl ethers (PBDEs) listed under the Stockholm Convention on Persistent Organic Pollutants; Draft July 2012

[58] Labunska I, Harrad S, Wang M, Santillo D, Johnston P (2014) Human Dietary Exposure to PBDEs Around E- Waste Recycling Sites in Eastern China. *Environ. Sci. Technol.*, 2014, 48 (10), pp 5555–5564

[59] Yu X, Zennegg M, Engwall M, Rotander A, Larsson M, Wong MH, et al. (2008) E-waste recycling heavily contaminates a Chinese city with chlorinated, brominated and mixed halogenated dioxins. Organohalogen Compd 70:813-816.

pollutants (PBDEs, Dioxins, dioxin-like chemicals, heavy metals) as well as on the exposure of humans to these pollutants (action plan).

See also section *2.3.7. Information on the state of knowledge on stockpiles, contaminated sites and wastes, identification, likely numbers, relevant regulations, guidance, remediation measures, and data on releases from sites.*

2.3.3.8. Potential impacts from PBDE and socio-economic considerations

Humans can be exposed to PBDE along the entire life cycle of PBDE from production, use, recycling and end of life treatment[53,60]. The concentration in human milk of population in developing countries are normally lower compared to industrialized countries, which are in particular high in countries with (former) elevated use levels of PBDE/BFR such as the United States, Canada or the UK[46,53].

However, high exposure can occur at non-BAT WEEE recycling and open burning sites. PBDE in animals (duck/egg, chicken/egg and fish) at WEEE recycling sites may have contaminated levels exceeding the acceptable human intake for PBDE with associated risks[58] .There is an urgent need to assess the extent of such activities in Sudan and to control them. Therefore the improvement of WEEE and end of life vehicle management is a priority in Sudan. It can bring benefits from improving recycling and resource recovery from this valuable material flow.[61]

WEEE and end of life vehicles contain a wide range of pollutants[61,62]. For an appropriate socio-economic assessment toxicity of the pollutant mixture needs to be considered. Therefore, for the end of life treatment schemes of WEEE and end of life vehicles (open burning, dumping and facilities treating these material flows such as secondary metal smelters) an assessment on the contamination level is needed for a wide range of pollutants (PBDEs, Dioxins, dioxin-like chemicals, heavy metals) as well as the exposure of humans (occupational exposure and exposure of the neighbourhood) to these pollutants (action plan). Since the volume of EEE/WEEE and end of live vehicles are increasing without appropriate treatment technology and infrastructure, the contamination of the environment and the human exposure will increase in future. Therefore it is addressed in the action plan.

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

2.3.4.1. General

Dichloro**d**iphenyl**t**richloroethane (DDT) is one of the well-known synthetic pesticides synthesized in 1874. The chemical formula of DDT is $(ClC_6H_4)_2CH(CCl_3)$. DDT readily binds to fatty tissue in any living organism and, due to its stability, bio-concentrates and bio-magnifies with increasing trophic level in food chains. The half-life of DDT in humans is more than 4 years; the half-life for DDE is probably longer. DDT is highly

60 Shaw SD, Blum A, Weber R, Kannan K, Rich D, Lucas D, Koshland CP, Dobraca D, Hanson S, Birnbaum LS. (2010) Halogenated Flame Retardants: Do the Fire Safety Benefits Justify the Risks? Reviews on Environmental Health 25(4) 261-305

61 Stockholm Convention (2012) Guidance on best available techniques and best environmental practices for the recycling and disposal of articles containing polybrominated diphenyl ethers (PBDEs) listed under the Stockholm Convention on Persistent Organic Pollutants; Draft July 2012

62 Swedish EPA (2011) Recycling and disposal of electronic waste - Health hazards and environmental impacts. Report 6417, March 2011.

toxic to insects, shrimps and fish, and adversely affects the reproduction of wild birds through thinning of egg shells. The global production of DDT for vector control is estimated at 4,550 t in 2003 and 4,740 t in 2005. In 2007, production increased, with 6,300 t produced in India.

According to the Stockholm Convention Secretariat data register, currently there are 3 Parties to the Convention (Ethiopia, India and Namibia) that are producing and using DDT for the acceptable purpose listed in Annex B and another 15 Parties that are only using DDT for the same acceptable purpose (Botswana, Eritrea, Madagascar, Marshall Islands, Mauritius, Morocco, Mozambique, Senegal, South Africa, Swaziland, Uganda, Venezuela, Republic of Yemen and Zambia).

2.3.4.2. Import

In the Sudan, the import of DDT in agriculture has been severely restricted since 1981. At present, DDT is not officially imported for any purpose (agricultural, medical or veterinary). However, according to the inventory report it is available illegally in some local markets especially in border States.

2.3.4.3. Use

The last application was in 1980/81 season on cotton in the agricultural schemes. These amounts were used in almost all the agricultural schemes, which are also known as malaria endemic areas (Gezira, Managil, White Nile, Blue Nile, and others). All public health pests were exposed simultaneously to these chemicals together with the agricultural pests by aerial spraying.

2.3.4.4. Use of DDT alternatives

According to the inventory report and research of the Department of Pesticides and Toxicology, and the Blue Nile National Institute for Communicable Diseases (BNNICD) of University of Gezira, DDT will not be needed for vector control in the near future. Moreover, by 2013 the Anopheles mosquitoes proved to be resistant to DDT in almost all Sudanese states.

Several studies were conducted to determine the susceptibility to several recommended insecticides (monitoring studies leading to degrees: M.Sc. and Ph.D.), last study being dated of March 2014. A new National Strategy for Malaria Control was launched January 2014 for Integrated Vector Control (IVC). The most recent results (2014) proved that the level of resistance in human health protection was not as high as that of the agricultural pests, and the situation up to March 2014 was under control and manageable, especially with the pyrethroids deltamethrin, permethrin and the carbamate bendiocarb in almost all the states.

Concerning the alternatives for mosquito control, powders of leaves, seeds, flowers and bark of more than 25 Sudanese plants (trees, shrubs, weeds and spices), in addition to the laboratory-prepared extracts, proved to be very effective in controlling the aquatic stages of Anopheles and Culex (not < 90% larval mortality).

The BNNICD team, in collaboration with NMP agreed to start in 2014 two programs regarding Anopheles mosquitoes, the first on gene mapping and sequencing in all Sudanese state and the second regarding mapping the resistance in all states to the commonly used and the recommended but not used insecticides, and the agricultural insecticides.

Sudan tries to engage itself also in regional research, though these attempts are always successful. That was the case of BNNICD which, together with the University of Nairobi (Kenya) and University of Makerere (Uganda), have applied to the TDR 2013 grant ($400,000) under the project of studying the mechanism(s) of resistance in malaria vectors at the molecular level in the three countries. Unfortunately, the response was negative because more information on the statistical analysis was needed. Nevertheless, the project proposal will be presented to other local or international donors.

Sudan, through BNNICD has established M.Sc. and Ph.D. programs, in collaboration with W.H.O for Medical Entomology and Vector Control (18 months; modules + Thesis). Two regional batches of trainees and three Sudanese batches have already graduated. The thesis topics covered the alternatives, susceptibility, awareness and awareness –raising, surveys, biology, ecology, behaviour, conditions in each state conducive to malaria, mitigation, IVC, IVM, policies, natural enemies, screening, etc.

Training workshops are planned be held on molecular genetics and genetic engineering at BNNICD in collaboration with the University of Makerere, Uganda, aiming at building the capacities of the NMP affiliates and researchers in the research centres, institutes and universities.

2.3.4.5. Storage, release and contaminated sites and

The current storages of POPs pesticides (including DDT stocks) and of other pesticides in Sudan are not appropriate (see *2.3.7.*). In the last approx. 10 years of Stockholm Convention implementation this situation has not improved due to the lack of funding. Many of the storage sites are closely located to irrigation channels and they are not protected against flooding. Areas where DDT has been applied can be expected to contain elevated DDT levels. Areas where DDT has been frequently applied and areas where DDT has been stored or formulated can be highly contaminated and should be considered in the action plan.

See also section *2.3.7. Information on the state of knowledge on stockpiles, contaminated sites and wastes, identification, likely numbers, relevant regulations, guidance, remediation measures, and data on releases from sites.*

2.3.4.6. Potential impacts and socio economic

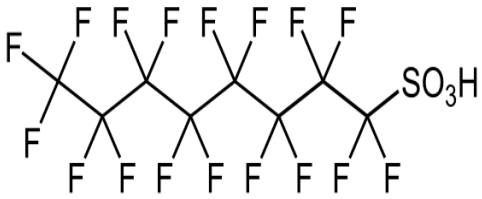
Currently and in the last 10 years DDT have not been used in Sudan and other approaches (chemical alternatives and alternative vector control) were used for control of Malaria vector. The ban avoiding potential illegal use of DDT must be strictly enforced.

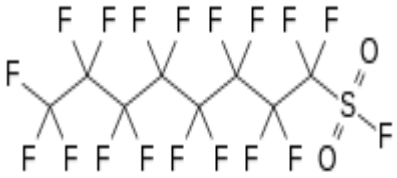
2.3.5. Assessment of PFOS, its salts and PFOSF POPs (Annex B, Part III chemicals)

2.3.5.1. General

Perfluorooctane sulfonic acid (PFOS), its salts and perfluorooctane sulfonyl fluoride (PFOSF) are fully fluorinated compounds and generally known as perfluorooctane sulfonate (PFOS). They are commonly used as salts or incorporated into larger polymer. Perfluorooctane sulfonyl fluoride (PFOSF) is used as an intermediate to produce different PFOS related substances. PFOS can be formed by degradation from a

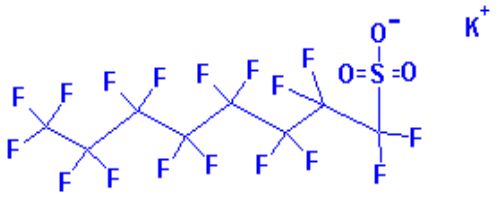
large group of derivative substances known as PFOS related substances[63]. PFOS structural formula, (Fig. 5), contains with eight-carbon chain length, which may be simple salts of PFOS (e.g. Potassium, Lithium, Ammonium, and Diethanolmine).





PFOS- acid ($C_8H_{17}O_3S$)

PFOSF – Fluoride salt ($C_8HF_{18}O_3S$)



PFOS- Potassium salt (C_8 $HF_{17}O_3S.K$)

Figure 5 - Structural formula of the PFOS, PFOSF, PFOSK

The spatial structure of the PFOS anion is shown in Figure 6.

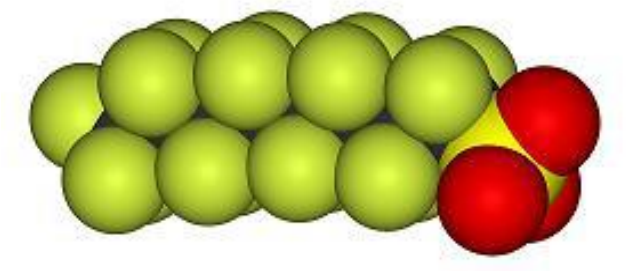


Figure 6 - Spatial structure of PFOS anion

PFOS and its salts have been used in different industrial and consumer applications and products since 1950s. The perfluorinated carbon chain has both hydrophobic and lipophobic properties. They can repel grease, dirt as well as water. These unique properties make them valuable as surface active substances. PFOS and related substances are produced since 1950s. Historically the major global manufacturer is the American 3M Company with subsidiaries in Europe. In 2003 this company voluntary stopped the production of PFOS. Since then, PFOS has been phased out for several uses in some regions. The

[63] Many PFOS-related chemicals are not specified in Annex B. PFOS-related chemicals are chemicals that contain the structural element PFOS in their molecular structure and are or were produced with PFOSF as starting or intermediate material. These chemicals are covered through the listing of PFOSF.

production amount dropped from approximately 4,500 tonnes to about 100 to 200 tonnes mainly produced in China with minor production in Germany. However, still PFOS is found in high concentration in different environmental samples of surface water, sediment and biota, breast milk and food. They are practically non-degradable and toxic and bio-accumulative in the environment.

PFOS and PFOS related substances have been listed as persistent organic pollutants under Annex B of SC in 2009. The Convention requires the government to include them in their NIP and to report every four years on progress made to eliminate them. Therefore, government authorities should conduct inventories to assess releases from relevant sources and the stockpiles. The government should also address the use, storage and disposal of PFOS and assess the possible need of exemptions and available alternatives.

Table 10 - PFOS compound included in Stockholm Convention

PFOS chemical	**CAS No.**	**Molecular Formula**	**Activity**	**Acceptable purpose/Specific exemption**
Perfluorooctane sulfonic acid (PFOS)	1763-23-1	C8HF17O3S	Production	*Acceptable purpose:* In accordance with part III of this Annex, production of other chemicals to be used solely for the uses below. Production for uses listed below. *Specific exemption:* As allowed for the Parties listed in the Register.
Perfluorooctane sulfonyl fluoride (PFOSF)	307-35-7	C8F18O2S		
Potassium perfluorooctane sulfonate (PFOS.K)	2795-39-3	C8HF17O3S.K	Use	*Acceptable purpose:* In accordance with part III of this Annex for the following acceptable purposes, or as an intermediate in the production of chemicals with the following acceptable purposes: • Photo-imaging • Photo-resist and anti-reflective coatings for semi-conductors • Etching agent for compound semi-conductors and ceramic filters • Aviation hydraulic fluids • Metal plating (hard metal plating) only in closed-loop systems
Lithium perfluorooctane sulfonate (PFOS.Li)	29457-72-5	C8HF17O3S.Li		
Ammonium perfluorooctane sulfonate (PFOS.NH3)	29081-56-9	C8HF17O3S.H3N		
Diethanolammonium perfluorooctane sulfonate (PFOS-DEA)	70225-14-8	C8HF17O3S.C4H11NO2		
tetraethyl ammonium	56773-42-3	C8H20N.C8F17O3S		

perfluorooctane sulfonate (TeEt-PFOS)				• Certain medical devices (such as ethylene tetrafluoroethylene copolymer (ETFE) layers and radio-opaque ETFE production, in-vitro diagnostic medical devices, and CCD colour fi lters) • Fire-fighting foam • Insect baits for control of leaf-cutting ants from *Atta spp.* and *Acromyrmex spp.* *Specific exemption:* For the following specific uses, or as an intermediate in the production of chemicals with the following specific uses: • Photo masks in the semiconductor and liquid crystal display (LCD) industries • Metal plating (hard metal plating) • Metal plating (decorative plating) • Electric and electronic parts for some colour printers and colour copy machines • Insecticides for control of red imported fire ants and termites • Chemically driven oil production • Carpets • Leather and apparel • Textiles and upholstery • Paper and packaging • Coatings and coating additives • Rubber and plastics.
Didecyldimethylammonium perfluorooctane sulfonate	251099-16-8	-		

Source: Stockholm Convention website

The unique surface active properties of PFOS make them of popular use for many applications. The main uses were/are:

- Fire-fighting foams;

- Aviation hydraulic fluids;
- Synthetic carpets;
- Impregnation of leather and leather goods;
- Impregnation of textiles and furniture;
- Impregnation of packaging (paper/cardboard);
- Cleaning agents, waxes and polishes for cars and floors;
- Surface coating, paint and varnish;
- Oil production and mining;
- Textile impregnation and surface protection;
- Photographic industry;
- Electrical and electronic parts;
- Semiconductor industry;
- Pesticides;
- Medical devices;
- Metal plating (non-decorative and decorative).

2.3.5.2. Production

According to the inventory report, PFOS and related substances are not manufactured in Sudan. Information received from the industries producing surfactants, papers protection and performance chemicals like acid mist suppressants, etc. indicated no industry manufacturing/formulating products or articles containing PFOS or its related substances exist in Sudan.

2.3.5.3. Import

Most of the consumer products and articles containing PFOS enter into the country through import but none of them was identified during the inventory due to the non-existing HS codes.

2.3.5.4. Export

No export of PFOS and PFOS containing articles and products from Sudan.

2.3.5.5. Use and stocks

A. PFOS and its related substances in industrial sectors

According to the inventory report, the suspected industries which are most likely use PFOS and further investigated are: oil and gas industry; mining; detergents production; and metals plating.

1. Chemicals use in driven oil and gas production

Many oil well drilling additives are used as surfactants in oil fields in the country. Information about types and quantities of surfactants used in mining was obtained from custom department and companies working in that field. Also, a list of chemicals used as additives in oil wells drilling was obtained from companies working in the field of oil exploration and production. The list indicated that they all use hydrocarbons and inorganic salts. The composition of additives is either Cox and various hydrocarbons or

some inorganic salts like CaO, NaOx, POx and chlorides. It could not be established if PFOS related substances were used in oil extraction.

2. Mining industries

No large mining industry operates in the country. The artisanal-small scale gold mining activity is highly practiced in different regions in the country for last five years. However, the process is very traditional and only elemental mercury is used for gold extraction and purification.

3. Detergent production

The surfactants used by a single existent company were investigated and found to be non-fluorinated compounds.

4. Metal plating

No metal plating industry exists in Sudan.

5. Consumer products and articles

Production for impregnation of packaging (paper/cardboard), cleaning agents, waxes and polishes for cars and floors, surface coating, paint and varnish textile impregnation and surface protection are not present in Sudan. Also metal/plastic plating, photographic industry, production of electrical and electronic parts, semiconductor industry, and production of medical devices are not present in Sudan.

Therefore, these industries are at the moment considered of no relevance.

B. Articles and products containing PFOS and its related substances on the consumer market

The following products and articles were further investigated for presence of PFOS and its related salts: synthetic carpets, car polish, cosmetics, household products, sport clothes, food packaging materials, textile and upholstery and toner and printing inks.

The inventory report concluded that stakeholders have no knowledge about the properties and chemicals content of their products. The investigations carried out could not establish if products and articles would contain PFOS and its related substances. However, this should not be taken as an indication of absence of PFOS. In particular in synthetic carpets made from polyacryl and other impregnated goods produced before 2002 (when 3M production stopped) PFOS can be expected. In the future, based on the availability of resources, samples screening should be done for verification of presence of PFOS and its related substances in the suspected products and articles, in particular old synthetic carpets which will still be in use for the next 15-20 years. The subject of analysis will be included in the action plan.

C. Fire-fighting foams, hydraulic fluids and insecticides containing PFOS and related substances

According to the information from the responsible national authority, the National Pesticides Council, sulfuramid or other insecticides containing PFOS are not registered in Sudan.

Concerning the fire-fighting foams inventory, Tables 11, 12 and 13 show the amount of foams hold in stockpiles by different stakeholders, PFOS-based foam used in 2012, the training sites and the quantity used by different categories for training.

For a conservative assessment for this inventory all AFFF was assumed to contain PFOS and its related substances. This is a reasonable assumption as most foam was imported from countries still producing foams containing PFOS.

In calculation of PFOS released during training exercises the worst-case scenario is taken by considering that foams used in training at these sites are PFOS-containing foams.

Table 11 - Quantity of PFOS in stockpiles

Professional user	Stockpiles of PFOS-based foam in litres (Kg)	Quantity of PFOS in stockpiles in Kg
Private companies involved on petroleum operations	88,800 (90,576)	Low 452.88 High 1,358.64
Sudanese Company to Generate Heat & Power	11,200 (11,424)	Low 57.12 High 171.36
Airports	62,400 (63,648)	Low 318.24 High 954.72
Traders (main suppliers)	2,000 (2,040)	Low 10.2 High 30.6
Total	**164,400 (167,688)**	**Low 838.44** **High 2,515.32**

Source: PFOS Inventory Report

Table 12 - Quantity of PFOS emitted in 2012

Professional user	PFOS-based foam used in 2012, in litres (Kg)	Quantity of PFOS emitted in 2012 in Kg
Private companies involved on petroleum operations	600 (612)	Low 3.06 High 9.18
Sudanese Company to Generate Heat & Power	20,000 (20,400)	Low 102.0 High 306.0
Airports	7,424 (7,572.48)	Low 37.86 High 113.59
Heglig	600 (612)	Low 3.06 High 9.18
Total	**28,624 (29,196.48)**	**Low 145.98** **High 437.95**

Source: PFOS Inventory Report

Table 13 - Quantity of PFOS from use of foam in training exercises

City (training location)	Quantity of PFOS base foam used in litre (Kg)	Quantity of emission in Kg
Khartoum	300 (306)	Low 1.53 High 4.59
Ad Damazin	200 (204)	Low 1.02 High 3.06
Kassala	200 (204)	Low 1.53 High 4.59
Al Junaynah	1,000 (1020)	Low 5.1 High 15.3
Al Fashir	300 (306)	Low 1.53 High 4.59
Al Daba	400 (408)	Low 2.04 High 6.12
Wadi Halfa	100 (102)	Low 0.51 High 1.53
Al Ubayyed	300 (306)	Low 1.53 High 4.59
Dongola	36 (36.72)	Low 0.18 High 0.55
Atbarah	200	Low 1.02 High 3.06
Kadogli	400 (408)	Low 2.04 High 6.12
Neyala	600 (612)	Low 3.06 High 9.18
Total	**4,036 (4116.72)**	**Low 20.58 High 61.75**

Source: PFOS Inventory Report

Private companies involved in petroleum operations have large quantities of stockpiles of PFOS-based foams. Sudanese Company to Generate Heat & Power is the largest user, its annual consumption varies from 600 to 6,000 litres related to frequency of incidents.

None of the respondents answered to the question on PFOS content and concentration of the products they use. No waste management plan of spills or expired products exists.

All respondents reported that they do not hold expired foams. The labels on containers of AFFF have no specification whether the foams contain PFOS-based substances or other fluorinated compounds. The countries from which foams are imported are China, India and United Arab Emirates.

Records about the stockpiles are considered to be reliable. However, there are no records about historic use. Most of users keep some of their stockpiles for more than ten years and this mainly due to low frequency of use.

Two training sites, Al Junaynah and Neyala, used large amount of foam compared to other sites, but there is no information about the type of foam used. Both sites, located on western part of the country, should be given priority as contaminated sites.

The amount of foams in the airports stockpiles is relatively high, the explanation being that it is kept for emergency situations. It can also be used by civil defence authorities for any emergency outside the airport premises. No information about fire-fighting foam held by the Armed Forces was identified.

In respect to hydraulic fluids, the main professional users considered in the inventory were Arm force, air ports and private companies.

The two stakeholders, arm force and airport authorities, had no idea about chemicals content of their purchased products. They had also no information about the concentration of PFOS in the brands they use. None of them provided information about the historical use of hydraulic fluid. No reply has been received from the private airlines. According to information obtained from the Custom Department the quantity of aviation hydraulic fluids entered the country in the last ten years was around 5 tonnes. This figure was used in the inventory.

According to the material safety data sheet the density of the fluid used is 0.887. This value was used to estimate the amount of fluid into kilogram instead of using litre unit. Because there was no information about PFOS concentration in the brands, the range of concentration in the UNEP guideline was used for the calculation of PFOS in the aviation hydraulic fluids.

Table 14 below summarize the estimated amount of PFOS and its related substances in the aviation hydraulic fluids used in 2013, as well as the amount of aviation hydraulic fluids containing PFOS and its related substances in stockpile at the level of 2013.

Table 14 - Stockpiles and PFOS (Kg) historical emission of aviation hydraulic fluid

User	Quantity of PFOS in aviation hydraulic fluid used in 2013		Quantity of PFOS in stockpile		
			Stockpile at the level of 2013		In last 10 years
Arm force	Low	55.44	Low	19.96	
	High	110.88	High	39.92	
Sudan Airways	Low	22.18	Low	19.96	
	High	44.35	High	39.92	
Private airlines	Low	49.63	Low	16.54	
	High	99.25	High	33.08	

Total	**Low** **High**	**127.25** **254.48**	**Low** **High**	**56.46** **112.92**	**Low** **749.62** **High** **1,499.23**

Source: PFOS Inventory Report

2.3.5.6. Use of PFOS alternatives

Alternatives to PFOS containing foams are globally available and will also be used in Sudan. The area of potential PFOS use in the country are fire-fighting foams. For this application several producers offer alternatives.

Other uses where substitution might need some technical modification (e.g. chromium plating or semiconductor industry) are not present in Sudan.

The use of PFOS for oil drilling could not be confirmed yet. The chemicals used as additives in oil wells drilling were obtained from companies working in the field of oil exploration and production. The list indicated that they all use hydrocarbons and inorganic salts. The composition of additives is either Cox and various hydrocarbons or some inorganic salts like CaO, NaOx, POx and chlorides. For the specific improvement of oil extraction the use of PFOS is not specifically required and therefore there should be a range of alternatives.

2.3.5.7. Registration and control

Fire fighting foams are considered most relevant for control of import and use.

The custom authority keeps records on fire-fighting foam suspected to contain PFOS (AFFF foams and other foams used for hydrocarbon fires). The General Civil Defence Administration is responsible for registration in Sudan of all imported fire-fighting foams, their uses and fire controls.

The National Pesticides Council, the responsible national authority for the registration and control of pesticides in Sudan. Sulfluramide has not been registered in Sudan.

There is no established authority for the investigation and analysis to monitor suspected products for PFOS content.

2.3.5.8. Storages, release and contaminated sites

PFOS are still in stocks in fire fighting foams and most probably in synthetic carpets and other articles in use in which PFOS has been used for impregnation. The use of fire-fighting foams has released and is still releasing PFOS to the environment contaminating soil, ground and surface water.

Areas where PFOS have been released in the past can be regarded as potentially PFOS contaminated sites. It includes the fire fighting practice areas and areas where fires have been extinguished with foams containing PFOS and related chemicals.

Also dumpsites where articles have been disposed containing PFOS can release PFOS and create contaminated hot spots.

No evidence for PFOS use in oil drilling was identified during the inventory preparation but it need to be further assessed.

See also section *2.3.7. Information on the state of knowledge on stockpiles, contaminated sites and wastes, identification, likely numbers, relevant regulations, guidance, remediation measures, and data on releases from sites.*

2.3.5.9. Potential impacts of PFOS and socio economic consideration

PFOS and related chemicals are threat for young woman's reproductive health as PFOS exposure may lead to subfecundity[64]. However, it seems that also the reproductive health of men are impacted by PFOS (The lower sperm quality in young Danish men showed a correlation with PFOS (and PFOA) levels[14] .).

PFOS and related chemicals contaminate ground water and surface water. In South Africa very high PFOS and PFOA contamination have been discovered in major rivers at levels up to 182 ng/l[65]. This shows that African countries also have a risk of surface water pollution. Initial measurements of PFOS in the Nile in Egypt showed relatively low values (< 1 ng/l) in 2010.[66] Since developing countries can hardly afford the removal of PFOS and related substances in drinking water treatment a precautionary approach is needed to prevent contamination.

The use of PFOS in fire fighting foams resulted in contaminated sites. Due to the very high persistence (no natural degradation is known) those sites could be considered in long term polluted. The remediation of PFOS contamination in soils and ground water is a challenge even for industrialized countries. Therefore, it was decided to restrict the use of PFOS containing fire fighting foams.

Considering the toxic effects of PFOS, its persistence and related contamination risk, as well as the availability of alternatives, it was decided not to request exemptions for PFOS and related substances.

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

2.3.6.1. General

Polychlorinated dibenz*o-p*-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) (Figure 7) together with polychlorinated biphenyls (PCBs), hexachlorobenzene (HCB), and pentachlorobenzene (PeCB) are listed in Annex C of SC as unintentionally produced POPs (UPOPs) often also called "by-products". PCBs,

---

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

65 Mudumbi, J.B.N., Ntwampe, S.K.O., Muganza, F.M., Okonkwo, J.O., 2013. Perfluorooctanoate and perfluorooctane sulfonate in South African river water. Water Science & Technology doi:10.2166/wst.2013.566

66 Mahmoud, Manal Abdalla Mohamed (2010) Studies on levels of some perfluorinated compounds and heavy metals os health significace that pollute the water of river Nile in Egypt.

HCB and PeCB have been industrially produced and used in several applications. PCDD/Fs were not produced commercially[67], and they have no known use[68].

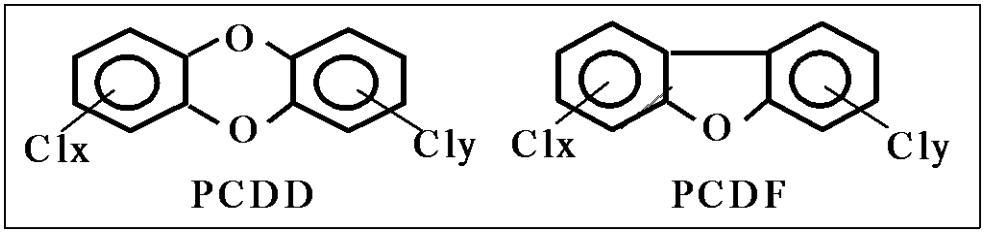


Figure 7 - Structure of the PCDD and PCDF molecule

Formation of PCDD/Fs and the other UPOPs and/or releases arises mainly from four types of sources. Three releases are process related:

- Chemical production processes – production of chlorine, chlorinated phenols and other chlorinated aromatic compounds, production of chlorinated solvents and oxychlorination of mixed feeds to make certain chlorinated solvents, use of chlorine in industrial process like production of magnesium or titanium oxide using elemental chlorine, pulp and paper using elemental chlorine for chemical bleaching;

- Thermal and combustion processes: destruction of POPs and other organochlorine containing waste, general incineration of wastes, thermal processing of metals in particular metal production from metal scraps;

- Biogenic processes or photolytic processes, which can form PCDD/PCDF from precursors mostly of anthropogenic origin such as pentachlorophenol and some other chlorinated aromatic pesticides[69]. Also degradation of certain organochlorines can form unintentionally produced POPs e.g. pentachloronitrobenzene (Quintozene) is partly degrading to UPOP PeCBz and is considered one of the largest sources of PeCBz.[70]

The fourth and probably the largest source is related to historic releases of PCDD/F and related contamination[71]:

- Reservoir sources from production and application of organochlorine pesticides/chemicals and landfills/dumps of wastes containing PCDD/F and other UPOPs. Historic PCDD/F inventories reveal that they have exceeded by far the documented releases from contemporary sources[71]. This can

[67] With the exception of analytical standards.

68 UNEP (2013) Toolkit for Identification and Quantification of Releases of Dioxins, Furans and Other Unintentional POPs under Article 5 of the Stockholm Convention on Persistent Organic Pollutants. Geneva (toolkit.pops.int).

69 Holt E, Weber R, Stevenson G, Gaus C (2012) Formation of dioxins during exposure of pesticide formulations to sunlight. Chemosphere, 88, 364–370.

70 Stockholm Convention document from the 6th POP Reviewing Committee meeting (UNEP/POPS/POPRC.6/INF/21)

71 Weber R, Gaus C, Tysklind M et al. (2008) Dioxin- and POP-contaminated sites—contemporary and future relevance and challenges. Env Sci Pollut Res 15, 363-393.www.springerlink.com/content/0q10km8582605r1x/fulltext.pdf

e.g be illustrated by the historic PCDD/F inventory compiled for Japan[72]. PCDD/F contamination from pesticide use between 1950 and 1998 in Japan alone was estimated at 460 kg TEQ (see Figure 8). Also the historic PCDD/F inventory from wood treatment in Sweden alone resulted in historical releases of between 205 and 250 kg TEQ.[73] By comparison, contemporary releases of PCDD/F from a total of 55 countries combined have been estimated at approximately 20 kg TEQ/year[74]. Similarly, this estimated contemporary inventories releases can be compared to other historic PCDD/PCDF releases, such as the release of 333 to 854 kg TEQ from a single factory producing HCH and 2,4,5-Trichlorophenoxyacetic acid (2,4,5-T) in Hamburg[75].

- Also in respect to HCB and PeCBz inventories, the contaminated sites, stockpiles and wastes exceed current releases by orders of magnitudes. HCB/PeCBz wastes have been disposed/stored in the order of 10,000 tonnes at single factories producing chlorinated solvents (tetrachloroethene, trichloroethene, tetrachloromethane, EDC etc.).[76]
- Also soils and sediments having accumulated PCDD/F and other UPOPs over the past 100 years of releases from PCDD/F sources are secondary sources. In countries where PCDD/F monitoring (human milk or food survey) has been performed for two or three decades, a significant decline of PCDD/F levels have been observed which can be explained mainly by stopping production of certain chlorinated organics like pentachlorophenol (PCP), 2,4,5-T or PCB and improvement and control of PCDD/F in pesticide and biocide products (see Figure 8). BAT/BEP measures in e.g. incinerators or metal industries also contribute to the reduction. The PCDD/F contaminated sites, soils and sediments from past PCDD/F release are still relevant for food contamination (e.g. fishes, chicken/egg, grazing cattle, and milk and dairy products) [68,71].

72 The historic PCDD/F inventory of Japan does not include the PCDD/F deposits from organochlorine/chlorine production.

73 Swedish Environmental Protection Agency (2005): Survey of sources of unintentionally produced substances. Report for the Swedish Government.

74 Fiedler H (2007): National PCDD/PCDF release inventories under the Stockholm Convention on Persistent Organic Pollutants. Chemosphere 67, 96-108.

75 Götz R, Sokollek V, Weber R (2013). The Dioxin/POPs legacy of pesticide production in Hamburg: Part 2: Waste deposits and remediation of Georgswerder landfill. Env Sci Pollut Res. 20, 1925-1936

76 Stockholm Convention (2010) SC document from the 6th POP Reviewing Committee meeting (UNEP/POPS/POPRC.6/INF/21).

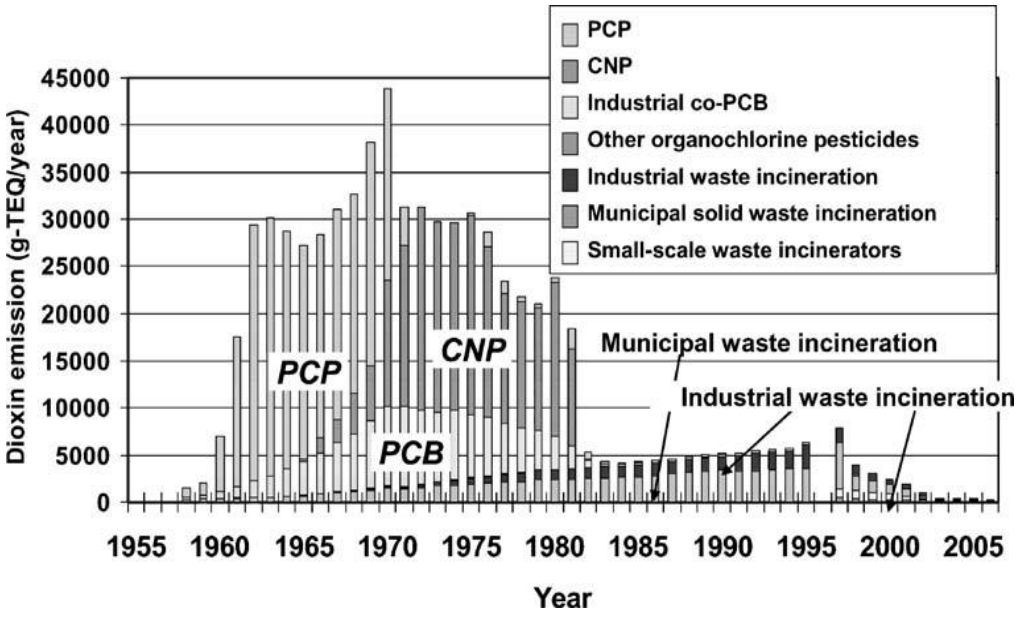


Figure 8 - Historic Japanese PCDD/Fs (WHO TEQ) inventory. The main pesticide application and air emission from thermal sources as well as release to the Japanese environment[77] (The PCB inventory includes only the release, not the production which is estimated for Japan alone to 470 kg TEQ[78])

2.3.6.2. Stockholm Convention obligation in respect to Dioxins/UPOPs (Article 5)

The framework for the action plan for dioxins and other annex C chemicals is given by the obligations of Article 5 of the Convention, as following:

- **Article 5** of the SC, covering the measures to reduce and eliminate releases from unintentional production states that each Party shall at a minimum take the following measures to reduce the total releases derived from anthropogenic sources of each of the chemicals listed in annex C, with the goal of their continuing minimization and, where feasible, ultimate elimination (paraphrased and summarized):

- **Article 5(a):** Develop an action plan with the elements 5a (i-v) to facilitate its implementation (subparagraph (b) to (e)

- **Article 5(a) (i):** Evaluate current and projected releases, including the development and maintenance of source inventories and release estimates, taking into consideration the source categories identified in annex C.

- **Article 5(a)(ii):** Evaluate the efficacy of laws and policies to manage releases.

77 From Weber, Gaus, Tysklind et al. Env Sci Pollut Res 15, 363-393 (2008).
78 Takasuga T, Kumar KS, Noma Y, Sakai S (2005): Chemical Characterization of Polychlorinated Biphenyls, -Dibenzo-p-Dioxins, and -Dibenzofurans in Technical Kanechlor PCB Formulations in Japan Arch. Environ. Contam. Toxicol. 49, 385–395

- **Article 5(a)(iii):** Identify strategies to meet dioxin reduction obligations, taking into account the evaluations in (i) and (ii).
- **Article 5(a)(iv):** Take steps to promote education and training and raise awareness of the strategies.
- **Article 5(a)(v):** Review, evaluate and report on strategies every five years in meeting release reduction obligations.
- **Article 5(a)(vi)**: Develop a schedule for implementation of the action plan, including the strategies and the measures identified in them.
- **Article 5(b):** Promote the application of available, feasible and practical measures that can readily achieve a realistic and meaningful level of release reduction or source elimination.
- **Article 5(c):** Promote the development and use of substitute or modified materials, products and processes to prevent the release of annex C chemicals.
- **Article 5(d):** Promote and as soon as practicable require BAT/BEP for new installations (sources) listed in Annex C Part II.
- **Article 5(e):** Promote BAT/BEP for existing installations (sources) listed in annex C Parts II and III and for new sources listed in Annex C Part II.

2.3.6.3. Inventory of PCDD/PCDF and other unintentionally produced POPs

The purpose of the inventory was to evaluate the Sudanese situation concerning the releases and presence of the two most relevant unintentionally formed persistent organic pollutants (POPs) classes (dioxins and furans) and where toolkit information was available also on hexachlorobenzene (HCB) and polychlorinated biphenyls (PCB) releases.

The inventory has been conducted by the Sudanese dioxin task team using the "Toolkit for Identification and Quantification of Releases of Dioxins, Furans and Other Unintentional POPs" updated by UNEP Chemicals in 2013[68]. The Toolkit assists countries in identifying sources and estimating releases of dioxins and furans. The procedures proposed by the toolkit and used by the project team is the five step approach:

1. Apply Screening Matrix to identify Main Source Categories;

2. Check source categories to identify existing activities and sources in the country;

3. Gather detailed information on the processes and classify processes into similar groups by applying the Standard Questionnaire;

4. Quantify identified sources with default/measured emission factors;

5. Apply nation-wide to establish full inventory and report results using guidance given in the standard format;

The estimated emissions and concentrations, which have been determined, are presented for each source category and subcategory. The investigated source categories included: waste incineration; ferrous and non-ferrous metal production; power generation; production of mineral products; the transport sector; biomass burning; production and use of chemicals and consumer goods; miscellaneous, disposal; and hot spots.

The quantities of dioxin and furan releases from source categories are summarized in Table 15. An estimated 194 g TEQ PCDD/PCDF was released in 2012. Open burning processes had the largest impact with an emission of 158.4 g TEQ/a, which is 81.6% of total emission. The main contributing source categories were forest fire with an estimated emission of 63.1 g (32.5% of total emission), followed by open burning of waste 51.8 g TEQ (26.7% of total emission) and agriculture residue burning (37.3 g; 19.2.% of total emission).

Other sources contributing to the total emission in the percent range were from category 2 ferrous and non-ferrous production (12.3 g; 6.3% total emission) and from category 3 heat and power generation (3.1 g; 1.6% total emission).

The releases to the 5 compartments/media – air, water, land, residues and products– were assessed. According to the toolkit approach, the main emission vectors were to air (155.1 g; 80.0% of total emission) and land (20.7 g; 10.8% of total emission) with minor releases to residue (10.6 g, 5.5% of total emission), product (7.6 g; 3.9% of total releases) and water 0.0 g (Figure 9). However, since PCDD/PCDF are semi-volatile compounds and can transgress from one media to another the emission vectors only give an idea of the direct releases from the sources and not of the final contamination.

Table 16 contains a preliminary inventory of unintentional PCB and HCB emission in Sudan where emission factors were available in the UNEP Toolkit.

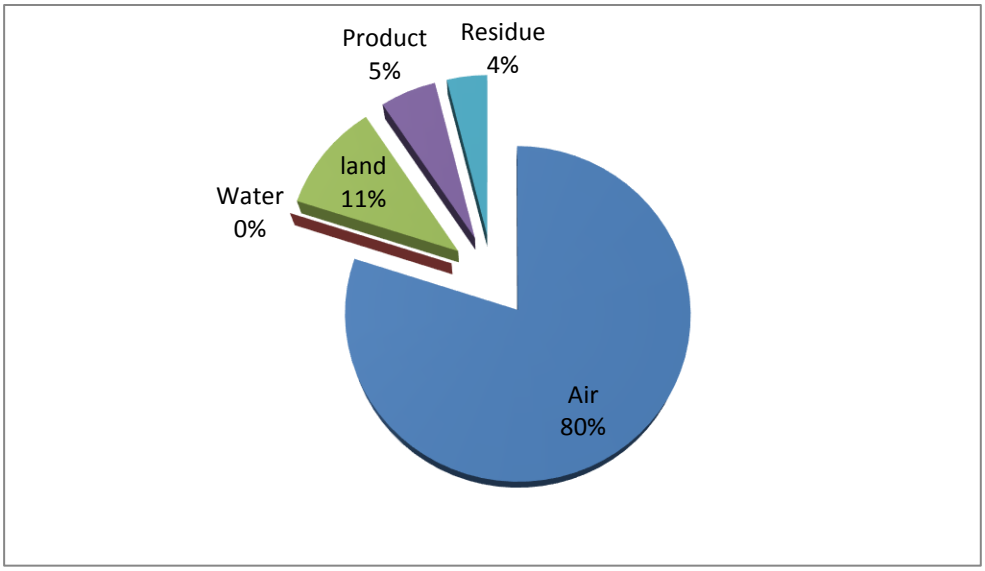


Figure 9 - Composition of overall releases of PCDD/F in Sudan per each vector

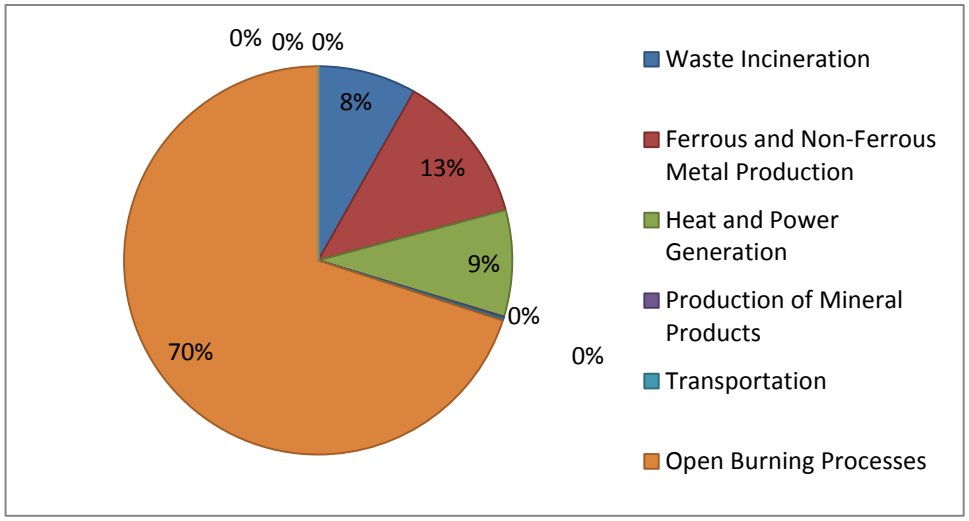


Figure 10 - Breakdown of potential releases to air

Table 15 - Summary of PCDD/PCDF Releases (inventory on 2012)

Group	Source Groups	Annual Releases (g TEQ/a)						
		Air	Water	Land	Product	Residue	Total	%
1	Waste Incineration	8.0	0.0	0.0	0.0	0.0	8	4.12
2	Ferrous and Non-Ferrous Metal Production	5.7	0.0	0.0	0.0	6.6	12.3	6.34
3	Heat and Power Generation	2.9	0.0	0.0	0.0	0.2	3.1	1.60
4	Production of Mineral Products	0.3	0.0	0.0	0.0	0.0	0.3	0.15
5	Transportation	0.6	0.0	0.0	0.0	0.0	0.6	0.31
6	Open Burning Processes	137.7	0.0	20.7	0.0	0.0	158.4	81.65
7	Production of Chemicals and Consumer Goods	0.0	0.0	0.0	6.9	0.0	6.9	3.56
8	Miscellaneous	0.0	0.0	0.0	0.0	0.0	0	0
9	Disposal	0.0	0.0	0.0	0.7	3.8	4.5	2.32
10	Identification of Potential Hot-Spots				0.0	0.0	0	0
1-10	**Total**	**155.1**	**0.0**	**20.7**	**7.6**	**10.6**		
	Grand Total	**194**						

Source: UPOPs Releases Inventory Report

Table 16 - Summary of releases of unintentionally produced PCB and HCB in Sudan from emission factors available in the toolkit* (inventory on 2012)

Source	PCB annual release g TEQ/a		HCB Annual release g /a	
	Air	Land	Air	Land
Aluminium production	0.054		0.675	
Thermal wire reclamation	0.042			
Household heating and cooking with biomass	0.011	0.001		
Agriculture residue impacted	4.79	0.48		
Agriculture residue impacted	0.047	0.001		
Sugarcane burning	0.01	0.002		
Forest fire	2.278			

Source: UPOPs Releases Inventory Report

* Please note that for most processes no emission factors for unintentionally HCB and PCB and has been assigned and that therefore this is an underestimation of releases.

Table 17 - Summary of PCDD/PCDF releases of the baseline inventory (inventory for 2004)

Group	Source Groups	Annual Releases (g TEQ/a)						
		Air	Water	Land	Product	Residue	Total	%
1	Waste Incineration	8.1	0.0	0.0	0.0	0.0	8.1	6.00
2	Ferrous and Non-Ferrous Metal Production	12.5	0.0	0.0	0.0	0.8	13.3	9.85
3	Heat and Power Generation	8.8	0.0	0.0	0.0	0.0	8.8	6.52
4	Production of Mineral Products	0.2	0.0	0.0	0.0	0.0	0.2	0.15
5	Transportation	0.2	0.0	0.0	0.0	0.0	0.2	0.15
6	Open Burning Processes	69.3	0.0	10.1	0.0	0.0	79.4	58.81
7	Production of Chemicals and Consumer Goods	0.0	0.0	0.0	24.0	0.0	24.0	17.78
8	Miscellaneous	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	Disposal	0.0	0.0	0.0	0.0	0.6	0.6	0.44
10	Identification of Potential Hot-Spots				0.0	0.0	0.0	0.0
1-10	**Total**	**99.0**	**0.0**	**10.1**	**24.0**	**1.4**		
	Grand Total	**135**						

Source: UPOPs Releases Inventory Report

2.3.6.4. Comparison of the updated inventory 2012 with baseline inventory from 2004

Estimated dioxins releases in 2004 were 135 g TEQ while in 2012 the estimate 194 g TEQ according this updated inventory (Tables 15& 17 and Fig. 11). The main factors contributed to this increase are:

a) Open burning processes

In the source category open burning process, releases increased by about 50%. Within this source the increases resulted mainly from forest burning (12.6 g TEQ in baseline inventory is 63.1 g TEQ in updated inventory) is 80%. There is limited awareness in Sudan on problem of wild land fire and very limited actions are taken to prevent and suppress fires. Fires set by farmers or nomads are unchallenged in most of the natural rangelands of Sudan. The rangeland seems to be everyone's property and therefore no one's responsibility.

b) Releases from Ferrous and non-ferrous metal production.

In this source the releases increased by 50%. This mainly related to high production in this sector, also the industry did not apply BAT for reducing the UPOPs releases.

c) Waste incineration

The increase is due to introduction of new medical waste incinerators. New incinerators are still using simple technology and did not use BAT/BEP technology for reducing pollutants.

d) Disposal

Increase in waste volume and introduction of composting as new source category is responsible for an increase of releases. The compost is not produced from organic waste separate at source but from the organic fraction separated from waste which has a higher emission factor[68].

e) Production of chemicals and consumer goods

A sharp decrease in the releases from production of textiles and leathers was noticed in this inventory due to reduced production capacity. According to information obtained from the concerned authorities these industries, in the last decade were affected by several economic and technical factors, the most important of which are:

- Reduction of cotton plantation in the country
- High cost of agricultural input e.g. pesticides, fertilizers
- High cost of new machines and maintenance of old machinery
- Low technical capabilities

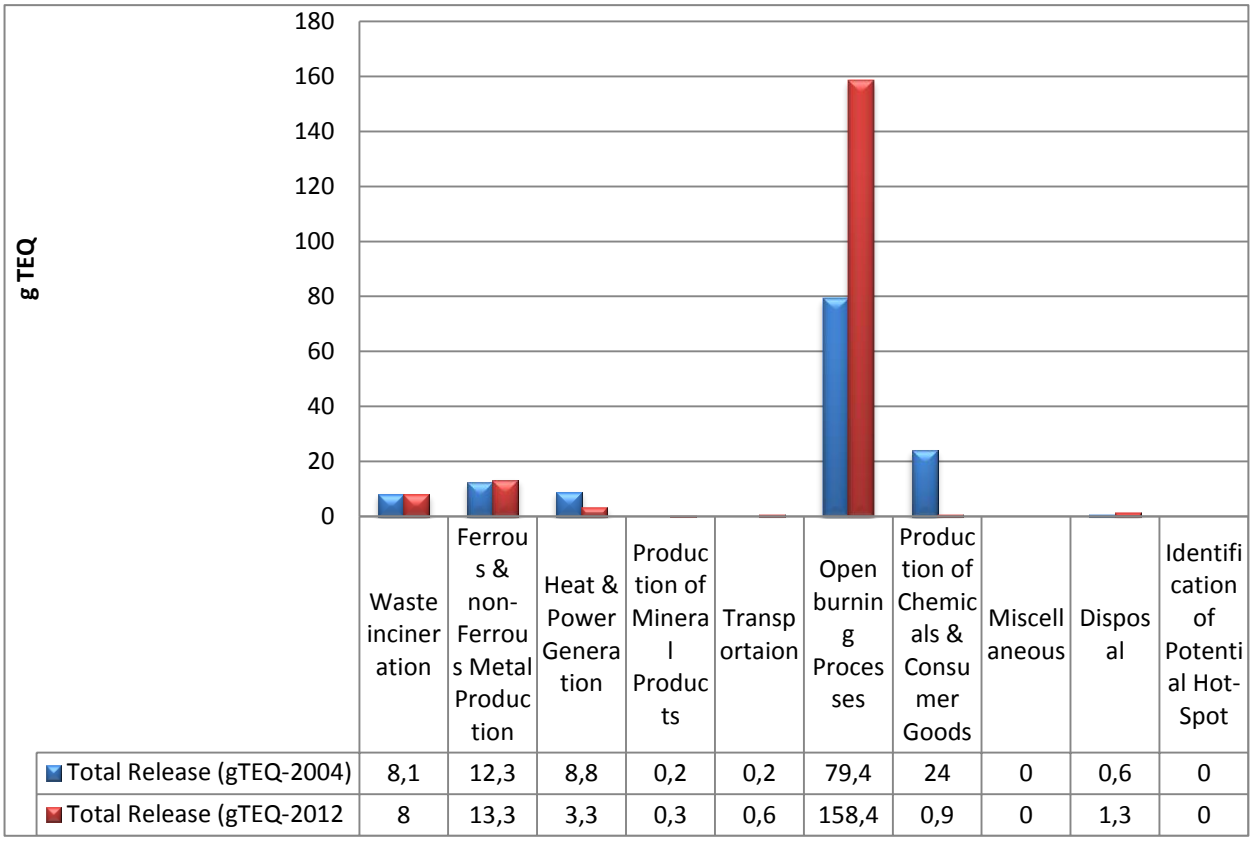


Figure 11 - Comparison of releases of baseline inventory (2004) and updated inventory (2012)

2.3.6.5. Sources not quantified in the current inventory with potential relevant releases

There are a range of uncertainties in the Dioxin inventory which should be mentioned. As for other developing countries uncertainties exist of the data quality such as the activity rates (see table 18).

The confidence in the inventory results of medical waste incineration is low because the data collected from incinerators located in clinical centres on rural areas, the exact quantities of incinerated waste are not readily available, and the frequency of incineration is not constant.

The confidence in the inventory results of aluminium production is low due to the fact that the work in this sector is not organized and it is difficult to get reliable data. The same situation can be applied to both brass and bronze production and thermal wire reclamation.

The data used for estimating releases from household heating and cooking with biomass obtained from an inventory conducted in 2009 by National Survey for Energy; hence the result in this inventory assessed has medium confidence.

There is no data compilation on bricks and lime production. The data used in this inventory obtained from the Ministry of Industry and a few theses for university degree which are not reliable enough to give high confidence in the inventory. Further detailed assessment should be carried out for future inventories.

The data on biomass burning are taken from Climate Change Project report dated back to 2003 which is the only available source of information. Comprehensive plan for collecting information needs to be undertaken in future inventory in combination with GHG emission (synergy). The same should apply to

forest fires. It is quite important because the releases from these sources have high contribution to total dioxins released (about 52%).

The confidence in inventory results from waste burned is also low because it is based on assumption made of waste generated per capita. Real data about waste managed either through burning or dumping is needed.

One uncertainty in the assessment is the total volume of waste burned and those burned on landfills though it has the second, or considering the uncertainty possibly the highest release of PCDD/F in the country.

Another uncertainty is the Dioxin contamination level of organochlorine pesticides used in Sudan. Several chemicals such as triclosan, chloranil, chlorinated paraffins or certain pigments contain unintentional POPs and listed in the 2013 toolkit, however their volume entering Sudan as chemical or as chemicals in products and articles could not be identified. A more detailed assessment needs to be done in this respect. Currently the country is importing inexpensive pesticides which might not be produced according to BAT/BEP and therefore might have elevated levels of dioxins.

Table 18 -Uncertainty assessment (level of confidence) of Sudan PCDD/PCDF Inventory 2013

Cat. No		Activity	Level of confidence		Confidence in inventory results
			Emission Factor	Data quality	
1	C	Medical waste incineration	Low	Medium	Low
	G	Destruction of animal carcasses	Medium	High	High
2	C	Iron and steel production and foundries	High (air), medium (residue)	High	High
	D	Cooper production	Medium	High	Medium
	E	Aluminium production	Medium	Low	Low
	H	Brass and bronze production	Medium	Low	Low
	I	Thermal wire reclamation	Medium	Low	Low
3	A	Fossil fuel plants	High	High	High
	B	Biomass power plants	Medium	Low	Low
	D	Household heating and cooking (biomass)	Low	Low	Low
	E	Domestic heating (fossil fuels)	High	High	High
4	A	Cement production	High	High	High
	B	Lime production	Medium	Low	Low
	C	Brick production	Medium	Low	Low
	F	Asphalt production	Medium	Medium	Medium
5	A	4-stroke engines	Medium	Medium	Medium
	B	2-stroke engines	Low	Medium	Low
	C	Diesel engines	Medium	Medium	Medium

6	A	Biomass burning		Low	Low
	1	Agricultural residue burning in the field, impacted poor burning conditions	Medium	Low	Low
	2	Agricultural residue burning in the field, impacted burning, e.g., cereal crops, not impacted	High	Low	Low
	3	Sugarcane burning	Medium	Medium	Medium
	4	Forest fires	High	Low	Low
	5	Grassland and savannah fires	Medium	Low	Low
	B	Waste burning and accidental fires		Low	Low
7	C	Petroleum industry	Medium	High	Medium
	D	Textile production	Low	Medium	Medium
	E	Leather production	Low	Medium	Medium
8	D	Dry cleaning	Low	Medium	Medium
	E	Tobacco smoking	Low	High	Medium
9	A	Landfills, waste dumps and landfill mining	Medium/low	Low	Low
	B	Sewage/sewage treatment	High	Medium	Medium
	D	Composting	High	High	High

Source: UPOPs Releases Inventory Report

2.3.6.6. Potential impacts of PCDD/F and socio economic consideration

A large part of the global population still exceeds the tolerable daily intake for PCDD/F (and dioxin-like PCB) as reported by WHO. Considering the PCDD/F (and dl-PCB) levels in the WHO survey the PCDD/F (and dl-PCB) levels in developing countries are lower compared to industrial countries[85].

PCDD/F from reservoirs including contaminated sites and hotspots represent nowadays an important source of human exposure, often through food contamination. Recent accidents involving food and animal feedstuff in Europe caused by historic PCDD/F contamination from past production of chlorinated organics and contaminated sites (Fiedler et al. 2000b, Torres et al. 2012, Weber et al. 2008) highlighting that PCDD/F could be released from these sources into the food chain.

2.3.7. Information on the state of knowledge on stockpiles, contaminated sites and waste, identification, likely numbers, relevant regulations, guidance, remediation measures, and data on releases from sites

The use and release of POPs to the environment over the last 50 years have resulted in global environmental contamination with POPs[30] and depending on the extent and duration of releases such areas were transformed into contaminated sites[68]. In this chapter the conditions of POPs stockpiles and POPs contaminated sites in Sudan are summarized for the different POPs categories.

Remediation measures have not been implemented in Sudan due to the lack of funding. The POPs releases to the environment from such sites have not been fully documented due to the limited monitoring capacity. The Contaminated site database or national inventory or remediation plan is also lacking.

2.3.7.1. POPs pesticide stockpiles and contaminated sites

Most pesticide stores in the irrigated agricultural schemes are near the irrigation canals (within < 25 m). Moreover, they are surrounded by water during the rainy-season (July to mid-October), which causes corrosion of the metal (corrugated zinc) walls of the store, and the pesticide containers. Only a few stores have been constructed properly with elevated concrete platform of least 25-50 cm. None of the visited stores have been maintained since its construction. The insides of all stores (especially the floors), with no exception, are heavily contaminated. Lighting in 90% of the stores is lacking. Ventilation in almost 70% of the stores is not provided. Bathrooms and running water are lacking in almost all of the stores. Canal water is the only available place for washing after finishing the job; this practice exposes most of the store personnel to Bilharsiasis and other water-borne diseases.

Obsolete pesticide stocks, particularly those in leaking and deteriorating containers, require immediate containment and disposal. Safe and environmentally sound disposal methods that are affordable are not yet applied in Sudan. At some of sites pesticides have been burned in the open releasing PCDD/F .Open burning and burying must not be used as these practices would pose severe pollution threats to public health and the environment.

According to the 1996 survey, obsolete pesticides barrels were collected in several stores in about 30 locations of Sudan. The 2004/2005 inventory showed that obsolete pesticides were buried (Dar Fur; Kordofan, Kassala, Abu Na'ama, Hesaheisa and others) intentionally or accidentally (sand movement).

Particular concerns are as follows:

- The surrounding of AL HASAHEISA pesticide store where a large quantity of pesticide, including POPs pesticides, are buried in the back yard of major store of Gezira agricultural scheme;
- The surrounding of Alfashir Pesticide store, North Darfur, where also large quantities of pesticides were buried; and
- Many other dismantled and /or disappeared pesticide stores in the Gezira Scheme.

In some areas, contaminated soil was packed some years ago in barrels and kept near the stores waiting for a decision to be shipped outside of Sudan for destruction. These barrels could also not be traced during the 2013 inventory. Most likely the “lost” barrels were used for other purposes.

Most of the so-called stores are in a poor conditions and rain water can leak either from the roof or through the different openings/doors/windows/ventilators. These stores must be rehabilitated as soon as possible. Guards (civilians and from security forces) are protecting pesticide stores (pesticides and fertilizers) 24 hours a day, but this measure proved to be of a short-term solution.

Empty and broken containers were found either under the shades or out-doors. During the rainy-season (July-October) the rain water washes the soil, even from the inside of stores and thus spread the contamination. Hence the quantity of the contaminated soil increased by 80% in the updated inventory (see Table 19 below). To prevent further contamination the stores must be cleaned, the collected material must be packed in barrels and sealed and the surrounding soils must be treated similarly (see action plan).

Figure 12 - Image of damaged pesticides containers

There has been no POPs pesticide remediation or destruction program in Sudan in the last 10 years. Table 19 below, shows the quantities of old and new POPs in stockpiles identified during 2013 inventory.

Table 19 - POPs pesticide stockpiles (POPs and some non-POP pesticides[79]) results for 2004/5 and update 2013 inventory and total stockpiles including empty containers (in tonnes)

Serial no.	Pesticide	2004/5	2013	Total (tonnes)
1	DDT	1.622	----	**1.622**
2	Torbidan	50.550	186.4	**236.95**
3	Heliotox	13.320	----	**13.320**
4	Aldrex-T	5.600	-----	**5.600**
5	Dieldrex-B	0.200	------	**0.200**
6	Endrin	0.180	-----	**0.180**
7	Dieldrin	0.310	0.250	**0.560**
8	Heptachlor++	8.000	3.500	**11.500**
9	Aldrin	129.700	-------	**129.700**
10	Endosulfan	-------	242.482	**242.482**
11	Lindane	------	3.600	**3.600**
12	Agrosan	-------	7.200	**7.200**

[79] It is often difficult to practically separate POPs and non-POPs pesticides in stocks.

13	Unknown	32.730	-------	**32.730**
	Total of POPs	**242.2**	**443.8**	**686.0**
14	Contaminated* Soil	8850	10356	19,206
15	Empty containers+	528	557.2	**1085.2**
Total	Total stocks	**9620.2**	**11357**	**Ca. 20977.2**

Source: Pesticides Inventory Report

Based on this information, an action plan for site remediation and identification of suitable disposal options in environmentally sound manner is developed in chapter 3.

2.3.7.2. PCBs

A range of potentially PCB contaminated sites have been discovered from inventory development and further considerations. Potentially PCB contaminated sites are the former maintenance areas, PCB storage sites and all locations where PCB transformers have been operating can have PCB contamination depending on leakage of transformers and condensers. The power plant in Khartoum North had a major fire in the past. This area is also potentially contaminated with PCB and PCDF, hence mentioned in the Dioxin inventory part. The place is very close to the Nile and contaminants might migrate from this area to the river.

Analytical data on PCB contamination in soils at the potentially contaminated areas are not yet available in Sudan due to the lack of monitoring capacity. Such assessment should be performed in the NIP implementation.

According to the previous inventory and data in the NIP 2007, the information available indicated that 8 tonnes of pure PCBs were in stock and 561 tonnes of contaminated fluid was in use (2-3% of 18,700 tonnes were suspected).

In the first NIP, the quantity of PCBs in liquid phase stored at NEC's premises was estimated at 8 tonnes. In the current inventory report PCBs contaminated fluids have not been found. Also, there is no record on their use and/or removal. An assessment on how the 8 tonnes of PCBs oils estimated in the first inventory and the PCBs oils generated in the last 8 years have been stored, used and/or disposed has to be carried out. The material flow of these PCB oils and wastes need to be assessed as well as part of the Action Plan.

To date dumping areas of PCBs have not been identified due to the lack of monitoring capacity. The scrap and old transformers have been removed and transferred to the new factories, and also to the workshops located in the industrial area of Khartoum North and all the scraped transformers had been either used for manufacturing new transformers or sold as raw material to steel factories. Therefore all these areas need to be considered as potential PCB contamination sites and included in monitoring programs (Action Plan).

All areas where transformers have been managed are considered potentially PCBs and possibly polychlorinated dibenzofurans (PCDF) contaminated sites. These include:

- Areas where PCB transformers have been stored;
- Areas where transformers have been produced maintained and repaired;
- Areas of the new factories where the transformers have been transferred.

Some of these sites are currently used for other purposes. But they should also be considered and assessed as contaminated sites (Action Plan).

2.3.7.3. POP-PBDEs contaminated sites and hot spots

A. POPs-BDEs in EEE equipment

There is no formal or institutional recycling of WEEE in Sudan. Recyclers are private persons dismantling, separating fractions and recovering materials from WEEE. WEEE is not separated from domestic waste. Wastes are taken to dump sites, where waste pickers remove all wastes of economic value and sell to interested retailers around the dumping sites.

There are few officially designated dumping sites in Khartoum State and even in cities in other states and there are many illegal waste dumping sites scattered in the residential areas in the country. The most recent designated area in Khartoum State, considered as a hazardous waste dumping, is located at the outskirts of Omdurman locality.

The dumping sites, even the official ones, have not been designed according to international or national standards or equipped with measures to avoid emissions of hazardous substances to the environment.

B. POPs-BDEs in transport sector

All three major EoL treatments (land filling, thermal treatment, recycling) in developing counties result in environmental pollution with associated exposure risk. The implementation of SC will introduce environmentally sound management practices and thus improve the state of environment.

For PBDEs, human exposure take place in all life cycle stages (UNEP 2010a,b) including the end of life with potential of additional releases (Hale et al. 2006, Sepulveda et al. 2008, Wong et al 2007) if non appropriate technologies are used for treatment (Nnorom & Osibanjo 2008) or wastes are burned (Stockholm Convention 2012b).

Disposal of PBDEs containing materials in the last three decades have already created reservoirs in landfills/dumps which are partly released to the environment (Danon-Schaffer et al. 2013, Odusanya et al. 2009; Oliaei et al. 2002, Osako et al. 2004, Weber et al. 2011). Considering the increased interest in landfill mining (van der Zee et al 2004; Krook et al. 2012, Jones et al. 2013) future exposure to POPs disposed in landfills need to be taken into account (Torres et al. 2013). These largely unmanaged dumpsites frequently catch fire and are continuously smouldering. Studies showed that landfill fires releases brominated and chlorinated dioxins at similar levels (Gullett et al. 2010) revealing that PBDE/BFR

containing materials are important Dioxin sources from landfills/dumps. Recycling of WEEE leads also to releases and human exposure (Sepulveda et al. 2008).

Assessing the flow of PBDE to single environmental compartments and exposure to humans via key pathways need to be evaluated. Yang et al. (2008) has suggested emission factors for PBDE from WEEE treatment to different compartments. However, the suggested equal value of PBDE flow to air, soil and water (Yang et al. 2008; used by Tien et al 2013 for substance flow) is too rough assumption to be used for a realistic assessment. Therefore, the material flow of POP-PBDE (and other pollutants in WEEE) should be monitored in areas with such WEEE and WEEE plastic management and recycling.

It is noted that c-DecaBDE was present in cat 3 and 4 samples at higher levels compared to POP-PBDE (Sindiku et al. 2014). Like POP-PBDEs c-DecaBDE is also restricted by the RoHS (Restriction of Hazardous Substances) Directive (European Commission 2002). Furthermore c-DecaBDE has been suggested by Norway as a POP to the SC (UNEP, 2013a), and it was concluded by the POP Reviewing Committee that it meet the POPs criteria of Annex D of the Stockholm Convention (UNEP, 2013b). Therefore polymers containing DecaBDE also needs to be managed appropriately in the end of life and cannot be recycled back to EEE (European Commission 2002). Also plastic from other 8 WEEE cat contain c-DecaBDE (and other BFRs) (Waeger et al. 2010) including e.g. cat 2 small household appliances (Waeger et al. 2010) or individual electronic equipment of cat 1 “Large household appliances” which have specific flammability requirements for material in particular for heating equipment (e.g. electric heating appliances and electric radiators). For an overall assessment of the pollution of WEEE plastic and WEEE, other BFRs/additives and further pollutants such as heavy metals need to be included in material and substance flows (Tien et al. 2013) for determining the overall environmental contamination and human exposure.

An ultimate goal of material flow analysis and accounting is to provide a basis for national and international planning. Knowing the stocks and flows of polymers and pollutants in polymers and forecasting these flows in a dynamic model (Morf et al. 2008) appropriate policies and waste management/recycling schemes can be development. In addition to managing the risk of pollutants, such information can also be used for material recovery policy, which will become more important when resources become scarcer. To properly address pollutants such as PBDEs (and the several hundred POP-like chemicals (Scheringer et al. 2012;)) in today’s material and recycling flow it is crucial for reducing risk when more materials are (or need to be) recycled in the frame of developing a more circular global economy (European Resource Efficiency Platform 2013; Weber et al 2013).

The SC implementation for POP-PBDE (and PBB and HBCD) in 179 countries would globally quantify and address the threat of PBDE and other pollutants in WEEE plastic and the plastic recycling schemes in particular in developing countries (and for industrial countries when considering import of recycled plastic products). Developing countries and countries in transition have no or very limited monitoring tools for the assessment of recycling streams or for market survey of such pollutants in sensitive use areas such as

children toys or kitchen wear. This could be significantly improved by regional studies coordinated by the regional centres of the Stockholm/Basel Convention[80].

A. POPs-BDEs in EEE equipment

Repairing, dismantling, articles separation, WEEE disposal, metal recovery and dumping result in emissions of hazardous substances to the environment, mainly to air and soil and possibly underground water sources or to the most near surface water sources.

All sites of these operations, in particular dumping sites and sites where these polymer fractions are burned in the open, are considered as hot spots that require assessment, monitoring and applying pollution control measures.

Depending on the recycling and treatment processes (e.g. shredding) elevated levels can be expected at these sites. The waste including upholstery, padding, and insulation materials derived from the shredding of cars, other vehicles and electrical appliances (so called "light shredder waste" or "fluff") contains in addition to PBDEs also PCBs and heavy metals (UNEP 1999, Stockholm Convention 2012B). This waste is often transported to landfills (including industrial and municipal waste sites). Therefore, investigation of these sites should be carried out in an integrated manner by considering all relevant pollutants.

2.3.7.4. DDT

The new data included in the inventory report revealed the presence of 3.425 tonnes of DDT, 227.26 tonnes of Torbidan (DDT + Toxaphene + Methyl parathion), and 18.32 tonnes of Heliotox (DDT + Toxaphene).

2.3.7.5. PFOS contaminated sites and hot spots

A. Storage

Different products and articles containing PFOS enter the waste stream after the end of their life time. The most suspected articles which may contain PFOS and its related salts entering the waste stream are those generated from used carpets.

According to the information provided by the custom, the amount of carpets entered into the country since 2003 has been 13,316 tonnes. However, the PFOS and its related salts could not be identified for carpets in this inventory. The same situation can be applied to other articles and products like papers and packaging materials, which may contain PFOS and its related substances have no separate waste management procedure. They are managed as domestic waste through either dumping or open burning process.

Khartoum is the only city which has a waste water treatment plant receiving waste water from both industrial and household sectors. The received waste water from household sector may contain PFOS and its related salts generated from use of some articles and household products, although it was not

[80] Babayemi J.O, Sindiku O, Osibanjo O, Weber R (2014), Substance flow Analysis of Polybrominated Diphenyl Ethers in plastic from WEEE/EEE in Nigeria as a Basis for Policy Advice, Environmental Science Pollution Research

identified in this inventory. According to information from airport authorities some of their aviation hydraulic fluids waste is disposed-off in the drainage system and finally end up in sewage water or sludge. Therefore, waste water and sludge generated from the waste water treatment plant in Khartoum needs to be investigated for the presence of PFOS and its related substances. For the aviation hydraulic fluid the area where the replacement or adding up to complete filling of the equipment is carried out may contain waste which needs to be managed, i.e. especial pre-treatment prior final disposal should be made. The stores at airport and airplane maintenance areas at Khartoum airport and military bases are considered to be contaminated sites.

According to information obtained from the users of fire-fighting foams, the waste water is released to the environment at the application site without any management. No regulation governing collection and management of such hazardous waste exists in the country. Moreover, there are no records of specific localized sites in which aqueous film forming foams were applied for fire incidents except the big incident at Heglig.

There are significant gaps in information related to PFOS content in suspected articles and products that enter the wastes streams. Large use of products and articles containing PFOS is expected to be found in the period between 1980 and 2000, but there is a lack of records for this period. Articles from this period are still present in use and therefore stocks are likely to contain synthetic carpets as they used for a long duration. Other articles (paper, textiles, leather) have likely ended in the landfills/dumpsites.

The SC requires developing a strategy for environmentally sound management of identified stockpiles of products and articles and wasting containing PFOS and its related substances. No stockpiles from industrial sectors, articles or insecticides have been identified during the inventory. The use of PFOS and its salts has been confirmed for two categories: aqueous fire-fighting foams and aviation hydraulic fluids.

According to the inventory report, all stakeholders store their stockpiles at their premises and stores conditions are good and well secured. All stakeholders claimed to have no expired stockpiles. The estimated amount of stockpiles of aqueous fire-fighting forming foams containing PFOS and its related substances found during the inventory is 167,688 Kg. The amount of stockpiles of aviation hydraulic fluids containing PFOS and its related substances found during the inventory is 112,914 Kg. According to information obtained all stores are secured and in good conditions.

B. Contaminated sites

PFOS have high chemical stability and low volatility and by these properties are persistent in the environment. As a result they can be found in soil and groundwater as contaminants also decades after use.

The inventory results indicated that the main roots of PFOS entering the country are either through import of fire-fighting foams or aviation hydraulic fluids. The suspected areas contaminated with PFOS-base foam are the training and equipment testing sites and those areas where fire drills, stockpiles storage, as well as accidental spills or leakages occur. For aviation hydraulic fluids the suspected contaminated areas are the maintenance sites, stockpiles storage areas where accidental spills or leakages occur.

The main contaminated site identified during this inventory is Heglig. Heglig (below map) is a small town situated in South Kordofan State at the boarder of South Sudan and it is an oil-rich region. An oil export pipeline initially began at Heglig and extended to Port Sudan at Red sea for export.

During the border conflict between Sudan and South Sudan in 2012, the Heglig area was bombarded by both sides which result in a set of fires at the pipeline and different installations in the city. After the end of battle the rescue brigade used a large amount of AFFF to control fires. The amount of foam estimated to be used at that time is 6,000 litres. The inventory report considered this site as the most contaminated site identified, which should have priority in investigation and remediation if proved to be highly contaminated by PFOS resulting from the use AFFF.

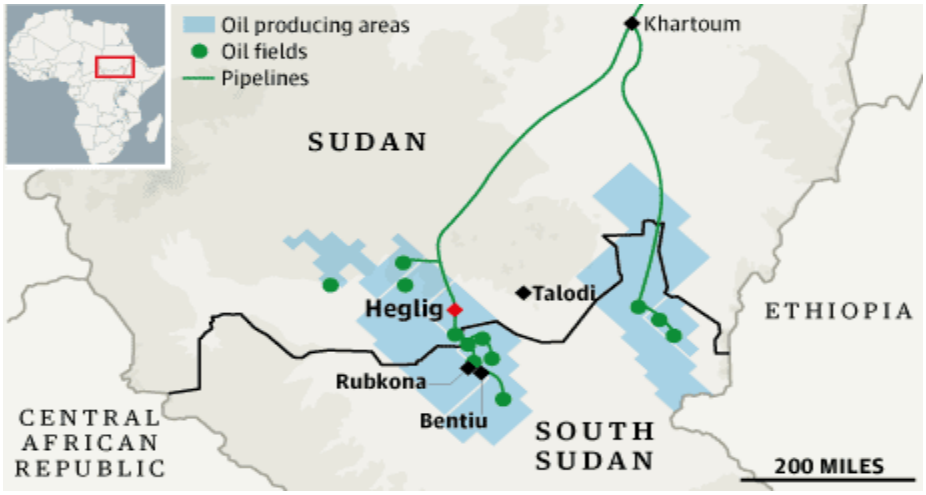


Figure 13 - Map showing Heglig location (the coordinate of Heglig: 9o59´58´´N 29o23´55´´E)

Other important contaminated sites are those where training exercises using fire-fighting foams are conducted. According to inventory training sites were identified as shown in the table 20 below.

Table 20 - Fire fighting training sites and PFOS-based foam used

City (training location)	Coordinates	Quantity of PFOS-base foam used in litre (Kg)	Quantity of emission in Kg
Khartoum	15°35´22.19´´N 32°33´11.38´´E	300 (306)	Low 1.53 High 4.59
Ad Damazin	11°47´09´´N 034°20´11´´E	200 (204)	Low 1.02 High 3.06
Kassala	15°23´14´´N 036°19´43´´E	200 (204)	Low 1.53 High 4.59
Al Junaynah	N13°28.70' / E22°32.28'	1,000 (1,020)	Low 5.1 High 15.3
Al Fashir	13°36´53´´N 925°19´28´´E	300 (306	Low 1.53 High 4.59

Al Daba	N19°9.16´/E 30°25.81´	400 (408)	Low 2.04 High 6.12
Wadi Halfa	21°47´N 31°22´E	100 (102)	Low 0.51 High 1.53
Al Ubayyed	13°09´11´´N 030°13´57´´E	300 (306	Low 1.53 High 4.59
Dongola	N19° 9.16´/E 30°25.81	36 (36.72)	Low 0.18 High 0.55
Atbarah	17°24´35´´N 34°03´25´´E	200	Low 1.02 High 3.06
Kadogli	11°08´16´´N 029°42´94´´E	400 (408)	Low 2.04 High 6.12
Neyala	9°59´58´´N 29°23´55´´E	600 (612)	Low 3.06 High 9.18
Total		**4,036 (4,116.72)**	**Low 20.58** **High 61.75**

Source: PFOS Inventory Report

From the above table, Al Genina and Neyala used high amounts of fire-fighting foams in training exercises. The types of foams used in this practice were not identified. Analysis of soil needs to be done for these sites, which are considered to be second priority in future planning for management of contaminated sites, after Heglig contaminated site.

The location of training sites is shown in the map of Sudan in Figure 14 below.

Figure 14 - Map of Sudan including fire-fighting training sites

2.3.7.6. PCDD/PCDF and UPOPs contaminated sites and hotspots.

According to the inventory, the largest amount of PCDD/PCDF present today are from historic releases of the chlorine and organochlorine industry, application of organochlorine pesticides and at contaminated sites including landfills and deposits but also in soils and sediments.[81] Furthermore long term industrial releases from metal industries or incinerators or disposal of solid residues can have resulted in PCDD/PCDF or other UPOPs contaminated sites.

The potentially PCB contaminated sites can also be considered contaminated as potentially PCDF contaminated and assessments should consider this contaminant.

81 Weber R, Gaus C, Tysklind M et al (2008) Dioxin- and POP-contaminated sites—contemporary and future relevance and challenges. Env Sci Pollut Res 15, 363-393. http://www.springerlink.com/content/0q10km8582605r1x/fulltext.pdf

In preparing the inventory in Sudan following has been found:

a) *Production sites of Chlorine:* One factory operated for short time produced chlorine. The site has not been contaminated. However, this need confirmation by analysis of samples taken from the site and from wastes disposed from the plant.

b) *Production sites of chlorinated organic and related deposits:* Sudan did not have such industry.

c) *Application sites of PCDD/PCDF containing pesticides and chemicals:* 2,4-Dichlorophenoxy acetic acid (2,4-D) is an organochlorine herbicide which is extensively used as defoliant to control water hyacinth in White Nile River in 1980s. Since the beginning of the last decade its use has rapidly been increased to control broad leaf plant in different plantation. In the last year 329,600 litres of 2,4-D were imported from different countries to control striga that infected sorghum in Elgadarif, El Damazin and sugar production areas. Soils are expected to be contaminated with this persistent organic herbicide. An obsolete quantity of this pesticide is expected to be found in some places in the country. 2,4,5 T and PCP which may contain dioxins are not registered in Sudan, but might have been used in the past.

d) *Timber manufacture and treatment sites:* Woods that are locally produced for construction are not treated by any chemicals.

e) *Textile and leather factories:* None of textile factories and leather tanneries has waste management system. They dispose their waste water and the sludge around their installation that led residents to complain and it is under consideration by the concern authorities. One big tannery located at Wad Madani city in Gezira State and two other big ones are on Albagair industrial area on Khartoum State. The old textile factories are on Khartoum State industrial area. These areas need to be considered as POPs and other pollutants contaminated sites.

f) *Use of PCB:* Following locations are potentially PCB and PCDF contaminated sites:

- Areas where PCB are currently stored;
- Areas where PCBs have been stored in the past;
- Areas of the companies which do or have done maintenance of transformers;
- Sites where PCB transformers have been used and have leaked;
- Sites where fires involving transformers or condensers have occurred. In 2002 a large power station in Khartoum (Buri Power Station) was accidentally burnt. Many transformers and capacitors which might have contained PCBs had exploded and made the site a possible reservoir of PCDD/PCDF. It is not known at which other sites transformer or condenser fires or explosions have occurred.

g) *Fire Accidents:* The main fire accidents which can be considered are:

- In 1998 El Shifa Pharmaceutical Factory was hit by American missile and all equipment, chemicals and products are exploded. The site should be considered as a possible PCDD/PCDF contaminates area and a reservoir. Furthermore other chemical pollution including pharmaceuticals is possible. To date no investigation on chemical contaminants has been done.

h) *Dredging of sediments; contaminated flood plain:* There is no information on dredging of sediments in Sudan. Since there has been dams constructed for hydropower plant sludge can be considered to be generated and dredged. The extent of these activities, the contamination levels and the fate of this sludge will be assessed in NIP.

i) *Dumps of wastes/residues from Source Groups 1-9:* Following areas, dump sites and landfill where wastes have been disposed:

- Sites where ashes from incinerators are disposed;
- Sites where ashes from metal industry are disposed;
- Sites where the sludge from textile industry and leather tanneries are disposed or where tanneries and textile industries released or releases their effluents. Most of the large industrial facilities, like sugar factories, tanneries, and textiles dispose of their waste water either in rivers or open land;
- Sites where copper cables and other electronic waste are or have been burned in the open. In some parts of cities, especially around industrial areas copper cables, tires and other solid wastes have been smouldered or burned on the ground making the area a potential hot spot;
- Sites where waste is and have been burned in the open for extended time. In some cities the industrial solid waste and the municipal solid wastes are compacted and dumped in pits without any separation where open burning frequently occurs. The pit is closed and the next pit is opened and filled. These filled pits may have negative impacts on ground water due to leachate migration and possible emission of gases.

j) *Kaolin or Ball Clay Sites:* High concentrations of mainly PCDD were found in mined ball clay from the USA and kaolinitic clay from Germany. However, only a part of Kaolinite is impacted by PCDD. Sudan has large Kaolinite resources and also industrially uses Kaolinite in various industrial applications. At present no estimation can be made if Kaolinite in Sudan is contaminated by PCDD.

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

2.3.8.1. POPs pesticides

As it was previously mentioned in sections 2.3.1.5 and 2.3.1.7, endosulfan is one of the oldest registered and used pesticides in Sudan. Large quantities are still imported and used by farmers. The inventory report stated that the lack of alternatives at national level will lead to postponing the ban of endosulfan in Sudan. Therefore, searching for appropriate, accessible and affordable alternatives represents one action to be taken during NIP implementation.

Concerning lindane, even SC derogation relates to the use only as human pharmaceutical for control of head lice and scabies as second line treatment, in Sudan it is used currently for controlling ectoparasites of livestock. However, the inventory report recommendation is to cancel its registration for the above mentioned uses, since several alternatives are available for controlling the ectoparasites of animals.

Endosulfan is currently used in Sudan and probably needs exemptions for some time.

2.3.8.2. POP-PBDEs

No exemption for recycling of PBDE containing plastic is needed at the moment.

2.3.8.3. DDT

DDT has not been used in recent years. Although DDT is kept in the register for vector control, no DDT import was imported for more than two decades and might not be needed in the near future.

2.3.8.4. PFOS, its salts and PFOSF

No exemption for the use of PFOS is needed. Alternatives to PFOS in fire-fighting foams are available.

2.3.9. Existing programmes for monitoring releases and environmental and human health impacts, including findings

2.3.9.1. POPs Pesticides

To date monitoring of POPs pesticides releases has not yet established in Sudan. The potential sources of POPs-pesticides and their impact on the population, have to be assessed during the implementation of NIP.

Although there are a few case studies on the influence of POPs pesticides on human health and the environment, a systematic and comprehensive analysis should be carried out to obtain an overall picture of the state of human health and the environment.

Currently, several Ph.D. and M.Sc. studies are conducted determining the levels of POPs insecticides, PAH, PCBs, dioxins and furans in the soil, human samples (urine, blood, breast milk), water and sediments in the University of Gezira. Other studies are also carried on to determine the level of the above mentioned

compounds in fatty tissues (post-operative) in cancer patients, especially breast cancer in women of the Gezira.

Research on POPs in general and specifically on POPs-pesticides due to lack of laboratory facilities for environmental monitoring (GC, HPLC, MS) and lack of trained staff is still in its infancy stage. As shortage of financial resources further encumbers the problem, monitoring of Pops pesticides is incomplete.

Concerning health monitoring, most of the laboratories in Sudan are not adequately equipped for POPs analyses in food and potable water. For successful monitoring of POPs presence in different media, fully equipped laboratories and trained staff are required. A few (2-3), partially equipped few laboratories exist in the country, but for adequate monitoring programs additional equipment (GLCs, MS, HPLC, IR, etc), accessories, chemicals, standards and training of involved staff would be required.

2.3.10. Current level of information, awareness, and education among target groups; existing systems to communicate such information to the various groups

The current level of information, information exchange, awareness and education among target groups; existing systems to communicate such information to various groups; mechanism for other Parties to the convention are described in this section.

2.3.10.1. General

National intersectorial exchange of information system or policies in the country has not yet been established and no effort is made towards developing of formal channels for exchange of information.

A national centre for information has been recently established, and affiliated to the council of ministers. It is still in the process of training, a national database has not yet built and it may take a long time to feed relevant national and international data on chemicals including POPs. The centre is still far from being connected via net working to various departments concerned with chemical management, however internal networking is available in many departments and in most cases departments have access to the internet. Initiatives have been made towards improving the quality of existing data and mechanism of sharing information. These include preparation for e-government (projects under discussion).

Preliminary chemical data base and a website hosted at HCENR were established in 2011 through the SAICM and were operational until 2012. A significant breakthrough was the establishment of the Sudanese Universities Virtual Libraries (SUVL) in 2005, which would connect all Sudanese universities by a networking facility. This network was developed in 2009 as the Sudanese Research and Education Network (SUDREN).

Different types of data concerning chemicals are kept in different departments and access to any data, except cbi, is possible upon request with official letter specially for governmental officials, researchers, students and NGOs.

There is no national policy on public access to government information. The traditional practice is to give information upon official request while keeping cbi secret. The majority of national data is kept in paper files or with person who conducted the work. Few data is computerized (such as pesticide data). The

findings of many research works were published in local reports, thesis, proceedings of local meetings and seminars, therefore they are of limited access to analyzers, policy makers or international community.

2.3.10.2. Information and Awareness on Chemicals and POPs

Farmers field schools (FFS) are based on educating and raising the awareness of the farmer and his family regarding crop protection /pest management concepts, strengthening the link between farmers and extensionists, making the right decision about the pesticides to be used, especially on vegetables; producing vegetables free from residues of pesticides, which will lead to protecting the farmer himself and the consumers from these hazardous practices and chemicals, etc. However the FFS established with the support of FAO have not been maintained.

Training of trainers (TOT) of farmer's leaders, the entomologists, field inspectors and extensionists and decision-makers were conducted. Dealing with insecticides, or pesticides in general, requires a special kind of training, including the crop protectionists. The environmental issues should always be in the back of their minds when selecting a pesticide or making any decision involving pesticides. Both subjects (i.e. pesticides and environment) are dynamic and new techniques, technologies, ideas, innovations, etc. are frequently encountered.

The information needed for application of IPM programs in different crops was of great use during the Second National Pest Management Conference at the University of Gezira (2004) and the 3rd National Pest Management Conference (2013).

Moreover, the First African Congress on Pesticides and Toxicology Sciences (2010), in collaboration between University of Gezira and The African Network for Chemical Analysis of Pesticides (ANCAP) presented 175 papers that can be of practical importance to IPM specialists and crop protectionists.

A Sudanese expert on IPM (Prof. Azim) has published a book on IPM in Arabic which could be used to strengthen the farmer schools. The experts trained in the Dutch projects on IPM are available and should be utilized in teaching and implementing IPM. The Dal group has started organic farming in Sudan with major export to Saudi Arabia. A successful and a good communication network is in place with approx. 200 farmer schools but it has insufficient funding.

2.3.10.3. Sustainable consumption and production and integration of POPs/chemicals

The sustainable consumption and production agenda has only recently been introduced in Sudan. To date POPs and other hazardous chemicals have not been addressed in the frame of SCP. However, the use of POPs is an example of unsustainable production and their appropriate substitution and the related substitution approaches have the potential to facilitate the introduction of green/sustainable chemistry and sustainable use of chemicals. The experience on POPs can be used for awareness raising in further developing the SCP agenda in Sudan. This topic is now being addressed in the updated NIP in the respective sections of action plan and will also be integrated in the SCP agenda of Sudan.

2.3.10.4. Information exchange between Parties

Information exchange with other parties is mainly done at international or regional workshops as well as meetings such as the Conference of Parties. No further specific information exchange exists with other parties.

2.3.11. Mechanism to report under Article 15 on measures taken to implement the provisions of the Convention and for information exchange with other Parties to the Convention

The reporting under Article 15 was completed in time. However, technical challenges delayed its timely submission.

2.3.12. Relevant activities of non-governmental stakeholders

There is a number of NGO's in Sudan. They include the Sudanese Environmental Conservation Society (SECS), the Environmentalist, and Consumer Protection Society. They are actively involved in the field of conservation and environment. Their activities are focused on awareness raising, municipal waste management and tree planting. However, none of them work specifically on chemicals.

In developing the original NIP in Sudan the WHO human milk study was guided by a woman NGO. This NGO was included in the POPs task team, collected samples from mothers in the human milk survey and communicated the results.

2.3.13. Overview of the technical infrastructure for POPs assessment, analysis, alternatives and prevention measures, management, research and development – linkage to international programmes and projects

This paragraph gives an overview of technical infrastructure for POPs assessment, measurement, analysis, alternatives and prevention measures, management, research and development as well as the linkage to international programmes and projects are discussed in this section.

2.3.13.1. Technical infrastructure for POPs assessment, measurement and analysis

Sudan recognized the need for scientific research in various disciplines as early as the beginning of the 20th century when research stations and institutions of higher education were established. Research on agriculture started in 1902 in the northern province, in 1904 Shambat experimental station was established, in 1918 the Gezira research farm was inaugurated, in 1931 the latter was expanded to include departments such as chemistry, entomology, botany (became the head quarter of agricultural research service) and in 1967 the agricultural research corporation was established in Wad Medani to lead and coordinate all research activities in agriculture. Various research stations were also set up (1940's -1960's) both at regional and sub-regional levels. Parallel to this higher education institutes were established as early as 1902 with the Gordon Memorial College which was affiliated to the University of London and later promoted the University of Khartoum following the independence in 1956. The school of agriculture was set up in 1938 and was promoted to the faculty of Agriculture in 1956. Other colleges were established to qualify human resources in other fields. Other Ministries acted similarly in establishing research units and conducting research. Currently, about 27 government universities, 4 private universities and over 45 private colleges scattered in various parts of the country.

a) Institutions involved in research or monitoring

Specialized centres for conducting research on POPs do not exist in Sudan. However, certain institutions are currently involved on management of certain groups of chemicals including some POPs, especially pesticides. For other POPs research has not yet been established. Institutions and their area of concern are summarized in table 21 below.

Table 21 - Institutions involved in chemical management and can potentially be involved on research on POPs in the Sudan

Name/Description of Institution*	Purpose
Agriculture Research Corporation (ARC) Ministry of Agriculture	Analysis of pesticide formulations; Analysis of pesticide residues in supervised trials; Research on pesticides; Training on pesticides; Surveillance for pesticides susceptibility and resistance, IPM
University of Khartoum, Faculty of: Agriculture, Faculty of Science, Institute of Environmental Studies.	Teaching at both graduate and undergraduate levels; Training and, Research on pesticides and other environmental pollutants.
University of Gezira, Faculty of Agricultural Sciences	Teaching at both graduate and undergraduate levels; Training and, Research on pesticides and other environmental pollutants
National Chemical. Laboratories; Ministry of Health (MoH)	Analysis of Food and Feed & Water for Quality control and their fitness for human consumption; Study and analysis of food products for registration; Analysis of Toxic chemicals and contaminants; Research and surveys; and Training.
Sudanese Standards & Metrology Organization	Analysis of exported and imported products for compliance with specifications; Research and supervision; and Training.

Source: National profile of chemical safety and questionnaire

From the table above it can be seen that:

- There are many research institutes and government laboratories that have in their mandate some sort of involvement in chemical management;
- Some degree of overlap exists between various entities;
- All entities are involved on broad groups of chemicals and none of them is solely specialized on POPs issues;
- Some institutes are focusing mainly on research while others participate voluntarily and cooperate with others in conducting research; and
- Most are located within the capital and only a few are found in other states.

b) Human Resources and Technical Infrastructure

There are great variability in resources and technical infrastructures available to the various groups; some have much of the human resources but poor laboratory facilities while others have the reverse and none of the entities have a complete set of resources.

Table 22 - Resources available to various institutions

Name/Description Institution*	No of Professionals	Analytical Equipment	GLP followed (Y/N)	Computer and communication system available, basic simple equipment, glassware and reagents (Y/N)	Separate budget allocated for rehabilitation, maintenance and consumables (Y/N)
Agriculture Research Corporation HQ[a] (ARC), Ministry of Agriculture	72 Chemical analysts, Toxicologist, Environmentalist, Chemical Engineers	GLC, IR, UV Spectrophotometer, Liquid Scintillation Counter	Yes	Yes	No
University of Khartoum, Faculty of Agriculture; Faculty of Science, Institute of Environmental Studies.	53 Chemists, Toxicologists, Environmentalist, Chemical Engineers	UV Spectrophotometer, Atomic Absorption, XRF	?	Yes	No
National Chemical Laboratories	12 chemists	GC, GCMS, HPLC, UV Spectrophotometer, Atomic Absorption	?	Yes	No
University of Gezira, Faculty' of Agricultural Sciences	22 Chemists, Toxicologists, Environmentalist	UV Spectrophotometer, Atomic Absorption	?	Yes	No
Sudanese Standards Metrology Laboratory.	10 Chemists, Chemical Engineers, Agriculturists	GLC, HPLC, Falling Number System, IR Analyzer	Yes	Yes	No

Source: National profile of chemical safety and questionnaire.

The following can be concluded:

- Most of the laboratories do not utilize international recognized protocols such as OECD Test Guidelines.

- However, some like the Sudanese Standards and Metrology Specifications Organization uses ISO guidelines and the National Chemicals Laboratories uses standard and official methods like AOAC and methods recommended by international organization like the Codex Alimentary.
- Other protocols such as WHO Specifications for Public Health Pesticides and CIPAC methods are used for pesticides formulations analysis in concerned laboratories.
- Occupational Health Administration uses NIOSH Analytical Methods for analysis and adopts WHO guidelines for pollutant standards.
- No national programme at present is conducted to improve the quantity and quality of the existing relevant laboratories.
- Many of them have become obsolete or out of order. However, efforts were made by individual laboratories to up-grade their equipment but most of these efforts were faced with financial constraints.

c) Institutions with experience and potential for POPs research and monitoring

Few institutions have been involved in research related to POPs and therefore can be considered as potential candidates for future research and environmental monitoring of POPs in Sudan.

Their capacity and potential for POPs research and monitoring is summarized in Tables 23 and 24 below. The two Tables include summaries of their experience, human resource, technical infrastructures, available budget, access to international literature and data base. Table 24 also includes information of extent and nature cooperation between these institutions.

Table 23 - List of institutions with experience and potential in POPs research and monitoring (human and technical infrastructure)

Category of POPs	Institutions /Activity	Experience in POPs Research (Y/N)	Professionals in POPs	Main Equipment	GLP	Budget sufficient (Y/N)
Pesticides	ARC-Residue and formulation lab (Research)	Yes; Methods for residue analysis were available	3 PhDs+ 4 masters + of bachelors	GLC-ECD, IR, UV Spectrophotometer Liquid Scintillation Counter	GLP followed	No
Pesticides	ARC-IPM	Yes; research and implementation of IPM in cotton, wheat and vegetables	5 PhDs + No of master and bachelors (IPM)	Basic entomology lab	GLP followed	No
Pesticides	University of Khartoum, Faculty of Agriculture, (Research)	Yes; Methods for residue analysis were available	3 PhDs + Number of postgraduate students	GC-FID, HPLC, UV-spectrometer, Atomic Absorption	GLP followed	No
Pesticides	University of	Yes; Methods for	3 PhDs + Number of	UV- spectrometer,	GLP	No

	Gezira, Faculty of Agric. Science (Research)	residue analysis were not available	postgraduate students	Atomic Absorption	followed	
Pesticides	National Chemical Laboratory (Monitoring)	Yes; Methods for residue analysis were available	4 Masters	GLC-ECD, HPLC Atomic Absorption UV Spectrophotometer, Flame photometer. IR	GLP followed	No
Pesticides	National Medical Laboratory			Microscopes, Amino acid Analyzer Spectrophotometer etc.	GLP followed	No
Pesticides	National Malaria Administration (MoH)	Yes; Method for monitoring of vector resistance and susceptibility	10 PhDs & Masters, 45 bachelors (biologists, medicals, chemists)	Bioassay kits, rearing facilities and basic equipment	GLP followed	No
Pesticides	Sudanese Standards & Metrology Laboratory (Monitoring)	No; Methods for residue analysis were not available	1 master + 1 Bachelor	GLC-ECD, HPLC Falling Number System, NIR Analyzer	GLP followed	No
Pesticides	National Centre for Research, Ministry of Science and Technology (research)	No; Methods for residue analysis were not available	1 PhD + number master	GLC-FID, Atomic Absorption, Spectroscopy.	GLP followed	No
Dioxins, Furans, PCBs, HCB, PFOS & tetra and penta BDE	National Chemical Laboratory (monitoring)	No; Methods for analysis were not available	20 (Chemists, Chemical Engineers, Environmentalist, Physicians)	GLC-ECD, Atomic Absorption, UV spectrophotometer, Flame photometer. IR	GLP followed	No
Dioxins, Furans, PCBs, HCB, PFOS & tetra and penta BDE	Central Petroleum Laboratories (CPL) (Monitoring)	No; Methods for analysis were not available	20 (Chemists, Chemical Engineers, Geologists)	GLC, HPLC, GC-MS XRF, Gas analyzer XRD, UV spectrophotometer, Atomic Absorption Spectroscopy, IR	GLP followed	No
Dioxins, Furans, PCBs, HCB, PFOS & tetra and penta BDE	Industrial Consultancy & research Centre, Ministry of Science and Technology (Research)	No; Methods for analysis were not available	49 (Chemists, Chemical Engineers and Environmentalists)	UV Spectrophotometer	GLP followed	No
Dioxins, Furans,	Sudanese Standards &	No; Methods for analysis were not	1 master + 1 bachelor	GLC-ECD, HPLC Falling Number	GLP followed	No

PCBs, HCB, PFOS & tetra and penta BDE	Metrology Laboratory (Monitoring)	available		System, NIP Analyzer		
Dioxins, Furans, PCBs, HCB, PFOS & tetra and penta BDE	University of Khartoum, Faculty of Science, Institute of Environmental Studies (Research)	No; Methods for analysis were not available	3 PhDs + Number of postgraduate students	UV-spectrophotometer, Atomic Absorption, XRF	GLP followed	No
Dioxins, Furans, PCBs, HCB, PFOS & tetra and penta BDE	Quality Control laboratory, Ministry of Electricity (Monitoring of PCBs)	No; Methods for analysis were not available, staff need training	16 Chemical Engineers and Chemists; 1 M.Sc holder + 4 engaged in M.Sc training, rest had B.Sc	GLC, HPLC, GC-MS, other simple analytical equipment	GLP followed	No

Source: National profile of chemical safety and questionnaire. GLP is followed but there is no official body for certification

Table 24 - Extent and nature of national cooperation and access to international literature and data base (National cooperation and Access to information)

Category of PoPs	Institutions /Activity	Affiliated to	Linked to	Nature of Linkage	Access to International literature	Access to International Database
Pesticides	ARC-Residue and formulation lab (Research)	Ministry of Agric.	Ministries of Agric., Health, Higher Education, Environment, Science and Technology	Official for certain interministerial committees and personal for access to facilities	EHC, JMPR, Pesticide safety data sheet	No
Pesticides	University of Khartoum, Faculty of Agriculture, Institute of Environmental Studies (Research)	Ministry of Higher Education	Ministries of Agric., Health, Environment, Science and Technology	Official for certain interministerial committees and personal for access to facilities	EHC, JMPR, Pesticide safety data sheet, Chemical safety cards	Chemical Abstract Data base
Pesticides	University of Gezira, Faculty of Agric. Science (Research)	Ministry of Higher Education	Ministries of Agric., Health, Environment, Science and Technology	Official for certain interministerial committees and personal for access to facilities	EHC, JMPR, Pesticide safety data sheet, Chemical safety cards	No

Pesticides	National Chemical Laboratory (monitoring)	Ministry of Health	Ministries of Agric., Science and Technology, Higher Education, Environment	Official for certain interministerial committees and personal for access to facilities	EHC,JMPR, Pesticide safety data sheet, Chemical safety cards, GLP, GMP, Material safety data sheet	TRPTC, ILO CIS IPCS INTOX, Chemical Abstract Data base
Pesticides	Sudanese Standards & Metrology Laboratory (Monitoring)	Council of ministries	Ministries of Agric., Science and Technology, Higher Education, Environment and Health	Official for certain interministerial committees and personal for access to facilities	JMPR	No
Pesticides	Documentation and information centre, National Centre for Research, Ministry of science and technology (research)	Ministry of Science and Technology	Ministry of Agriculture, Environment, other research institutes	Official for certain interministerial committees and personal for access to facilities		No
Dioxins, Furans, PCBs, HCB, PFOS & tetra and penta BDE	National Chemical Laboratory (monitoring)	Ministry of Health	Ministries of Agric., Science and Technology, Higher Education, Environment	Official for certain interministerial committees and personal for access to facilities	EHC,JMPR, Pesticide safety data sheet, Chemical safety cards, GLP, GMP, Material safety data sheet	TRPTC, ILO CIS IPCS INTOX, Chemical Abstract Data base
Dioxins, Furans, PCBs, HCB, PFOS & tetra and penta BDE	Central Petroleum Laboratories (CPL) (Monitoring)	Ministry of Energy and Mining	Ministries of Health, Environment, Higher Education, Science and Technology	Official for certain interministerial committees and personal for access to facilities		No
Dioxins, Furans, PCBs, HCB, PFOS & tetra and penta BDE	Industrial Consultancy & research Centre, Ministry of Science and Technology	Ministry of Science and Technology	Ministries of Health, Environment, Higher Education, Science and	Official for certain interministerial committees and personal for access to		No

	(Research)		Technology, Agriculture	facilities		
Dioxins, Furans, PCBs, HCB, PFOS & tetra and penta BDE	Sudanese Standards & Metrology Laboratory (Monitoring)	Council of ministries	Ministries of Agric., Science and Technology, Higher Education, Environment and Health	Official for certain interministerial committees and personal for access to facilities	JMPR	No
Dioxins, Furans, PCBs, HCB, PFOS & tetra and penta BDE	University of Khartoum, Faculty of Science, Institute of Environmental Studies (Research)	Minister of Higher Education	Ministries of agric., Health, Environment, Science and Technology	Official for certain interministerial committees and personal for access to facilities	EHC, JMPR, Pesticide safety data sheet, Chemical safety cards	Chemical Abstract Data base
Dioxins, Furans, PCBs, HCB, PFOS & tetra and penta BDE	Quality Control laboratory, Ministry of Electricity (Monitoring of PCBs)	Ministry of Electricity	Ministry of Energy, Health, Environment, Higher Education, Science and Technology	Official for certain interministerial committees and personal for access to facilities	No	No

Source: National profile of chemical safety and questionnaire

The following conclusions can be drawn from the tables above:

- Experience and some equipment were available for the category of pesticides, while for other POPs (Dioxins, Furans, PCBs, PCB, PFOS, PBDE) there is no previous experience nor specific equipment.
- Institutions may have enough number of professionals, especially in the area of pesticides yet they all require additional training.
- Laboratory equipment is not appropriate for POPs testing (only for basic pesticides) and they need to be completed and upgraded. Also specific accessories (for analysis of POPs) need to be supplied as well.
- Method of analysis and experience is lacking for the category Dioxins, Furans, PCBs, PFOS, PBDE, PBB, and HBCD. For pesticides it may need up grading and further training.
- There is no official body for accreditation, yet GLP is followed.
- Adequate and dedicated budget would be required for maintenance, consumables and other needs.
- There are significant gaps in the availability of literature, information base and its distribution in the country.

- Background information on specific chemicals, such as pesticides and pharmaceuticals are acquired and maintained in the country, however, for other industrial chemicals such data are not available.

- Missing international literature includes OECD guidelines for the testing chemicals and WHO/UNEP Global Environmental Library Network.

- The following databases are not accessible: Global Information Network on Chemicals (GINC), STN Database & relevant Databases from other countries.

- The majority of national data is kept in paper files or with the person who conducted the work. Only few data are partially computerized (pesticide data).

- Very limited initiatives are currently directed towards improving the quality of existing data. A national centre affiliated to the council of ministers has been recently established and has not yet built its national data base. It may require a long time to include data on chemicals.

- Access to international database or documentation is not sufficient. Missing databases or international literatures were outlined earlier.

- Further information on a specific chemical or group of chemicals can only be obtained by direct contact with the manufacturer, the suppliers and sometimes from specific web sites.

- There is no national policy on public access to government information. The traditional practice is to give information upon official request while keeping classified information confidential.

- Legal cooperation between various departments is taken place through national committees and councils, however accessing facilities (libraries and laboratories) is not legalized in most cases and even the present level of cooperation is practiced against payment or free subject to personal consideration.

- National plans for monitoring and research are absent and therefore they should be formulated and put forward for execution.

2.3.13.2. Technical infrastructure on assessment of POPs alternatives

Considerable research activities and pilot and full size project for substituting hazardous pesticides (see 2.3.1.10) have been carried out. The knowledge and experience gained and the existing technical infrastructure should be utilized and extended to research on endosulfan alternatives.

For industrial chemicals no infrastructure and research capacity of assessing alternatives e.g. for PBDEs or PFOS, is available in Sudan. This assessment would need to be done by international cooperation or by gathering information on alternatives conducted by institutes in industrialized countries.

2.3.13.3. Infrastructure for POPs management

Sudan does not have infrastructure of POPs management.

A) Limitation of POPs measurement capacity

The first limitation is the infrastructure of monitoring of several listed POPs. Such monitoring would either mean the development of measurement capacity in the country or links to institutions and laboratories abroad with the capacity of POPs measurement.

B) Infrastructure of handling of POPs stockpiles and wastes

Due to the lack of projects on POPs management in the country no experienced company in handling of POPs exists in Sudan. In the original NIP resources for process development were available for e.g. educating staff for packing of POPs pesticides. With the NIP update budget such education was not possible. No training has been conducted yet on PCB management or new POPs management. Therefore there is a lack of infrastructure of handling POPs stockpiles and waste. However, awareness raising on POPs management can be performed as national experts are available.

C) Infrastructure of destruction of POPs

To date no obsolete POPs or stockpiles have been destroyed in Sudan as there is no dedicated facility for POPs or other hazardous waste destruction. There are some modern cement kilns which might be utilized for POPs destruction, however only very limited use of even secondary fuels (e.g. tyres) is practised. Therefore, there is an urgent need to develop capacity in this area.

2.3.13.4. Activities on POPs research and research & development

A wide range of research on alternatives to POPs pesticides and other hazardous pesticides have been conducted. These activities will be extended and will in particular look to alternatives to endosulfan.

Sudan also had/has dedicated research on the toxicity of pesticides. For the new listed POPs, Prof. Bashir (Khartoum University) had dedicated research on the endocrine effects of endosulfan and found a strong endocrine effect in rats. The results are compiled in a report and are planned to be published.

There is however no research capacity for several POPs groups due to the lack of analytical capacity including unintentionally produced POPs, PCBs, PFOS, PBDE or HBCD. Currently there is also no research cooperation on these POPs chemicals with international research groups. Therefore there is an urgent need to improve this situation.

2.3.13.5. Participation in international programmes and projects

Sudan participated in fourth round of WHO human milk studies for assessment of POPs in human milk in 2006/2007. Sudan is interested to participate in another round of assessing human milk including new listed POPs.

Sudan also participated in the global POPs air monitoring in cooperation with Stockholm Convention Regional Centre (RECETOX, Czech Republic).

2.3.14. Identification of impacted populations or environments, estimated scale and magnitude of threats to public

This section elaborates on the estimated scale and magnitude of threats to public health and environmental quality and social implications for workers and local communities.

While there are large threats for the individual POPs for the Sudanese population at large (e.g. pesticides or PCBs) or for vulnerable groups such as farmers or fire fighters or (informal) recyclers of WEEE (see the individual chapters for POPs above) there is a lack of capacity to assess these exposure and the impact.

2.3.14.1. POPs Pesticides

The assessment of POPs pesticide pollution in the last two decades revealed adverse effects on human including fatalities and environmental contamination in Sudan.

Leaking drums and torn bags can seriously increase the occupational risks and affect the health of staff working at storage sites and others who happens to come in contact with pesticides. In addition, these items often pose a broader risk to public health and the environment. Factors determining the level of hazard include:

- The quantity of pesticides; the condition of containers and packaging; and the degree of leakage;
- The toxicity of the products;
- The behaviour of the product in the environment (persistence, mobility in soil, solubility in water, volatility);
- The storage location (inside or outside a store); and the floor material (degree of permeability);
- The proximity of the storage site to densely populated areas;
- The groundwater level and the proximity of the storage site to water bodies.

A) Environmental pollution

In a study by Babiker (1998), 32 samples were collected from 12 locations inside the pesticide dumping site, viz. Qurashi store area, Hesaheisa H.Q. Stores (Gezira (Gezira State), and outside (50 and 100 m from the site in four directions). Gross residues of endosulfan (α and β), DDT, nitrogen and 2,4-D (in form of 2,4-dichlorphenol) appeared as the dominant contaminants over the origin of the dumping site, 50 and 100 m from the dumping area for the 4 directions. Western and northern directions were found to have the higher level of the 7 pesticides. Water samples showed lower level for HCH and heptachlor. The study concluded that the poor storage, exposure of obsolete and leaky containers of pesticides under various climatic conditions acting as a major factor of air, water and soil pollution.

A total of 100 soil samples were collected from 12 locations representing different parts of the Sudan during the period May to August, 1994 (Elmahi, 1996). These locations included the irrigated cotton and sugarcane schemes, rive rain region of Northern Province, mechanized and traditional rain-fed areas in

eastern and western Sudan, and the desert area of northern and western Sudan. The study concluded that DDT, heptachlor and dieldrin represented the major contaminants of irrigated cotton soils, although the levels were relatively higher in Gezira. Sugarcane production schemes soils showed some levels of dieldrin and heptachlor. Similar residue levels of aldrin, dieldrin and heptachlor were also detected in the rive rain soil of Northern Sudan. Mechanized, traditional and desert regions represent areas of little or no-pesticide use. Contrary to the expectation, relatively low levels of dieldrin and heptachlor were detected in these soils. The study proved that the usage of these pesticides in a certain area is the main factor behind the appearance of their residues in this area or even elsewhere. Soil residue levels obtained were not high, even over Hesaheisa dump site.

Cotton plant shoots, soil and canal water were sampled and analyzed for residues of the insecticide endosulfan sprayed on cotton during the season 1982/1983. Detectable residues were found in all three media, one month after spraying. Concentrations were 0.59 ppm, 2.55 (ppb) and 2.789 ppm for soil, water and plants, respectively. Endosulfan was first introduced into the Gezira in 1966/67 at a rate of 0.95 kg a.i./ha. Formulations used were Endosulfan 50% and 35% EC. In 1974/75 season ULs were introduced. In 1982/8 season about 250,000 I.G. were sprayed conventionally, and 55,000 I.G. as UL (Abdalla et al., 1985).

Human Contamination:

Elbashir (1998) collected 195 human blood samples, from 11 locations representing areas of limited and intensive pesticide use in the Sudan during May-August 1994. The regions surveyed were the same regions of the above study. DDT (DDE), heptachlor epoxide and dieldrin were detected in all locations surveyed. Their levels were quite variable between locations. Aldrin was not detected in all samples analyzed. Samples collected from residence of irrigated cotton schemes showed the highest level of all detected pesticides (average 260.63 ppb), followed by sugarcane schemes (204.0), traditional rain-fed area (55.11), and rive rain area (55.13). It is apparent that blood levels of tested OC's decreases with increasing distance from irrigated cotton schemes, where huge amount of these pesticides was used up to 1981. The highest concentration of DDT (617.94 ppb), heptachlor epoxide (170.23 ppb), HCH (91.66), and dieldrin (82.00ppb) were observed in blood samples collected from Medani, Hesaheisa, and Kenana, respectively. The total OC burden in the traditional rain-fed area was 67.83 ppb, in sugarcane schemes 204.05, in mechanized rain-fed area 55.11, in irrigated cotton schemes 20.63, and in rive rain area 55.13 ppb. The percentages of the samples test positive were as follows: HCH 86.15%, heptachlor 100%, DDE 100%, and dieldrin 98.46%.

Several studies were conducted in the Sudan aiming at studying the fate of these compounds in fish, birds, rats and plants (cotton and vegetables).

A study on the levels of POPs pesticides on DLCO-EA Staff and the Plant Protection Department staff (22-63 year old.) was performed in 1976. 90 blood samples were taken, analyzed for AchE and OC's, namely DDT, dieldrin and BHC and HCH (Lindane). For the latter, the minimum detectable concentration (g/ml whole blood) was 0. For the unexposed populations the levels were not assessable at that time. The upper acceptable limit used in the study was 20 ng/ml. For dieldrin the respective values were 1.0, 3.5 and 100,

following the same order. DDT figures were 10.0, 10.0 and 500. Some workers had very high OC levels in their blood.

Pesticide using staff, Wad Medani, Sudan, was expected to be occupationally exposed to insecticides, rodenticides and fungicides, either by selling, mixing or spraying, and more likely to suffer from their effects. OCs are known to affect the biochemistry of mammalian systems in various ways. The problem is mainly their chronic effects. The results obtained from the blood serum of occupationally exposed people were as follows:

- DDE was found in all samples with a range of 0.02 to 0.72 μg/ml;
- p,p-DDT was detected in seven samples out of 24 (0.01-0.18 μg/ml); o,p'-DDT and TDE (DDD) were also detected (0.01- 0.4 and 0.02-0.2 μg/ml, respectively.
- BHC was detected in 11 samples (0.07-0.15 μg/ml).
- The occurrence of aldrin and dieldrin (HEOD) was less frequent; their concentrations were lower than 0.03 g/ml.
- There is a correlation between DDE level in the whole blood and adipose tissues.
- DDT in the blood indicated very recent exposure, whereas DDE reflected the chronic level of DDT exposure.
- One year was required for the metabolism of DDT into DDE, when volunteers were fed high DDT dosages (5-35 mg/day).
- The results of this work showed that there was no correlation between year of exposure and the concentration in blood serum. The values obtained, when compared with those from Tunisia and Brazil was higher; but lower than those of India.

Sirag et.al. (1999) reported the mean concentrations of DDT, HCH, heptachlor and the OP chlorpyrifos (Dursban®):

- DDE accounted for 64% of total blood DDT, which was comparable with those reported in the other parts of the world (78-88%).
- No correlation was found between concentration of the identified pesticides and the age, body weight, duration of exposure, or occupation.
- Attempts were made by Sirag and his colleagues to reveal that a possible relationship between DDT concentration and the occurrence of neurological symptoms, e.g. chronic headache and tremor.
- The results did not show a significant correlation, but those who have OC's other than DDT, e.g. Lindane, α-HCH, heptachlor, and the OP chlorpyrifos tend to produce these symptoms.

This study concluded that:

a) Not DDT alone, but also other pesticides to be blamed in the toxic effects in humans, and its use as an effective chemical in agricultural pests and vector control should be re-evaluated, taking into consideration the ecological impact;

b) Spray men is a high-risk group, and the use of protective device, suitable for hot climate, is encouraged.

Overall, the threats to farmers from pesticides are considered high. In particular the fatalities (including those from endosulfan exposure) need to be taken serious and safer alternatives including organic farming need to be further developed in Sudan.

2.3.14.2. PCBs

Occupational exposure for workers dealing with PCB contaminated oils is a large threat and had resulted in high contamination of workers dealing with PCBs. As the ENVIO case in Germany has revealed such occupational exposure even take place today in industrialized countries[82]. The presence of PCB oils in Sudan in transformers requires that companies have to take precautionary measures to ensure that risks to both workers and the environment are reduced and eliminated. An assessment on contamination of personnel treating transformers and condensers and managing these waste oils is necessary (action plan).

Since a comprehensive survey of PCB contaminated sites has not been conducted yet, the impacts that may occur cannot be determined. However, PCBs when released to the environment can pose a serious threat to human health. The maintenance operation of transformer stations in the last 40 years has most probably resulted in contamination of the area and the surrounding. Storage sites of transformers and condensers most likely have resulted in PCB contamination of these areas and their vicinity. Chicken eggs and cattle around these areas can be expected to be contaminated with PCBs. An assessment on the contamination of these areas and the food chain is necessary (see action plan).

In addition to the responsibility of the companies, assistance will be required from government agencies and research institutions.

2.3.15. Details of any relevant system for the assessment and listing of new chemicals

Agricultural chemicals suggested for commercial use in the Sudan must go through a stringent system of testing and evaluation. No agricultural pesticide is accepted for commercial use without the permission of the National Pesticides Council (NPC). Upon recommendation by the National Pests and Diseases Committee (PDC), chaired by the Director General of The Agricultural Research and Technology Corporation (ARTC), the following actions have to take place:

- Detailed chemical information of newly introduced pesticides, in accordance with the Pesticide Act 37 of 1974, has to be submitted to the NPC (Same for the Act 1994).

82 ENVIO – the PCB scandal (http://envio.derwesten.de/ in German)

- A technical committee (TC) emerged from the NPC shall study all available data about the chemical (s). This committee raises its recommendations to NPC to decide about the chemical(s).
- Accepted application(s) will be given permission to introduce only experimental samples to the country for testing.
- The experimental samples will then be handed to the relevant section of the ARTC to conduct the necessary testing according to the regulations decided by the PDC.
- The work on testing of each chemical will be carried out by a working team headed by a research scientist.
- By the end of the test period, the scientist in charge of the chemical will present his/her findings before all PDC members; the latter will decide whether to pass or reject the recommendation (s) of the scientist in charge.
- Recommended chemical(s) will be passed to the registrar of the NPC, together with all necessary information about dose per unit area, crop, pests, residues, etc. for final registration.
- • Copies of the recommendations will be sent to the agricultural schemes.
- • Following the payment of the final registration fees, the applicant (s) is allowed to market the chemical (s) in the Sudan.

2.3.16. Details of any relevant system for the assessment and regulation of chemicals already in the market

Pesticides released by PDC (ARC) are subject to further testing on commercially grown crops at the agricultural schemes all over Sudan, what is known as demonstration trials (5,000 to 10,000 F). Pesticide companies provide the product and ensure the compensation for any crop losses, due to the use of product. The testing sites and other requirements are arranged in coordination between the company and the scheme. Companies carry out such trials to display the efficacy and efficiency of their chemicals, so as to encourage the schemes to use these products.

Pesticides that prove to perform as required are likely to be given a chance for nomination by the specialists when discussing the purchase of next season products.

The Public Health pesticides and the Veterinary pesticides follow the same procedure.

Endosulfan is currently registered and used in Sudan to control a wide range of pests on a variety of crops including coffee, cotton, rice, sorghum and soy. Endosulfan is one of the oldest chemical registered in Sudan. This insecticide is used alone and in mixtures for controlling cotton pests either the pest alone or complex. Endosulfan is not regulated yet but will be regulated in the frame of implementation of the convention.

In Sudan, lindane is registered and used currently for controlling ectoparasites of livestock, and onion farmers use the same formulation to control thrips and cutworms. The inventory showed that in the northern state, where faba beans are produced, farmers are using lindane to protect their products from store pests. The inventory also showed that lindane is illegally commercialized through the eastern borders in 10 kg sacs. Quantities are illegally used in Gadarif and the Northern State. The chemical is very cheap (10 pounds/kg) compared to other pesticides. According to the inventory farmers confessed that they can easily get it and retailers have not denied this statement.

3. Strategy and action plan elements of the national implementation plan

Section 3 has the two following elements: the formal policy statement and the implementation strategy for the NIP. The implementation strategy sets out specific action plans or strategies to achieve Convention obligations and any additional objectives set by the country.

3.1. Policy statement

Sudan was one of the first African countries promulgating legislation concerning protection of the environment. Although there are about 150 Acts, local orders, and related regulations addressing environmental issues, these laws are sectorally fragmented and lack a comprehensive view to the overall environment.

Various times, Sudan expressed its commitment in meeting the sustainable development goals. Sudan's main objectives and priorities for sustainable development were spelt out in the National Comprehensive Strategy (NCS 1992-2002,) which provided policy directions to all economic and social sectors. NCS incorporates the country's environmental strategy, which states clearly that environmental issues must be embodied in all development projects including Sugar Industry. Sudan pays great attention to preventing negative effects of various national developments on human health. It also makes informed decisions, raises public awareness to decide on development projects after carrying out mandatory environmental impact assessment.

Despite all above, the country faces many challenges and obstacle such as lack of adequate financial resources, poor technical, institutional and human capacity and week infrastructure; institutional challenges to achieve integration between different themes; weak implementation mechanisms; and poor data and information systems to guide program planning.

Sudan is a signatory to the conventions dealing with hazardous waste and chemicals (Basel, Rotterdam and Stockholm Conventions). Sudan is also signatory to many regional and international conventions, such as RAMSAR Convention, which addresses conservation of wetland. The country has taken considerable effort towards providing hydropower in the Nile Basin and producing bio ethanol from sugar molasses, which had previously been wasted. These are steps for Sudan towards more sustainable consumption and production (SCP). An action plan for sustainable consumption and production has however not been developed yet. The efforts on developing an inventory of material flows of EEE/WEEE and transport sector initiated by the NIP update can be regarded as an impulse for more SCP for these material flows. In particular the option for a better management of resources in these material flows can contribute to SCP if the waste management and recycling can be improved.

Sudan is confronted with many challenges such as the reconstruction, development and peace building that would require a international support. In addition, rapid urbanization and growth of the population is placing a heavy burden and paramount pressure on urban facilities, like sewage and drainage systems. The lack of sound management of industrial waste should be addressed While iron and some other metals are recycled, other wastes including chemicals, polymers, industrial waste water are largely dumped posing a threat to health and environment.

Since 1984, Sudan has made great efforts to improve the fragmented environment laws by formulating an umbrella law with strong policy orientation providing a basis for coordinated actions. The Environment Protection Act 2001 represented an important development in harmonizing different environmental sectoral laws. Adopting of such a legislative act was the first step Sudan made towards an integrated and coordinated implementation of environmental sectoral laws.

The establishment of the Higher Council for Environment and Natural Resources (HCENR) under the supervision of the President of the Republic and presided by the federal Minister of Environment and Physical Development, with membership of relevant ministers and a number of members with sufficient know-how, experience and interest in affairs of environment and natural resources, shows that Sudan's commitment to address environmental issues is placed at the highest possible level on its national agenda.

HCENR is also the governing body responsible for Stockholm Convention implementation, whose functions is the long term planning and co-ordination at national level in dealing with the negative effects of Pops.

The adoption of 'modernization' in agriculture (which is actually not modernization but horizontal expansion in agricultural practices with very little vertical direction), using POPs pesticides unsustainably, has become an instrument of interference in the traditional sector, taking away from its resources such as lands, forests, ranges, pastures and wildlife.

Mindful of the effects of "unsustainable agriculture" and as a Party of conventions on climate change, on combating desertification and biodiversity loss, Sudan is committed to implement their requirements in an integrated manner in order to protect human health and environment.

Sudan is aware that POPs are only a part of the chemical management challenge. Therefore HCENR is aiming to coordinate different activities on chemical management (POPs, mercury, ozone depleting substances, SAICM) as well as climate change mitigation considering short-lived climate pollutants, which for carbon black emission reduction linked to unintentional POPs reduction including open burning. There is also an overlap of reduction of unintentional POPs and mercury in different industrial sources. Therefore, Sudan will aim to harmonize the implementation of these two conventions. The waste management and destruction of hazardous chemicals need to be addressed in an environmentally sound manner and should address all type of hazardous chemical wastes and their destruction securing co-funding for implementation. It is Sudan's view that dealing with POPs issues in an integrated manner, as part of country's framework action plans (chemical management plans, waste management plans, contaminated sites action plans etc.), will lead to an effective and efficient implementation resulting in professional confidence and attracting international donors.

In respect to the public awareness on POPs, the efforts exerted by HCENR through implementing POPs projects and projects related to environmental impacts of chemicals, such as SAICM activities, have contributed in attributing greater importance to the POPs issue in Sudan and in enhancing awareness raising. The environmental education has been introduced in the curricula of several universities. Some of them created environmental colleges or environmental departments and the University of Khartoum established the Institute of Environmental Studies for post graduate students.

Sudan also recognizes the need for scientific research in various disciplines, especially in the POPs field and its goal is to setup institutions for POPs monitoring and research.

The Sudanese Government is aware that undertaking just legislative measures is insufficient for the implementation of international commitments of the country concerning the management of POPs. Hence other measures are contemplated and applied, including allocation of funds from state budget and seeking for additional financing under international and intergovernmental funding programs. As it can be seen from previous chapters, Sudan proved to be a serious partner in several projects implemented and aims to build further its image for international donors in order to attract more funding for environment issues, including POPs management, reduction and phase out.

3.2. Implementation strategy

3.2.1. General

Sudan is a developing country with limited resources available to address both national and global environmental issues. In respect to the latter, the protection of biodiversity while allowing sustainable resource development, and managing the country's high vulnerability to desertification and climate change remain overall national priorities. However, it is also recognized that management of POPs and more broadly ensuring sound management of chemicals are linked to the above issues and will require attention.

This underlines the importance of maximizing synergies and coordinating action plans related to chemicals issues and chemicals related international obligations. In light of this MoE will dedicate resources to implement SC. However, a key part of the implementation strategy will involve solicitation of international assistance from both bi-lateral and multi-lateral sources.

The strategy for implementation of the updated NIP is based on the following principles:

- Integrated approach considering synergies between conventions and integrated in national plans on chemical management and waste management (see policy statement);
- Sustainable management of POPs aiming at prevention and mitigation of the risk for human health and the environment;
- Priority of prevention of the harmful impacts of POPs and other dangerous pollutants of the environment;
- Comprehensive application of BEP and BAT, wherever technically feasible and affordable;
- Application of the principle of polluter pays for damages caused and of extended producer and importer responsibility for articles containing POPs;
- Application of the principle — liability of producers‖ for prevention and reduction of hazardous wastes, formed in producing their products;

- Involvement of the community and stakeholders, and transparency in the decision-making process in POPs management.

The strategy for implementing of the objectives and priorities includes:

- Applying an integrated approach in implementing SC coordinated by MoE through active involvement of ministries and institutions responsible for laws and regulations related to the management of POPs.

- Use of effective and efficient measures for implementation and support of planned activities including legislation and control, information and training, economic measures, use of existing structures and improvement of these structures.

- Monitoring of human health and the environment contamination level.

- Prioritization of the activities which may affect positively the health of population.

- Engagement of NGOs in informing communities and stakeholders regarding the effects of new listed POPs on human health and the environment including awareness on sustainable consumption and production.

- Provision of access to information on POPs via the Internet by MoE.

- Coordination of activities for managing POPs through cooperation in the application of the Stockholm, Rotterdam and Basel Conventions and where appropriate other conventions and national activities for chemical and waste management as well as SCP.

The Higher Council for Environment and Natural Resources (HCENR) as the national focal point to implement the Stockholm Convention and the Convention related administrative activities was established. Even though, in future, the management of POPs mitigation and phase-out activities might turn to sector-specific actions (e.g. specific stakeholders responsible for pesticide management or WEEE management or owners of PCB stockpiles) and programs, it is highly recommended that the implementation remains the sole responsibility of one organization, i.e. HCENR which will not only manage the Convention related administration but manage the overall POPs issue, coordinate and balance the efforts and monitor the progress.

Implementation of NIP actions should be well integrated with national environmental action plans or environmental strategies as well as chemical and waste management plans. NIP implementation should be linked to related initiatives where possible to ensure maximum efficiency and reduce duplication of efforts. Therefore, implementing technical projects requiring specific technical and scientific skills and introducing new industrial practices should all be reviewed under the Stockholm Convention. An effective and efficient implementation asks for good communication and extensive cooperation with the national partners (Ministry of Agriculture, Ministry of Health, Ministry of Industry, Ministry of Justice, Ministry of Finance, industry associations and individual industries, civil society groups/NGOs, research institutions and universities), as well as with external partners, such as co-financiers and donors.

3.2.2. Integrated approach of implementing chemical conventions and other conventions

In recent years, the importance for coordination of implementation chemical conventions has been emphasized. At international level, the Conferences of Parties to the three conventions called for greater cooperation and coordination among the three conventions, and measures to be taken for a more harmonized implementation. The secretariat of the three conventions has been combined and the Conference of Parties of the Conventions has been organized back to back.

The harmonized implementation approach will also be considered at national level as a policy and strategy. Sudan has ratified and is a signatory to the three chemical conventions and other international conventions and agreements. At national level efforts need to be made to synchronize the implementation of the 3 conventions. Environmentally sound hazardous waste management is an important prerequisite for implementation of the Stockholm and Basel Conventions but also for the mercury convention. Furthermore, international efforts on protecting the ozone layer have waste management aspects such as management and destruction of Ozone Depleting Substances (ODS) present in air conditioners including cars. The inventory of vehicles and electronic waste in the frame of the Stockholm Convention for POP-PBDEs and the initiation of their end of life management can at the same time used for a better management of ODS present in vehicles and other air conditioner. Also the inventory and management of polystyrene in housing/construction can possibly be combined with the inventory and management of PUR foam containing CFCs.

The expensive and time-consuming waste management and export efforts for PCBs, POPs pesticides, but also ODS, have alarmed the government and the private sector to seek a more sustainable management of chemicals and articles containing hazardous chemicals. It becomes obvious that a policy for imports of chemicals and articles containing hazardous chemicals is urgently needed. It becomes even more obvious considering new POPs containing waste fractions like electronic waste, waste from end-of-life vehicles or synthetic carpets imported without notice that these articles might contain hazardous chemicals. Such high volume wastes containing hazardous chemicals have entered Sudan in thousands of tonnes over the last two decades and have been dumped or burned in the open. While it has been recognized that disposal of waste in Sudan contaminates soils and threatens precious ground water resources, the listing of new POPs - present even in household wastes (e.g. EEE, cars/vehicles, furniture, mattresses, synthetic carpets, impregnated textiles, impregnated paper) - emphasizes that a new waste management and import policy is required to cope with materials and articles containing hazardous chemicals and to move to more sustainable consumption.

The effects of leaching POPs and other chemicals from landfills and dumps into water resources and contamination of natural resources such as biota, emphasize the need for an integrated management of import, consumption, waste management and treatment of these POPs and POPs-like[85] material flows. A development strategy for a green economy aimed at incorporating environmental aspects into all national plans and programmes, such as green economy, can facilitate this approach.

The waste management efforts are directly link to sustainable production. Considering the challenges of managing POPs and new POPs, such policy needs to be developed within the framework of the implementation of SC and Basel Convention. Such efforts can be linked to sustainable consumption of the

Sudanese population. The issue of POPs and new POPs can be used as an awareness raising tool for all stakeholder groups.

Sudan is strongly impacted and threatened from climate change and therefore highly active and committed in this area. There are strong interlinks between POPs and climate change[83]. E.g. the reduction of unintentional POPs releases by reducing open burning (waste, agricultural residues) is also mitigating climate change by reduction of carbon black emission, which is a short-lived climate pollutant. Improved waste management and recycling reducing waste volume which in Sudan otherwise are burnt on the dump sites or resulting in methane emission.

3.2.3. Integrating POPs/chemical management and policy with waste and resource management considering the waste hierarchy

POPs are only a part of thousands of hazardous chemicals in current use. Sudan's strategy is to manage hazardous chemicals and chlorinated, brominated and fluorinated POPs in an integrated manner.

To manage PCBs and pesticide stockpiles in the last 10 years in SC implementation have revealed large challenges for Sudan It was recognized that PCBs negatively impact a large recycling flow of used oils. With the listing of POP-PBDEs the threat of other material flows were revealed (plastic from EEE and polyurethane foam), which resulted even in the exemption for recycling. Also PFOS is impacting recycling flows of carpets and possibly textiles. These examples demonstrated how POPs and other hazardous chemicals are negatively impacting reuse and recycling.

The need for a better resource management and higher recycling rates highlight the need for a quick phase out of POPs and POPs-like chemicals from articles and products not only for the protection of human health but also for the protection of recycling flows. Clean recycling cycles are a base for moving towards a more circular economy. At the same time this would reduce and minimize the waste volumes. The policy and strategy of Sudan is to phase out chemicals and materials which hinder or hamper the reuse, recycling or recovery (including energy recovery) of products and materials.

3.2.4. Addressing POPs phase out and use of alternatives within sustainable consumption and production approach

In accordance with the provisions of the Article 7(3) of SC, "Parties shall endeavour to utilize and, where necessary, establish the means to integrate national implementation plans for persistent organic pollutants in their sustainable development strategies where appropriate" Sudan is aiming to address POPs in connection to sustainable consumption and production efforts. Activities towards more sustainable consumption and production (SCP) have been initiated but an action plan for SCP has not yet been developed.

The contamination of several potential recycling flows by POPs revealed the negative impact of POPs and threat for a circular economy and resource conservation. The negative impact of halogens in high calorific fractions such as PBDEs/BFRs and PVC in WEEE plastic or polymer fraction of end of life vehicles hampering or restricting their thermal recovery e.g. in cement industry. Since most of these materials are imported

83 UNEP/AMAP (2011) Climate Change and POPs: Predicting the Impacts. Report of the UNEP/AMAP Expert Group.

to Sudan their sustainable production should be performed in the countries producing these articles. A contributing policy shift in Sudan can be an extended producer and importer responsibility for EEE/WEEE and vehicles. The efforts in developing an inventory of material flows of EEE/WEEE and transport sector initiated by the NIP update can be regarded as a first step of addressing these material flows an appropriate strategy of substitution and regulatory frame The option of a better management of resources in these material flows can contribute to SCP if waste management can be improved. Improved recycling and recovery are also opportunities for development of small and medium sized companies and therefore for eradication of poverty and improvement of standard of living for those becoming employed by this work.

A key is the substitution of POPs or otherwise hazardous chemicals with more benign substances. The alternative chemicals are best selected from green chemistry“ approach, which represents the design of chemical products and processes that reduce or eliminate the use and generation of hazardous substances. Fewer hazardous substances mean less hazardous waste and a healthier environment with an overall lower contamination and exposure. This green approach is securing recycling and reuse and therefore supporting the waste hierarchy and SCP. These efforts on alternatives to POPs and other hazardous chemicals can be seen as business opportunity. For Sudan as agricultural country the science based substitution of POPs (and other hazardous) pesticides can be seen as a large opportunity and contribution to SCP.

3.3. Activities, strategies, and action plans

3.3.1. Activity/Action Plan: Institutional and regulatory strengthening measures

Strengthening institutional and regulatory mechanisms to manage, monitor and control POPs is fundamental to addressing national POPs issues. However, the basic assessment of the legal and institutional framework on POPs has identified several gaps and limitations which restrict environmentally sound POPs management. A major challenge is the lack of national legislation for management of all POPs, especially new POPs, including a lack of standards and occupational safety instructions for workers handling POPs in Sudan. Another major limitation in proper POPs management is the lack of a legal framework on information gathering, public awareness raising and knowledge exchange. Moreover, there is lack of capacities and legislation on monitoring and control and monitoring of POPs. The goal of the action plan on institutional and regulatory framework strengthening measures is to develop and enforce a legal framework for environmentally sound management of POPs.

Table 25 - Legislative, institutional and regulatory action plan

POPs Group	Description	Responsible Institution		Priority Low=1 High=5	Timeframe	Costs (USD)
		Main Responsibility	Partial			
General	1. Developing/adopting of improved legislation and enforcement for management of POPs integrated in general management of hazardous chemicals and waste	HCENR	MoA; MoH; MoJ; MoI; MoM	4	Medium Term 2-5 years	50,000
	2. Improved information management for POPs integrated in general information management hazardous chemical/waste	HCENR	MoA; MoH; MoJ; MoI; MoM	4	Medium Term 2-5 years	40,000
	3. Improvement of traceability of POPs/PTS chemicals and chemicals in products and articles: Implementation of GHS; database development and update	HCENR	MoH& Department of Custom	2	Medium Term 2-5 years	100,000
	4. Database development for POP/PTS chemicals, stockpiles, wastes and contaminated sites	HCENR	MoA; MoH; MoJ; MoI; MoM	3	Medium Term 2-5 years	30,000

	5. Empowerment of an agency for consumer protection	HCENR	MoA; MoH; MoJ; MoI; MoM	2	Medium Term 2-5 years	20,000
	6. Development of tools and indicators to assess socio-economic impact of POPs/PTS	HCENR	MoA; MoH; MoJ; MoI; MoM; MoF	2	Medium Term 2-5 years	30,000
	7. Assessment of progress of implementation of various environmental conventions	HCENR	MoA; MoH; MoJ; MoI; MoM	1	Medium Term 2-5 years	5,000
Custom Control	1. Assessment of gaps in import legislation of POPs/PTS and POPs/PTS in articles and improve custom control	Customs Administration	Ministries of Industry ,Trade, Agriculture and Health	5	Medium Term 2-5 years	10,000
	2. Update of Customs Office databases to track imported chemicals	Customs Administration	Ministries of Industry ,Trade, Agriculture and Health	3	Medium Term 2-5 years	10,000
	3. Establishment of Protocols between Customs Office and Ministry of Environment to build comprehensive and user friendly records on chemical import and export.	Ministry of Environment (HCNER)	Customs Administration	4	Medium Term 2-5 years	10,000
	8. Updating existing regulations for newly listed pesticides in the respective Convention annexes	NPC	MoJ	5	Short term 1-2 years	10,000

POPs Pesticides	9. Need' assessment and listing of exemptions	HCENR	MoH; MoA	3	Short term 1 years	5,000
	10. Defining measures to combat illegal traffic of banned pesticides and counterfeit products	Dept of Custom	NPC; HCENR; MoH; SAGA	3	Short term 1-2 years	5,000
	11. Defining a strategy on preventive measures to avoid reoccurrence of obsolete pesticides stocks	NPC	HCENR; MoH; SAGA	3	Short term 1-2 years	5,000
	12. Ensuring implementation of good agricultural practices	MoA	Farmer Union	2	Short term 1-2 years	50,000
	13. Providing training for farmers in safe and sustainable use of available pesticides in the market	NPC	HCENR; MoH; SAGA; Universities	3	Short term 1-2 years	40,000
	14. Establishing of POPs/PTS focal point, administration or center	HCENR	MoA; MoH; MoI	3	Short term 1-2 years	5,000
	15. Training of administration and research staff in the area of POPs in general, and POPs-Pesticides specifically	NPC	HCENR; MoH; SAGA; Universities; Research institutions	3	Short term 1-2 years	40,000

	16. Identifying, strengthening and improving capacity (laboratory infrastructure) to deal with POPs and PTS issues (scientific, analytical, modelling, accreditation, risk assessments, etc.)	HCENR	MoH; Universities; Research institutions	3	Medium Term 2-5 years	1,000,000
	17. Encouraging development of tools and indicators to better assess the impact of POPs/PTS on socio-economic activities and the progress of implementation of various environmental conventions	HCENR	MoA; MoH; MoI; universities	3	Medium Term 2-5 years	10,000
PCBs	1. Review adequacy of regulations in removing and eliminating PCBs in use and out of use and strengthening existing legislation	MoED	HCENR	3	Short term 1-2 years	10,000
	2. Establishing penalties and fines for improper management of PCBs containing equipment (in use and out of use), for late or no submission of progress reports to the responsible authorities on amount of PCBs containing equipment that are still in use, the out of use equipment and on	MoED	HCENR	3	Short term 1-2 years	10,000

	the number and size of equipment disposed					
	3. Developing and implementing incentives for electric utilities to comply with phasing-out of PCBs	MoED	HCENR	3	Short term 1-2 years	5,000
	4. Defining a National PCBs Elimination Plan to be included in the National Hazardous Waste Management Plan and defining the liabilities of institutions and companies in PCBs containing wastes management and disposal	MoED	HCENR	3	Medium term 2-5 years	20,000
	5. Strengthening control and inspection of locations where PCBs containing equipment are still in use interim storages and disposal facilities that are operating	MoED	HCENR	3	Medium term 2-5 years	20,000
	6. Setting up legislative requirements for interim storage and disposal facilities of PCBs containing wastes	MoED	HCENR	2	Medium term 2-5 years	5,000

POP-PBDEs	1. Update of all existing legislation on updated Stockholm Convention Annexes	HCENR	MoJ	5	Short term 1-2 years	5,000
	2. Update of legislation for new requirements identified under NIP update process such as restriction on recycling of POP-PBDE containing plastics and on imports of used EEE/vehicle/goods	Ministry of Environment HCNER	Moj; MoI; Dept of Customs and Traffic Administrations)	3	Short term 1-2 years	20,000
PFOS, its salts and PFOSF	1. Review laws and regulations on management of PFOS	HCENR	MoJ, MoH, custom department Private sector, Municipalities, NGOs	2	Short term 1-2 years	100,000
	2. Amend existing laws or develop new laws as required on management of PFOS.					
	3. Banning of PFOS with exemption for use of aviation hydraulic fluids and possibly fire-fighting foams (exemption period to be determined by responsible authorities).					
	4. Establish database on PFOS and related substances in a chemical database including integrated management and waste disposal					

	5. Develop a programme for control and elimination of PFOS from identified sources					
UPOPs	1. Amend existing laws or develop new laws as required on management of UPOPs	HCENR MoE	MoJ, MoH, MoI, Private sector	3	Short term 1-2 years	20,000
	2. Establish regulations on chemicals and materials aiming at reducing UPOPs, such as preparing memoranda of understanding (MOU) with industry groups on phasing out machinery and equipment that are sources of releases					
	3. Develop release standards for UPOPs to relevant environmental media by assessinglevels of UPOPs inair, soil, water, product, residue, food					
	4. Conduct awareness and training courses for stakeholders on legal issues of UPOPs					

3.3.2. Activity: Measures to reduce or eliminate releases from intentional production

Article 3 of SC requires Parties to take legal and administrative measures to reduce or eliminate releases from intentional production and use of POPs. Results of the inventory showed that no POPs are intentionally produced in Sudan.

3.3.3. Activity/Action Plan: Production, import and export, use, stockpiles, and wastes of Annex A POPs pesticides (Annex A, Part I chemicals)

POPs pesticides are imported and used in Sudan (endosulfan). Also stockpiles and wastes exist and have not been disposed of due to the lack of funding.

The overall objective of updated NIP strategy and action plan is to have safe use of pesticides and minimization and substitution of pesticides for protection of human health and the environment. The strategy that is executed in NIP implementation is based on:

- Improve the substitution of POPs pesticides and other hazardous pesticides by non-chemical alternatives
- Use of less hazardous pesticides
- Safe use of potential hazardous pesticides if no alternative exist
- Banning the use of POPs pesticides and other extremely hazardous pesticides as soon as possible
- Environmentally sound disposal of POPs pesticides and pesticides stockpiles

For successful implementation of the strategy and enforcement of regulations shall be closely followed to ensure environmentally sound handling, storage and disposal of pesticides. To adequately address gaps (registered in a comparable format, information about the risks of pesticides, lack of a system of liability and enforcement), the action plan focus on activities that need to be undertaken in areas of legal and institutional measures, inventory development, handling, storage, transfer and disposal of POPs pesticides, monitoring of POPs pesticides, research on alternatives and awareness of stakeholders (Table 27).

It has been recognized that collecting empty pesticides containers in stores and preventing their use by the public, raising public awareness regarding the use of such containers, and availing cheaper substitutes for those who are using them for one purpose or another should be done through extension offers, physician, radio stations, T.V., schools, mosques and churches, newspapers, pictorials and posters, etc., (see action plan). Local governments must do their best efforts to provide sustainable clean water supply to people who would leave the unhealthy practice of storing drinking water in pesticide barrels and containers.

Table 26 - Action plan POPs pesticides

Group \Activity	Description	Responsible Institution		Priority Low=1 High=5	Timeframe	Costs USD
		Main Responsibility	Partial			
Develop and update POPs pesticides inventory	1. Improvement of POPs Pesticide inventory (stockpiles, hazardous waste, contaminated sites)	NPC	MoA; MoH; MoAR	5	Short term 1-2 years	50,000
	1. Providing training for farmers in safe and sustainable use of available pesticides in the market	NPC	MoA; MoH; MoAR; Universities	5	Short term 1-2 years	30,000
	2. Ensuring implementation of good agricultural practices	MoA	Farmer Union	2	Short term 1-2 years	50,000
Pesticide management:	3. Improvement of POPs pesticide (endosulfan) and general hazardous pesticide management	NPC; MoA	Farmer Union	2	Short term 1-2 years	40,000
	4. Establishing capacity to address disasters and emergencies related to POPs pesticides (spillage, poisoning, contamination, explosion, etc.)	NPC	States and NGOs	4	Medium term 2-5 years	50,000
	5. Establishing of empty containers collecting and management system with specific	NPC	States, SAGA and NGOs	5	Medium term 2-5 years	50,000

Handling, storage, transfer and disposal of POPs pesticides	attention to address the use of empty pesticides containers					
	6. Disposing obsolete POPs pesticides stockpiles and remediating contaminated sites	NPC	States, Universities and Research institutions; SAGA and NGOs	5	Medium term 2-5 years	1,000,000
	7. Establishing of environmentally sound pesticide stores in all schemes and Federal and State Ministries of Health	MoA	MoH; MoAR	2	Medium Term 2-5 years	1,000,000
	8. Conducting risk assessment for POPs pesticides and their alternatives using existing and new data	NPC	Universities and Research Institutions	2	Medium Term 2-5 years	30,000

3.3.4. Activity/Action Plan: Import and export, use, identification, labelling, removal, storage and disposal of PCBs and equipment containing PCBs (Annex A, Part II chemicals)

The overall objective of the strategy and action plan is for eliminating the use of PCBs containing and contaminated equipment by environmentally sound management and phase-out of this equipment. To adequately implement such a strategy and action plan it is necessary that a comprehensive inventory is prepared with risk assessments on both electrical devices and other sources of PCBs such as 'open applications'. To prepare this inventory the following actions will be implemented (Table 28).

The present action plan includes actions and measures, such as legislative measures, measures on development and update of PCBs inventory and on handling, storage, transfer and disposal of PCBs, PCB-containing materials and PCBs wastes, as well as PCBs monitoring actions. For ensuring an effective and efficient implementation the responsible authorities and timeframes are defined. A priority ranking and the funding requirements is included for sound implementation.

The activities for PCB contaminate sites and for environmental monitoring are included in chapters 3.3.13 and 3.3.18.

Table 27 - Action plan PCBs

Group \Activity	Description	Responsible Institution		Priority Low=1 High=5	Timeframe	Costs
		Main Responsibility	Partial			
Legislative measures see action plan on legislative measures						
Develop and update PCBs inventory	1. Updating inventory of PCBs containing transformers (in use and out of use) in electric utilities including distribution networks, industrial facilities, railroad systems, underground mining operations, residential and commercial buildings, research laboratories, waste water discharge facilities, automobile service stations, etc	MoED	HCENR	2	Medium term 2-5	20000
	2. Developing of inventory of PCBs containing capacitors in power generation, power transmission and power distribution industry sectors	MoED	HCENR	2	Medium term 2-5	10000
	3. Developing of inventory of PCBs in open applications (construction, sealants and flooring)	MoED	HCENR	2	Medium term 2-5	10000
	4. Developing and regularly updating PCBs information database	MoED	HCENR	2	Medium term 2-5	5000

	5. Monitoring progress on PCBs phase-out	MoED	HCENR	2	Medium term 2-5	5000
Handling, storage and transfer of PCBs, PCB-containing equipment and PCBs wastes	1. Assessing existence of interim storage and disposal facilities for PCBs	MoED	HCENR	2	Medium term 2-5	5000
	2. Implementing Convention guidelines for environment sound management of PCBs	MoED	HCENR	2	Long term 5-10	10000
	3. Establishing regular inspection and control on handling, storage, transfer and disposal of PCBs, PCBs containing materials and PCBs wastes	MoED	HCENR	2	Medium term 2-5	10000
	4. Proving proper training for operators, owners of PCB containing equipment, government and custom authorities staff on environment sound management and disposal of PCBs	MoED	HCENR, Customs, MoI, Private sector, Universities	2	Medium term 2-5	20000
Disposal of PCB containing wastes see action plan on POPs waste disposal						
Monitoring of PCBs (environment, food, contaminated sites) see action plan on monitoring						

3.3.5. Activity: Action Plan: Import and export, use, stockpiles, and wastes of hexaBDE and heptaBDE (Annex A, Part IV chemicals) and tetraBDE and pentaBDE (Annex A, Part V chemicals) (and HBB, where applicable (Annex A, Part I chemicals))

According to the inventory report POP-PBDEs have never been produced in Sudan and most probably, articles containing POP-PBDEs have not been produced as well. However, a large amount of POP-PBDE has been imported via electrical and electronic equipment. It is present in vehicles and possibly other goods and wastes.

The action plan implementation will lead to tracing of the presence of POPs-PBDEs containing products used by consumers, and currently recycled, stockpiled, or land fill. Actions on strengthening collaboration among stakeholders are included to bridge the gaps in the information required for future in-depth quantitative estimation of POPs-PBDEs.

For managing PBDEs, the life cycle management (import, export, use, recycling, and destruction) of POPs containing articles and products and wastes needs to be developed, in particular for EEE/WEEE, vehicles and end of life vehicles. In addition, PBDE and in particular HBCD are used in insulation (polyurethane and polystyrene) of housings.

For these three large material and waste flows resource recovery and recycling need to be considered, following the waste management hierarchy for recovery of resources. Pollutants such as PBDE, HBCD and other POPs/PTS need to be phased out of recycling.[84]

84 Stockholm Convention (2012) Guidance on best available techniques and best environmental practices for the recycling and disposal of articles containing polybrominated diphenyl ethers (PBDEs) listed under the Stockholm Convention on Persistent Organic Pollutants; Draft July 2012

Table 28 - POP-PBDEs action plan

Activity group	Description	Responsible Institution		Priority Low=1 High=5	Timeframe	Costs USD
		Main Responsibility	Partial			
Refining and improvement of PBDE inventory	1. Improvement of PBDE inventory	HCNER	Universities and Research Institutions	2	Medium term 2-5 years	5,000
	1. Assessment of material flow of POPs (and other) flame retarding articles, products and recycling streams	HCNER	Universities and Research Institution, Customs	4	Medium term 2-5 years	20,000
	2. Carrying out e-waste inventory needed for environmentally sound management of EEE/WEEE (incl. future time perspective)	HCNER	MoI; Universities and Research Institution, Customs	3	Medium term 2-5 years	20,000
	3. Carrying out inventory of transport sector including end-of-life vehicles (incl. future time perspective)	HCNER	MoI; Universities and Research Institution, Traffic	3	Medium term 2-5 years	10,000
	4. Preparing inventory of construction insulation and textile that containing HBCD and assessing if furniture, mattresses, or	HCNER	MoI; Universities and Research Institution,	1	Long term 5-10 years	10,000

	other articles are PBDE contaminated (regional level)					
	5. Development of material flow analysis and substance flow analysis of PBDE-containing materials and their relevance for recycling	HCNER	MoI; Universities and Research Institution, Traffic	2	Long term 5-10 years	10,000
	6. Regular update of inventories according Stockholm Convention requirement	HCNER	Stakeholders	4	Continuous	15,000
	7. Assessment of risks to humans and the environment including the risks to future recycling and end of life management	HCNER	Universities and Research Institutions	3	Medium term2-5 years	20,000
	8. Restrict import of WEEE and the import of second hand EEE older than 4 years and used vehicles older than 10 years.	Ministry of Health	Customs Administration	5	Medium term2-5 years	10,000
Monitoring of PBDE (technosphere, environment, biota, food and contaminated sites) see action plan monitoring						
Environmentally sound management (ESM)/BAT/BEP of PBDE-containing articles and materials	1. Assessment of recycling activities of WEEE plastic in the country, technologies used and pollutants present	Ministry of Health	HCNER	2	Medium term2-5 years	5,000
	2. Management of WEEE polymers	Ministry of Health	HCNER	3	Medium term2-5 years	100,000
	3. Identification of BAT/BEP options for separation of PBDE containing plastic	HCNER	MoI	3	Medium term2-5 years	10,000

	4. Need assessment for improving or changing the recycling technology of WEEE plastic (in polymer management)	Ministry of Health	HCNER; MoI	3	Long term 5-10 years	5,000
	5. Storage of PBDE-containing materials in environmentally sound manner	Ministry of Health	HCNER	2	Long term 5-10 years	100,000
For destruction and disposal of PBDE-containing materials/wastes see action plan destruction and disposal						
Listing of exemption and restriction	1. Development and implementation of guidelines concerning articles which must not be reused and recycled as containing POP-PBDE	Ministry of Health	HCNER	3	Medium term2-5 years	10,000
Identification of contaminated sites is in the general action plan on contaminated sites						
Awareness raising activities	1. Conduct awareness raising activities for industry, manufacturers, informal sector, importers, exporters, retailers, policy makers, implementing agencies, custom authorities and public on industrial POPs	HCNER	NGOs and relevant stakeholders	4	Medium term2-5 years	50,000
	2. Communicating the hazards of POPs (and other PBT substances) in the recycling flow as an obstacle for sustainable production and circular economy (POP-PBDE as a case study).	HCNER	Stakeholders	4	Medium term2-5 years	20,000
	3. Elaboration of chemicals assessment (assessment of alternatives) for moving to more sustainable production by phase out	Ministry of Environment (HCNER)	MoH; MoI; MoHESR (Universities);	3	Medium term2-5 years	50,000

	of POPs and PBTs in consumer goods and production processes		MoSC; Rersearch Institutions			
	4. Awareness raising of consumers on POPs in articles in education on sustainable consumption (e.g. eco-labels')	Ministry of Environment (HCNER)	Stakeholders and NGOs	3	Medium term2-5 years	20,000

3.3.6. Activity: Production, import and export, use, stockpiles, and wastes of DDT (Annex B, Part II chemicals) if used in the country

Sudan does not produce, import or use DDT.

The existing stockpiles and wastes are addressed in the action plan for wastes and stockpiles (chapter 3.3.10).

3.3.7. Activity: Production, import and export, use, stockpiles, and wastes of PFOS, its salts and PFOSF (Annex B, Part III chemicals)

According to the inventory report, PFOS and related substances are not manufactured in Sudan. Information received from industries producing surfactants, papers protection and performance chemicals like acid mist suppressants, etc. indicated no industry manufacturing and formulating products or articles containing PFOS or its related substances exist in Sudan.

Most of consumer products and articles containing PFOS enter the country through import but none of them was identified in the inventory due to non-existing HS codes.

The main issues to be considered in the action plan below are related to identification, sorting, safe handling and treatment of waste potentially containing PFOS and to contaminated sites and hot spots associated. In Sudan the environmentally sound waste management and recycling industry does not meet international requirements due to the lack of enforcement.

Table 29 - Action plan PFOS, its salts and PFOSF

Activity group	Description	Responsible Institution		Priority Low=1 High=5	Timeframe	Costs USD
		Main Responsibility	Partial			
Improvement of PFOS and related substances inventory	1. Detailed inventory of PFOS present in fire-fighting foams and aviation hydraulic fluid and stock (screening PFOS and related substances)	HCENR	MoH, custom department, municipalities	3	Medium term 2-5 years	20,000
	2. Detailed inventory of PFOS in synthetic carpets (produced before 2002 & recently produced)					
	3. Screening of finished suspected imported consumer products and articles for PFOS content					
Conducting training and awareness raising and establishing network for information exchange	1. Inform and sensitize stakeholders (e.g. fire fighters; users of aviation fluids) and public on environmental and health impact, environmentally sound management and on alternatives of PFOS and related substances (in particular in exempted uses)	HCENR	NGOs, MoHESR, MoH, universities and research institutes Fire fighter association Custom authorities	3	Continuous	40,000
	2. Development of related education and awareness materials in Arabic (considering available materials)					
	3. Establish free access on PFOS awareness and information materials (web and database)					
	4. Training of fire fighters in use of PFOS containing foams and its alternatives					
	5. Sustainable training and education of customs authorities on POPs and other hazardous substances in articles and products					

Application of BAT/BEP in exempted uses	1. Use and disposal of fire-fighting foam containing PFOS; development of guidance for collection and treatment of run-off water from fire incidents where PFOS containing foams are used 2. Use and disposal of aviation hydraulic fuel; establishing a system for management of waste oils and maintenance work with aviation hydraulic fuel including environmentally sound disposal	HCENR	NGOs, MoHESR, MoH, universities and research institutes Fire fighter association Custom authorities	3	Long term 5-10 years	40,000
Storage and disposal of PFOS containing articles and wastes	1. Environmental safe storage of PFOS-containing materials 2. Stop recycling and reuse of PFOS containing articles (in case such activities are discovered)	HCENR	Administration of Civil Defence, Arm Force and Civil Aviation authority, municipality	3	Long term 5-10 years	50,000
For destruction of PFOS see general action plan POPs destruction						
For monitoring PFOS see general action plan POPs monitoring						
For assessment and management of Hot Spots and contaminated sites see general action plan contaminated sites						

3.3.8. Activity: Continuing need and register for specific exemptions (Article 4)

A few exemptions for POPs uses are considered to be needed in Sudan:

1) POPs Pesticides

Following the national inventory carried out during NIP preparation, Sudan will notify the Secretariat and register for certain uses in case of endosulfan.

2) PFOS

For PFOS, its salts and PFOSF only the exemption for the continued use as hydraulic fluid and fire- fighting foams is needed. Alternatives to PFOS in fire-fighting foams are available.

3) PBDE

No exemption for POP-PBDEs containing plastic recycling is needed in Sudan.

3.3.9. Action plan: Measures to reduce releases from unintentional production (Article 5)

The following activities are proposed for the action plan to reduce releases from unintentionally produced POPs (PCDD/PCDF and UPOPs PCB and HCB).

In the action plan the priorities have been set by considering Annex C of SC, the total amount of estimated releases as an outcome of inventory process and considering point sources with potential risk to humans.

Sudan updated inventory of UPOPs showed an increase in releases of dioxins from 135 g TEQ on the baseline inventory, 2004 to 194g TEQ (37%) from the updated inventory, 2012. The largest sources of the releases are open burning process (86.6%), followed by ferrous and non-ferrous production (6.7%). The country need to establish and implement action plan to eliminate or reduce releases from all sources with particular considerations for these two sources in order to fulfil its obligation of SC. Release reduction from these sources will reduce other harmful substances such as polycyclic aromatic hydrocarbons, heavy metals and others.

Other sources like medical wastes incineration contributed to increase of releases.

The first action plan for reduction of UPOPs was developed in 2004. However, only minor activities of that action plan were implemented. These include development of training guidance on SC and awareness training conducted in five states; training workshop using UNIDO Toolkit, FAO manuals and guidelines to experts from relevant institutions to enable them collect scientific data from contaminated sites; and participation on POPs in PERSGA work programme in which personnel were trained in sampling and analysis of POPs. The lack of international funds and coordination with the national policy, strategy and follow up were the main reasons behind failing the implementation.

Activities under objective 2 in action plan should have priority in implementation because of high UPOPs releases from these target sources.

Objectives and suggested priorities:

1. To establish policy and legal framework for prevention/reduction of unintentional PCDD/F, HCB and PCBs;

2. To reduce releases of PCDD/F, HCB and PCBs into the environment from open waste burning, landfill fires and accidental fires including biomass burning;

3. Adoption of BAT and BEP in Ferrous and non-Ferrous Production and minerals production processes to reduce or eliminate releases of PCDD/F, HCB and PCBs;

4. To reduce or eliminate releases of PCDD/F, HCB and PCBs from incineration of medical waste;

5. Assessment and reduction of PCDD/F and other unintentional POPs in chemicals and products and evaluation of alternatives;

6. To support alternatives for household heating and cooking;

7. Implementation of synergies among chemical and waste MEAs. In the integrated approach consider national priority activities in managing chemicals and wastes in coordination with cross cutting issues in climate change, biodiversity and desertification;

8. Incorporating UPOPs issues in national strategic plan and development plan;

9. To conduct awareness raising and establishing network for information exchange;

10. Monitoring activities.

Table 30 - Action Plan for Reduction of UPOPs (PCDD, PCDF, PCB, PeCB and HCB)

Activity group	Description	Responsible Institution		Priority Low=1 High=5	Timeframe	Costs USD
		Main Responsibility	Partial			
Establishment of policy and legal framework for prevention and reduction of unintentional PCDD/F	See Policy and legal framework action plan					
Reducing releases of PCDD/F, HCB and PCBs into the environment from waste burning and accidental fires including biomass burning	1. Introduce and encourage sound management of waste (including reduce, re-use, recycle, principles and waste separation practice)	HCENR	MoJ, MoH, MoA, Private sector, Municipalities, NGOs	3	Medium term 2-5 years	2,000,000
	2. Construct well controlled and engineered landfills for waste disposal					
	3. Promote and implement strategy in using agriculture residues in energy production (biogas and boilers)					
	4. Encourage investment in generated bio wastes, e.g. production of organic fertilizers, compost and others					
	5. Identify BAT and BEP for incineration and open burning					
	6. Develop a mechanism for detection and prevention of dumpsite fires					
	7. Develop and run continuous awareness programmes for waste management operators					

	on the impacts of waste burning in their education agenda					
	8. Develop methods for reducing forest fires (e.g. by encourage the build of fire breaks and other means)					
Adoption of BAT and BEP in Ferrous and non-Ferrous Production and minerals production processes to reduce and eliminate release of PCDD/F, HCB and PCBs	1. Detailed assessment of individual industries for BEP options for UPOPs reduction and need and options for BAT	MoI, HCENR	Private industrial sector, Universities	3	Short term 1-2 year	1,000,000
	2. Introduce and effectively implement Guidelines on BAT and BEP to release sources of UPOPs (existing and new industry)					
	3. Removal of barrier of introduction of technologies that minimize UPOPs through environmentally sound management practices					
	4. Promote technical institutions to support implementation of cleaner production and BAT/BEP technologies					
	5. Apply environmental impact assessment for key industrial sources					
	6. Assessing synergies for reduction of unintentional POPs, GHG, mercury and other priority pollutants and where possible address these pollutants together					
Reducing or eliminating release of PCDD/F, HCB and PCBs from	1. Develop guidelines for sound management of medical waste including improvement of incineration of waste	HCENR	MoH, Universities	3	Medium term 2-5 years	300,000
	2. Strengthen institution and human resource capabilities to implement medical waste					

incineration of medical waste	management and establish respective guidelines for medical waste management 3. Assessment of technologies to treat medical waste 4. Selection and introduction of appropriate technologies to treat medical waste					
Supporting alternative for household heating and cooking	1. Promote the use of charcoal and wood alternative in cooking, like gas, solar system and ovens 2. Conduct research on alternative for energy sources in households	HCENR	Universities and research institutions	4	Short term 1-2 years	100,000
Endorse synergies among waste and chemical MEAs	1. Develop synergies and coordination on implementation of Multilateral Environmental Agreements 2. Develop a unified database for chemicals regulated by MEAs	HCENR	MoA	4	Ongoing	10,000
Incorporating UPOPs issues in national strategic plan and development plan	1. Develop clear programme for reduction or elimination of UPOS from identified sources	HCENR	All relevant ministries	4	Short term 1-2 years	10,000
Conduct awareness raising and establishing network for information exchange	1. Sensitize the public and stakeholders on environmental and health impact of UPOPs 2. Develop education and awareness materials on health and environmental effects of UPOPs 3. Establish free access web and database on UPOPs 4. Organize awareness raising campaigns on UPOPs through mass media and direct action to poor community and vulnerable people focusing	HCENR	NGOs, MoHESR (universities) MoH, municipalités	3	Continues	20,000

	on open burning processes, forest fires and household cooking in using proper fuel					
For monitoring PCDD/F see general action plan POPs monitoring						
For assessment and management of PCDD/F/UPOPs Hot Spots and contaminated sites see general action plan contaminated sites						

* MoE: Ministry of Environment; MoJ: Ministry of Justice; MoI: Ministry of Industry; MoH: Ministry of Health; MoA: Ministry of Agriculture; MoT: Ministry of Technology

3.3.10. Activity: Measures to reduce releases from stockpiles and wastes (Article 6)

3.3.10.1. POPs Pesticides

The goal of activities described in the updated NIP action plan for obsolete and POPs stockpiles are to:

- Eliminate or contain the direct risks caused by POPs stockpiles and wastes
- Eliminate or reduce the release of contaminants in the environment

These overall objectives can be achieved when site specific clean-up programmes are designed in such a way that mitigation, remediation and containment measures are:

- Sustainable;
- Realistic;
- Cost effective;
- Appropriate.

The goal is to develop and implement a programme to reduce releases from stockpiles and waste, in accordance with internationally guidelines and practices for handling, storage, transportation and disposal.

The inventory of POPs pesticides stockpiles and wastes shows that a large volume of obsolete pesticides have to be disposed in an environmental sound manner.

The inventory studies identified a limited but adequate in-country capacity for handling, transportation and disposal of hazardous waste. However, the storage capacity for chemical and hazardous waste that cannot be disposed of in an environmentally sound manner is very limited.

Certain disposal practices identified during the inventory process, such as open burning of assorted waste, burying waste, and inadequate storage of obsolete POPs pesticides are responsible for the generation and release of UPOPs, and soil and groundwater contamination.

3.3.10.2. PCBs

In the original NIP, the quantity of PCBs in liquid phase stored at NEC's premises was estimated at 8 tonnes. In the inventory progress report no stock of PCBs contaminated fluids has been found and records of its use and/or removal have not been found either. Therefore, a survey on the fate of the estimated 8 tonnes of PCBs oils in the original inventory has to be carried out. The material flow of these PCB oils and wastes need to be assessed in the Action Plan.

3.3.10.3. HexaBDE and heptaBDE and tetraBDE and pentaBDE (and HBB, where applicable)

All WEEE generated from refurbishing, dismantling, recycling are collected and disposed with the domestic waste, as there is no formal or institutional recycling of WEEE in Sudan. WEEE is not separated from domestic waste. All wastes are taken to the dump sites (surface dumping) where waste pickers remove any waste with economic value and sell it to interested retailers around the dumping sites.

There are few official designated dumping sites in Khartoum State and even in cities in other states and there are many other (illegal) waste dumping sites scattered within the residential areas in the country.

None of the dumping sites, even the official ones, has been designed according to international or national standards or operated such a way to avoid releases of hazardous substances to the environment.

National policy or strategy for WEEE and end-of-life vehicles does not exist in Sudan. Likewise laws and regulations for end of life vehicles and their management has not yet been established.

3.3.10.4. DDT

The inventory revealed that there is significant amount of DDT contaminated waste which waits to be disposed in an environmental sound manner. In the last approx. 10 years of SC implementation this situation has not improved due to the lack of funding. Many of the storages are close to irrigation channels and they are not protected against flooding.

3.3.10.5. PFOS, its salts and PFOSF

SC requires each Party to develop a strategy for environmentally sound management of its identified stockpiles of products and articles and waste containing PFOS and its related substances.

According to the current inventory, no expired stockpiles from industrial sectors, articles or insecticides were identified.

The use of PFOS and its salts has been confirmed for two categories: aqueous fire-fighting foams and aviation hydraulic fluids, and according to the inventory report, all stakeholders store their stockpiles at their premises and, stores conditions are good and well secured.

3.3.11. Strategy: Identification of stockpiles, articles in use and wastes

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

Table 31 - Action plan on management and reducing and eliminating releases from stockpiles and wastes

POPs Group	Description	Responsible Institution		Priority Low=1 High=5	Timeframe	Costs USD
		Main Responsibility	Partial			
General for all POPs categories	1. Overall improving of management of POPs and other hazardous waste	HCENR	MoH; MoA; MoI; MoAR	4	Short term 1-2 years	50,000
	2. Assessing options of destruction capacity (cement kilns, option of incinerators and possibly other technologies)	HCENR	MoH; MoA; MoI; MoAR; Universities	4	Short term 1-2 years	20,000
	3. Providing destruction capacity	HCENR	MoH; MoA; MoI; MoAR	1	Long Term 5-10 years	1,000,000
	4. Consider export of those POPs which cannot be destroyed or disposed in Sudan	HCENR	MoH; MoA; MoI; MoAR	1	Medium Term 2-5 years	1,000,000
POPs Pesticides	1. Establishing of proper pesticide storages in all schemes and Federal State	NPC	MoH; MoA; MoAR	2	Short term 1-2 years	1,000,000
	2. Securing pesticide storages	NPC	MoH; MoA; MoAR	4	Short term 1-2 years	200,000

	3. Disposing of obsolete POPs pesticides stockpiles and remediating the sites contaminated by such chemicals:	NPC	MoH; MoA; MoAR; Universities	4	Medium term 2-5 years	10,000,000
PCBs	1. Assessment and establishment of interim storage and disposal facilities for PCBs containing wastes	MOED	HCENR	2	Medium term 2-5 years	5,000
	2. Implementing existing Convention guidelines for environment sound management of PCBs	MOED	HCENR	2	Long term 5-10 years	10,000
	3. Establishing regular inspection and control of handling, storage, transfer and disposal of PCBs, PCBs containing materials and PCBs wastes	MOED	HCENR	2	Medium term 2-5 years	10,000
	4. Proving proper training for operators, owners of PCB containing equipment, government and custom authorities staff on environment sound	MOED	HCENR; Customs; Private sector; MoI; Universities	2	Medium term 2-5 years	15,000

	management and disposal of PCBs					
POP-PBDEs	1. Management of WEEE polymers	MoH	HCENR	3	Medium term 2-5 years	10000
	2. Identification of BAT/BEP option of separation of PBDE containing plastic	HCNER	MoI	3	Medium term 2-5 years	10,000
	3. Need assessment for improving recycling technology of WEEE plastic	MoH	HCNER; MoI	3	Long term 5-10 years	5,000
	4. Storage of PBDE-containing materials in an environmentally sound manner	MoH	HCNER	2	Long term 5-10 years	10,000
	5. Assessment of status and destruction options for PBDE-containing WEEE plastic	MoH	HCNER	3	Medium term 2-5 years	10,000
	6. Assessment of status and options for disposal of polymers from end-of-life vehicles	MoH	HCNER	3	Medium term 2-5 years	10,000
	7. Assessment of existing capacity for disposal and	MoH	HCNER	3	Medium term 2-5 years	10,000

	destruction of PBDE containing materials and need assessment for appropriate treatment					
	8. Minimisation and possibly restriction of land filling PBDE-containing materials and application of the waste management hierarchy (see PBDE BAT/BEP guidance (Stockholm Convention Secretariat 2012);	MoH	HCNER	2	Medium term 2-5 years	10,000
	9. Implementation of BAT/BEP for treatment and disposal techniques for PBDE-containing materials	HCNER	MoH	2	Long term 5-10 years	10,000
	10. Integration of the management of POP-PBDE-containing articles and materials in overall WEEE management, end of life vehicles and other possibly impacted waste fractions.	MoH	HCNER	3	Long term 5-10 years	10,000
	11. Assessment of the material flow of POPs (and other) flame retarded articles and products, including the risks to humans and the environment, as well as the	HCNER	Universities and Research Institutions	4	Long term 5-10 years	20,000

	risks to future recycling and end of life management					
PFOS, its salts and PFOSF	1. Environmental safe storage of PFOS-containing materials 2. Stop recycling and reuse of PFOS containing articles (in case such activities are discovered) 3. Assessment of destruction option of PFOS containing stocks and waste 4. Destruction or export of PFOS containing waste 5. Use and disposal of fire-fighting foam containing PFOS; development of guidance for collection and treatment of run-off water from fire incidents where PFOS containing foams are used 6. Use and disposal of aviation hydraulic fuel; establishing a system for management of waste oils as well as maintenance work with aviation hydraulic fuel including an established frame for environmentally sound disposal	HCNER	Administration of Civil Defence, Arm Force and Civil Aviation authority, municipality	3	Medium term 2-5 years	1.000.000

3.3.12. Activity: Manage stockpiles and appropriate measures for handling and disposal of articles in use

It is of particular importance to manage the articles in use at the end of life. This need to be considered for the individual POPs groups listed here and linked to the action plan of disposal of the individual POPs groups (see action plan on disposal).

3.3.12.1. POPs Pesticides

As previously described in sections 2.3.1.5 and 2.3.1.7, endosulfan is still used in Sudan and large quantities are currently imported and used by farmers. Due to the lack of alternatives at national level the endosulfan banning in Sudan is currently postponed. Therefore, the action plan includes actions to environmentally sound and sustainable use and management of endosulfan, adopting and implementing good agricultural practices and searching for appropriate and easy accessible alternatives.

3.3.12.2. PCBs

The Convention allows for PCBs to be used in equipment (e.g. transformers and capacitors), while setting out priorities for action toward the goal of eliminating them by 2025 at the latest. Priorities for action for identifying PCB equipment are set out in Annex A, Part II. For PCB-containing equipment still in use, Sudan shall promote measures to reduce exposure to PCBs. Removal and elimination of PCBs from equipment must be carried out in an environmentally sound manner.

Sudan shall make determined efforts to identify, label, and remove from use equipment containing (i) greater than 10 per cent PCBs and volumes greater than 5 litres and (ii) greater than 0.05 per cent PCBs and volumes greater than 5 litres; and endeavour to identify and remove from use equipment containing greater than 0.005 percent PCBs and volumes greater than 0.05 litres.

Sudan will make determined efforts designed to lead to environmentally sound waste management of liquids containing PCBs and equipment contaminated with PCBs having a PCBs content above 0.005 per cent, in accordance with paragraph 1 of Article 6, as soon as possible but no later than 2028.

3.3.12.3. HexaBDE and heptaBDE and tetraBDE and pentaBDE (and HBB, where applicable)

Even though POP-PBDEs were never produced in Sudan, the main challenge for their elimination is the identification of existing stockpiles and articles containing POP-PBDEs currently in use, and the disposal of POP-PBDEs-containing materials at end-of-life.

Currently there is no particular control and management of the major PBDE-containing material flows – plastic in EEE/WEEE and polymers in end of life vehicles. The management of WEEE is still in it's infancy in Sudan. It has therefore been highlighted as a key issue in the action plan of NIP.

Concerning the transport, the end of life management of vehicles is largely uncontrolled and mainly driven by recovery of metals and spare parts. Polymers are not recycled and not managed but either just burned in the open, dumped or otherwise thrown away around road sides or car repair shops etc. Preventing such practices is an action included in the action plan.

3.3.12.4. PFOS, its salts and PFOSF

SC requires each Party to develop a strategy for environmentally sound management of its identified stockpiles of products and articles and waste containing PFOS and its related substances.

The use of PFOS and its salts has been confirmed for two categories: aqueous fire-fighting foams and aviation hydraulic fluids. As there are alternatives available, Sudan's next step is to switch to it as soon as practicable, as well as to implement the SC Guidance on BAT/BEP.

3.3.12.5. Capacity building to manage stockpiles and appropriate measures for handling and disposal of articles in use

The overall capacities of stockpiles management, handling and disposal of articles in use should be strengthened in Sudan, especially when it comes to new POPs substances. Defining the responsible coordination body and the cooperating entities, strengthening their collaboration and cooperation, providing proper training and ensure appropriate funding resources for monitoring and control of POPs represents the keys to a successful implementation of SC in Sudan.

3.3.13. Strategy: Identification of contaminated sites (Annex A, B and C Chemicals) and remediation in an environmentally sound manner

The overall goal of the action plan (Table 33 below) is to properly manage and ultimately clean up all sites contaminated by POPs listed in Annex A, B and C of SC. The specific objective of this action plan is to identify, manage and reclaim sites contaminated with POPs in order to reduce human health and environmental risks from POPs. The specific activities of this action plan are to:

- identify all sites contaminated by POPs;
- manage all sites contaminated by POPs; and
- reclaim contaminated sites by POPs phase by phase.

To date, there is no intergovernmental policy instrument that addresses the identification and remediation of contaminated sites. Countries that have ratified SC (Parties) must however endeavour to develop strategies for identifying sites contaminated with POPs (Article 6 SC). While not explicitly requiring remediation of contaminated sites, SC stipulates that any remediation attempts must be carried out in an environmentally sound manner (Article 6 SC).

The inventory process revealed that appropriate strategies for identification of contaminated sites and their management have not been integrated in activities of the institutions responsible for POPs. It is important that appropriate infrastructure and capacity is developed and established for soil and groundwater assessment and the remediation of contaminated sites.

Table 32 – Action plan for contaminated sites

Activity Group	Description	Responsible Institution		Priority Low=1 High=5	Timeframe	Costs
		Main Responsibility	Partial			
General activities **POPs contaminated sites**	1. Develop and update legislation to set criteria for determining if a site is contaminated (soil and sediment limits for POPs), including liability issues related to contamination and clean-up procedures	HCNER	MoJ; MoA; MoH; MoAR; Administration of Civil Defence	3	Continuous	300,000
	2. Develop and update POPs contaminated sites inventories and make prioritization based on risk assessment					
	3. Set up a central contaminated sites database (general contaminated sites with POPs as pollution category) Including a cadastre map of all potentially contaminated sites identified					
	4. Develop a National Strategy and Action Plan for contaminated Sites management					
	5. Develop/implement guidelines for identification and assessment of					

	POPs contaminated sites, including prioritization of the sites (considering risk) for further assessment and clean-up					
	6. Training in identification and management of contaminated sites (including sample collection procedures)					
	7. Monitoring including analytical confirmation of POPs contamination for identified locations (prioritization list) and monitoring approach for cleaned sites. (See below for individual POPs)					
	8. Develop strategies for the environmentally sound management of POPs contaminated sites					
	9. Identification of clean-up measures and initiate clean-up procedures for the high priority contaminated sites					
	10. Take measures to secure the contaminated sites waiting clean-up					
	1. Identification of all POPs pesticides use and storage/disposal locations	**NPC**	**MoA; MoH; MoAR**	**5**	**Short term 1-2 years**	**10,000**

POPs pesticides	2. Identify the level of contamination of soil and ground water	**NPC; HCENR**	**Universities and Research Institutions**	**5**	**Medium term**	**10,000**
	3. Secure and possibly monitor locations up to remediation process takes place	**NPC**	**MoA; MoH; MoAR**	**5**	**Short term 1-2 years**	**10,000**
PCBs	1. Identification of PCB contaminated sites (former maintenance areas and at PCB storage sites, scrap yards, as well as locations where PCB transformers and capacitors are/have been operating)	**MoED**	**HCENR; Private sectors**	**2**	**Short term 1-2 years**	**5,000**
	2. Identify the level of contamination of soil	**MoED**	**Universities and Research Institutions**	**2**	**Medium term 5-10 years**	**5,000**
	3. Secure and monitor locations up to remediation process takes place	**MoED**	**MoED**	**2**	**Medium term 5-10 years**	**5,000**
	1. Compilation of potentially PBDE contaminated sites (e.g. E-waste and ELV treatment sites; dumpsites/landfills) and potential related risks	MoH	HCNER;	3	**Medium term 5-10 years**	**5,000**

POP-PBDE	2. Assessment of the sites and potential securing and remediation activities needed	MoH	HCNER;	3	**Medium term 5-10 years**	**5,000**
	3. Assessment (literature & monitoring) if PBDD/PBDF are potential co-contaminants (thermal treatment of PBDE-containing wastes) and link to Dioxin/UPOPs contaminated site inventory	MoH	HCNER;	3	**Medium term 5-10 years**	**5,000**
PFOS, its salts and PFOSF	1. Compilation of potentially PFOS contaminated sites Investigation of the training and equipment testing and training exercise sites, the areas where fire drills, stockpiles storage, as well as accidental spills or leakages occur for determining the contamination with PFOS fire-fighting foams (especially Heglig town) Investigation of the maintenance sites, stockpiles storage areas where accidental spills or leakages occur from aviation hydraulic fluids	Civil defence	HCENR	3	**Medium term 5-10 years**	**20,000**
	2. Secure and monitor locations up to remediation process takes place	Civil defence	HCENR	3	**Medium term 5-10 years**	**10,000**
	1. Investigation of chlorine production sites, application sites of PCDD/F containing pesticides and	MoH	HCENR	3	**Medium term 5-10 years**	**20,000**

PCDD/PCDF and UPOPs	chemicals, textile and leather factories, locations where PCBs were and are stored, locations were fire accidents took place, deposits of sediments, contaminated flood plains, dumps of wastes/residues of category 1-9 UNEP Toolkit and Kaolin or Ball Clay Sites					
	2. Secure and monitor locations up to remediation process takes place	MoH	HCENR	3	**Medium term 5-10 years**	**10,000**

3.3.14. Activity: Facilitating or undertaking information exchange and stakeholder involvement

3.3.15. Activity/Action Plan: Awareness of stakeholders, information and education (Article 10)

Awareness raising activities are included in the NIP update in paragraphs on Pesticides, PCBs, UPOPs and new POPs. For certain groups like farmers or (informal) workers of WEEE recycling or for staff responsible for PCB management awareness is needed for a particular POP and for a particular exposure scenario.

For awareness of the public and for policy makers a concept of overall awareness of POPs and other hazardous chemicals is required. It should coordinated with the health and environmental education, the sustainable development agenda, the need of sustainable consumption and production, and with the sustainable development goals and their implementation .

3.3.15.1. POPs as part of general chemical and SD/SCP awareness raising

Awareness on chemicals and waste in connection with environmental pollution and human health impacts is an important part of education of sustainable development and can be used for education on sustainable consumption and production By developing education modules, the awareness raising can be tailor-made for different stakeholders including policy makers, industries on sustainable production and for policy makers and consumer groups on sustainable consumption.

POPs have some particular features which need to be utilized for SCP education, namely:

- Chemicals (materials) which are brought into the environment can return as pollutants in food and water.
- The effects are long term and need forward looking approaches.
- Inventions praised even with the Nobel price (Muller 1948) could within a decade turn into the opposite (Rachel Carlson: Silent Spring 1962[92]) showing that life cycle thinking and forward looking impact assessments are needed for an appropriate decisions[85].
- Being ignorant as a consumer lead to chemical exposure in daily life which impacts own health and in particular the health of the next generation.

POPs can be referred to explain the need to look at the bigger picture of global waste management and chemical pollution challenges revealing that cooperation among nations are required to cope with the challenges of our time. Global science have since some years shown the “bigger picture” and that the current time need to be called the Anthropocene (www.anthropocene.info) and that humanity have the responsibility for many of the effects we see on the degradation of the ecosystem services which are the base for development of societies and humanity at large. This responsibility has to be elaborated and be broken down for the individual stakeholder groups (policy makers, industry, finance sector, military, science community, civil society, faith communities, and individuals).

The awareness raising activities on POPs/chemicals, chemical safety or waste need to be coordinated. Related existing awareness raising programmes on health or climate change should also be linked for developing an overall national awareness raising programs for sustainable development including sustainable consumption and production.

There are already excellent materials available including films on POPS chemicals (see 3.3.15.3 below) or publications such as the two publications from the European Environmental Agency "Late lessons learn from early warnings"[85] including a wide range of POPs issues. These and other materials will be tailored to the Sudanese situation and translated where needed as a part of the action plan.

3.3.15.2. Environmental awareness of religious teachers and with religious leaders

Environmental pollution and the challenges with waste management have reached a stage where they are becoming a threat for human life and for society at large. Therefore they are becoming a core question of ethic and need to be taken up also by spiritual leaders if they want to address the relevant topics of the presence – the fate of our children and the coming generations. All religions have in their core the protection of creation[86]. It is however only until recent that there is such a pressing need for comprehensive action for such protection of nature and the Earth as a whole. Therefore environmental issues have only recently be elaborated by some protagonists in the faith communities and are often not yet present in the general education of the faith communities and education of religious leaders. UNEP has therefore in 2012 emphasized the importance to work with faith communities for the protection of the environment and brought together faith communities from publication have been "Many Heavens, one Earth, and our Continent"[87] . The first faith community from Sudan which have officially dedicated work to long term environmental protection is the Sammaniya Sufi Sect[88]. Since sometimes detailed scientific background is missing such activities would best be linked with research community. The evaluation of the option and possibly cooperation between religious leaders or communities and members of the research community will be part of the POPs action plan.

The scientific background of religious leaders on environmental pollution, chemicals or waste is not well developed. An approach to improve this situation is the integration of basic information on environmental and sustainability topics into the education of imams at University. Initial activities in this respect have been already initiated in many universities. Within the action plan this education will be extended to chemical issues and to waste issues including selected topics of POPs.

3.3.15.3. Approach of using films on POPs/chemicals as education tools

In SC activities the UN Safe Planet Initiative and Biovision have started to work with film and art as awareness raising tool. Films which have been shown within COP or other UN events for awareness on POPs chemicals can also be recommended for national awareness raising e.g.:

- The film "Silent Snow" on causes of global POPs contamination: (http://www.silentsnow.org/);
- GEF film "Planet DeTox" www.arrowheadfilms.com/documentary/gef-mission-planet-detox
- The film "Submission" on chemical pollution of today human blood: (www.underkastelsen.se/).

85 European Environmental Agency (2013) Late lessions from early warnings. http://www.eea.europa.eu/publications/late-lessons-2

86 Denny FM, Islam and Ecology: A Bestowed Trust Inviting Balanced Stewardship. http://fore.research.yale.edu/religion/islam/

87 Alliance of Religions and Conservation (2012) Many heavans, one earth, our continent. http://www.arcworld.org/downloads/African_Commitments_web-FINAL.pdf

88 Summaniya Sufi Sect (2012) African faith commitments for a living planet http://www.arcworld.org/downloads/Sudan-Sammaniya-Sufi-Summary-Sep2012.pdf

- The “big picture” on POPs (www.ipen.org/articles/big-picture-video).

There are already country approaches of environmental awareness by film (e.g. Switzerland) titled “Films for the Earth” (https://filmefuerdieerde.org/en/) where Swiss.com supports the public viewing of such films and the free distribution of DVDs. Also an NGO approach “Story of Stuff” (www.storyofstuff.org) has developed comprehensive awareness raising materials having POPs/chemical as a crucial issue within the bigger picture of consumer products (e.g. Electronics http://storyofstuff.org/movies/story-of-electronics/ or general global material flow http://storyofstuff.org/movies/story-of-stuff/).

The impact of showing and viewing (short) films in POPs in workshops has been proven their larger impact compared to other awareness raising inputs. The approach of showing films has the advantage of a simple to use tool which does not need a dedicated presentation and therefore can be “transmitted” also by non-experts (best with a discussion). This gives the opportunity to teachers in school or NGOs doing awareness raising for the public to communicate topics on POPs and chemicals after only a short education or even just by e-learning in an entertaining way and by additional discussion in an interactive way. Therefore this approach has a high chance to reach a large audience. Since many of these films are creative commons available in the internet people from the audience can forward these information (in particular when encouraged and motivated to do so) and by this a dynamic can be generated which is only possible by the Web 2.0 tools like Face book, Twitter etc.

The possibilities will be explored in the NIP implementation. This approach can be easily brought to schools and universities and could be distributed via TV mass media also for education of the public.

The Higher Council of Sudan will explore the possibilities of utilizing these contemporary tools for POPs and general environmental and sustainability education in cooperation with universities.

3.3.16. Activity: Effectiveness evaluation (Article 16)

According to Article 16 Parties, in accordance with their technical and financial capabilities and using existing monitoring programmes and mechanisms to the extent possible, are to co-operate on a regional basis, when appropriate, and contribute to a global monitoring programme of the Convention.

As main matrices selected for assessment of effectiveness of implementation, human milk and air have been chosen. UNEP together with W.H.O and the Stockholm Convention Secretariat are conducting and supporting human milk surveys in developing countries.[89] Alternatively to human milk, human blood can possibly be used as monitoring matrix.

Sudan has participated successfully in the 4th WHO POPs human milk survey. Sudan also participated in the global POPs air monitoring with passive samplers.

Sudan is considering participating in the next human milk survey and will take further steps to contact to the responsible UN agencies to seek for guidance and funding options.

89 http://www.who.int/foodsafety/chem/pops/en/index.html

Sudan also will also further participate in air monitoring activities and keep or establish contacts to the international groups organising these monitoring.

3.3.17. Activity: Reporting (Article 15)

According to Article 15 Parties are required to report periodically on the measures taken, and on their effectiveness in meeting the objectives of the Convention. The Secretariat established an Electronic Reporting System SC-ERS. For the third reporting period (August 2014), possible synergies with the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal should be considered. To support countries in fulfilling their reporting obligation the Secretariat has developed a written guidance and provided training through webinars.

Sudan has completed a report for the third reporting round and is planning to submit the report after technical challenges have been resolved.

3.3.18. Activity/Action Plan: Research, development and monitoring (Article 11)

3.3.18.1. Research & development

Sudan recognized the need for scientific research in various disciplines as early as the beginning of the 20th century when research stations and institutions of higher education were established. Research on agriculture started in 1902. (northern province), 1904 (Shambat experimental station), 1918 (Gizera research farm), 1931 the later expanded to include related departments such as chemistry, entomology, botany (became the head quarter of agricultural research service) and in 1967 the agricultural research corporation was established in Wad Medani to lead and coordinate all research activities in agriculture. Various research stations were also established (1940's -1960's) both at regional and sub-regional levels. Parallel to this higher education institutes were established as early as 1902 with the Gordon Memorial College which was affiliated to the University of London and later promoted the University of Khartoum following the independence in 1956. The school of agriculture was established in 1938 and. was promoted to the faculty of Agriculture in 1956. Other colleges were established to qualify human resources in other fields.

Other Ministries realized and act similarly in establishing research units and conducting research. Currently there are about 27 government universities, 4 private universities and over 45 private colleges scattered in various parts of the country.

In respect to POPs, there is no coordinated programme on POPs research in Sudan. Usually research activities on POPs are conducted at the MoE request and depending on the available financial resources. Also, some universities have M.Sc. and Ph. D. programmes were some POPs thematic are dealt with. One major challenge is that analytical capacity for most POPs are missing.

There is a wide range of activities on research & development related to pesticides use, the impact of pesticides and also on alternatives of pesticides. In 2013 the first book on alternatives of pesticides was published in Arabic (Asim 2013).[90]

90 Ashim "Integrated Pests Management" ISBN 978-99942-3-092-1. Published by Mudarik for Printing, Publish and Services.

The action plan on POPs research is listed together with the monitoring action plan in Table 34 below.

3.3.18.2. Monitoring

There is no integrated POPs monitoring programme in Sudan. This is mostly due to the lack of financial and human resources. Also the instrumental equipment has severe limitations and several POPs group cannot be measured (PBDEs, PFOS, PCDD/F). An overview of technical infrastructure for POPs assessment, measurement, analysis, research and development as well as the linkage to international programmes and projects are described in the section 2.3.13.

Based on the national POPs assessment findings, performed during the NIP update, the following action plan have been compiled (Table 34 below).

Table 33 - Action plan on research & development and monitoring

Activity Group	Description	Responsible Institution		Priority Low=1 High=5	Timeframe	Costs USD
		Main Responsibility	Partial			
General POPs research/monitoring topics	1. Compilation of monitoring data of new and initial POPs in Arab/African countries and priority list of monitoring data need for Sudan	HCENR	MOH; MoA; MoAR	4	Short term 1-2 years	**5,000**
	2. Supporting/participating in intra-African and intra-Arab states collaboration on POPs and PTS projects and research to support associated conventions (Stockholm, Basel, Rotterdam, Bamako, etc.). Assessment what POPs monitoring studies can be performed by such cooperation and for which studies own analytical capacity is available or needed	Universities	HCENR	4	Short term 1-2 years	**5,000**
	3. Development/participation in POPs research expert networks to establish research and monitoring of both POPs and PTS in Sudan	Universities	HCENR	4	Short term 1-2 years	**10,000**
	4. Development of monitoring capacity for the POPs where the need of own analytical capacity have been concluded	HCENR	MOH; MoA; MoAR; Universities	3	Medium term 2-5 years	**500,000**

	5. Integrating POPs/PTS studies with health (epidemiological) studies and exposure (environment, food, indoor). Data compilation and accessibility. Formalizing a multi-sectoral participation of Government, academia, industry and NGOs in health and environmental monitoring program of POPs	HCENR	MOH; MoA; MoAR; Universities	3	Medium term 2-5 years	**30,000**
	6. Modelling existing and new POPs/PTS data for the fate, transport and effects of POPs in Sudan	Universities	HCENR	4	Medium term 2-5 years	**10,000**
POPs pesticides	1. Monitoring and establishing a POPs pesticide monitoring programme (food, soils, water, occupation, consumer etc.)	HCENR	MOH; MoA; MoAR; Universities	3	Medium term 2-5 years	**50,000**
	2. Supporting implementation and research on IPM/IVM, including the use of alternatives as a measure for reducing POPs pesticides use, especially in vectors	Universities	HCENR; MOH; MoA; MoAR;	4	Medium term 2-5 years	**40,000**
	3. Conducting a risk assessment for POPs pesticides and their alternatives using existing and new data, specifically aimed at determining the risk to the human population and biota	Universities	HCENR; MOH; MoA; MoAR;	4	Medium term 2-5 years	**40,000**

PCBs	1. Developing an integrated environment and health monitoring for assessing the PCBs presence in humans, environment and biota, as well as food mainly the animal products (priority potentially contaminated/affected sites & imports)	MoED	HCENR; Universities	2	Medium term 2-5 years	**5,000**
	2. Monitoring of occupational exposure (maintenance and remediation staff)	MoED	HCENR; MoH; Universities	2	Medium term 2-5 years	**10,000**
POP-PBDE	1. Monitoring activities of POP-PBDEs in the technosphere and in environmental compartments	MoH	HCENR	3	Medium term 2-5 years	**10,000**
	a) Monitoring in articles and products i) Monitoring in e-waste plastic (in particular if recycled or exported) ii) Monitoring of PBDE in plastic used in TVs assembled in Sudan iii) Monitoring of PUR foam (in recycling and generally) iv) Monitoring of articles produced from recycled plastic materials or PUR foams	MoH	HCENR; Customs	3	Medium term 2-5 years	**10000**

	b) Monitoring of human exposure: i) Occupational exposure (recycling sector; disposal including certain secondary metal industries) ii) Consumer exposure (indoor, food and other)	MoH	HCENR	3	Medium term 2-5 years	**10,000**
	c) Monitoring of cattle and wildlife: i) Monitoring of cattle and wildlife (including fish) having potential exposure (near selected industries) and background exposure	MoAR	HCNER	3	Medium term 2-5 years	**10,000**
	d) Monitoring of potentially POP-PBDE contaminated site (within general POPs contaminated site assessment)	MoH	HCNER	3	Medium term 2-5 years	**10,000**
PFOS, its salts and PFOSF	1. Assessment of options for monitoring of PFOS and related substances in Sudan. (international collaboration with experienced institute; regional UN project or development of own capacity)	HCNER	Universities and research institutes	3	Medium term 2-5 years then continuous monitoring	1,000,000)
	2. Improvement of inventory by monitoring approach where knowledge gaps have been found					
	3. Conduct research on the level of contamination dredged sediment near dump sites and from the Nile					

	4. Monitoring of chemicals and chemicals in products/articles, waste suspected to contain PFOS and its related substances.					
	5. Monitor of potentially PFOS contaminated sites and related exposure					
PCDD/PCDF and UPOPs	1. Improvement of inventory where knowledge gaps have been found. This also to include a projection of releases considering future perspective of growth and national strategies.	HCENR	MoH	3	Medium term 2-5 years	1,000,000
	2. Establish and strengthen the national capacity for UPOPs monitoring					
	3. Conduct research on the level of contamination dredged sediment near dump sites and from the Nile					
	4. Collect and analyze environmental and foods samples for UPOPs (including samples on human exposure for residents around suspected hot spot).					
	5. Monitoring of major sources generating and releasing PCDD/F, HCB and PCBs					
	6. Monitoring of chemicals and chemicals in products/articles known to contain PCDD/F, PCB and HCB.					
	7. Monitor UPOPs in selected waste fractions					

3.3.19. Activity: Technical and financial assistance (Articles 12 and 13)

Sudan needs technical and financial assistance and will seek this assistance when implementing its NIP.

3.4. Development and capacity-building proposals and priorities

This section details the priority areas where current capacity and capability need to be strengthened to achieve the objectives of the NIP. Priorities based on the need to meet Convention obligations and country priority issues are highlighted.

3.4.10. Priorities in Capacity building

Capacity building priorities for the further implementation of the Stockholm Convention NIP in Sudan are similar to the capacity building priorities which have been discovered in the GEF National Capacity Self-Assessment[91]. Therefore also in the capacity building area the approaches for POPs can be linked to general action on improving the national capacity for environmental and sustainable development.

1) Awareness, information and environmental education

As highlighted an overall awareness on sustainable development (the "big picture") is needed and awareness on POPs can be used as a tool for awareness on sustainable consumption and production in particular when integrating green alternatives to POPs chemicals and their phase out. When integrating the long term perspectives of the POPs challenges and the global impacts including the historic lessons learned and impacts on global recycling flows then it can be developed for as tool for sustainable development.

The information and awareness raising approaches in Sudan needed to be tailored for policy makers, industry and the society at large Since some of the new POPs are present in goods of daily life (electronics, car shredder residues, synthetic carpets, flame retarded or surface treated textiles, furniture, mattresses etc.) the highest priority is the communication for consumers. While for pesticides and for PCB occupational exposure has the highest priority.

2) Development of policy and regulatory frameworks and enforcement

The need of a more comprehensive regulatory framework has been highlighted and an action plan has been elaborated (3.3.1). Better policy and regulatory frameworks for POPs should be addressed in the framework of hazardous chemicals and hazardous waste and should be used to support the development of comprehensive policies and regulatory frames and relate enforcements.

For the material flows of consumer goods (EEE/WEEE and end of life vehicles) it is seen that a policy and regulatory frame is needed to guide the entire life cycle of these products to guarantee the safety of humans and the environment.

91 GEF, UNDP, UNEP (2010) National Capacity Self-Assessments Results and Lessons Learned for Global Environmental Sustainability)

For these resource containing material flows (EEE/WEEE, ELVs) also the policy of waste hierarchy (reuse, recycling and recovery) will be elaborated as a model for other waste streams in accordance with SC BAT/BEP guidelines and guidance[56] and the PBDE BAT/BEP Guidance[92]. For such articles/material flows industrialized countries have included in policy and regulatory frame the extended producer responsibility (EPR). Currently no policy and regulatory frame exist in Sudan and should therefore initiate the development of EPR approach.

The work on unintentional POPs releases revealed that the emissions from Annex C II & III sources need a better regulatory frame in respect to release to air, water and solids/waste. A policy is needed that within the development of a regulatory frame also the enforcement approach is considered and developed for implementation of BEP and were appropriate also BAT.

Currently no policy and regulatory frame exist for contaminated sites. Human health and the environment should be protected from the harmful POPs releases from contaminated sites and the environmentally sound management of these sites should be developed.

3) Institutional and regulatory strengthening measures and improvement of structures;

Institutional and regulatory strengthening measures are required in Sudan. When developing the regulatory frame for chemicals, wastes, and contaminated sites an appropriate institutional and regulatory structure need to be developed and strengthened that implementation can be successfully achieved. The life cycle of POPs and of POPs in articles (e.g. EEE/WEEE) is a good case study for assessing and improving the regulatory and institutional framework of responsibilities of involved ministries and other regulatory institutions for the life cycle management (import, production, consumption, recycling/reuse and end of life) of POP/hazardous chemicals and of POPs/hazardous chemicals containing material flows. Such a case study may be used for enhancing institutional and regulatory bodies and improving their structures in the country.

4) Information management and exchange;

The POPs, POPs waste and contaminated site management as well as the awareness raising in individual POPs and POPs group need management of information as well as approaches for exchange and exchange portals of this information. These information need to be integrated in information and awareness on hazardous chemicals and wastes as well as sustainable production and consumption issues.

For POPs chemicals, stockpiles, hazardous waste and contaminated sites the development of central national databases is needed as a priority. They do not exist yet and are one precondition for information management and for the management of chemicals, waste and contaminated sites itself. Release

92 Stockholm Convention (2012) Guidance on best available techniques and best environmental practices for the recycling and disposal of articles containing polybrominated diphenyl ethers (PBDEs) listed under the Stockholm Convention on Persistent Organic Pollutants; Draft July 2012.

inventories of POPs and other pollutants should possibly be included in a PRTR or similar system which would also need to be developed.

5) Economic instruments and sustainable financing mechanisms.

The financing of Stockholm Convention has become a large challenge with the gradual shift from 1:1 financing to 6:1 financing. Therefore, modified financing approaches are needed including regional projects or integrated projects addressing waste from POPs perspective and climate change perspective and integrated projects in this respect. The extended producer responsibility and polluter pays principle need to be applied in a rigorous manner.

3.4.11. Other implementation priorities

As high priority areas for the implementation of SC the following areas have been recognized during inventory making process and stakeholder workshops. Activities of different priority areas are listed in the action plan tables.

The high priority areas listed below are not ranked

I. Strengthening the coordination between institutions and stakeholders; integrated implementation approach

SC activities should be coordinated with national priorities and in particular with overall chemical management and waste management. The aim is to establish POPs and chemicals management and waste management to support sustainable development.

Where possible and where appropriate the implementation of SC should seek synergies with the implementation of other Conventions. While for Basel and Rotterdam Convention the synergies have been elaborated by the secretariat, also clear synergies exist now with Montreal protocol (ODS) and Minamata Convention (mercury) and will be further explored and considered in the implementation where appropriate.

Several of the listed priorities need the support and cooperation of different ministries and stakeholders. Without coordination of activities between the different stakeholders the effectiveness of the implementation of the action plan is threatened. Therefore the strengthening of cooperation between the different ministries, institutions and other stakeholder is an important factor for an effective implementation of the Stockholm Convention.

II. Management of POPs pesticides (use, phase out, stockpiles)

Capacity building should be further enhanced regarding prevention of reoccurrence of POPs pesticides waste stockpiles and of illegal traffic of obsolete POPs stockpiles.

III. Manage PCB stockpiles

Regarding PCB, there is a need to set up government incentives to trigger the PCB containing equipment removal and disposal. Also, there is a need to strengthen capacity for identification of PCB in open applications, which is currently absent in Sudan.

IV. Improvement of waste management for reduction of unintentionally formed POPs and management of new POPs potentially present in waste streams including household waste

Sudan does not have waste destruction capacity and therefore POPs containing wastes need to be exported at high cost.

New POPs (in particular PBDEs and PFOS) can be present in several waste streams (electronic waste, car shredder residues, synthetic carpets, flame retarded or surface treated textiles, furniture, mattresses etc.). These wastes are currently all deposited in Sudan. Therefore and considering other contaminants (e.g. heavy metals) and resources in the waste, the lack of waste management is a large threat to soil and ground water. The lack of recycling and recovery is a loss of materials and resources.

The improvement of waste management is therefore of high priority for current and future control of unintentionally POPs releases and for the management of new POPs in waste streams in Sudan.

It can be achieved by development of a national strategy for waste management accompanied by the respective legislation to improve and better regulate the overall waste management at the country level. Setting up intermediate waste disposal facilities complying with environmental standards is a must in Sudan. Moreover, setting up an appropriate sewage and drainage systems is a priority in Sudan in relation to the improvement of waste management.

V. Implementation of BAT/BEP for unintentional POPs release reduction

The Annex C facilities relevant for PCDD/F releases (hospital waste incinerator, crematory, secondary metal industry) do not comply with BAT. The assessment of facilities revealed that for Environmental Impact Assessment (EIA) the technology itself is not sufficiently described and assessed and that in this respect improvements are needed in the permitting process. Also it was revealed that no release standards (air, water and wastes) are in place in Sudan. Therefore there is a need for considering BAT in the EIA.

Implementing BAT/BEP can reduce releases of other pollutants and improve energy efficiency. The aim should be an integrated pollution prevention approach and optimisation of energy use.

VI. Monitoring of POPs, effectiveness evaluation and initiate research and collaborations

There are hardly any monitoring data for POPs in the country. In particular there are no data of POPs in the population of Sudan or of POPs in air which are both the selected matrices for effectiveness evaluation of SC. Sporadic studies based on some research were found. Also no monitoring data on POPs in biota were found.

For the implementation of the Convention baseline data of human POPs levels are needed for the support of refined priority setting and for effectiveness evaluation of implementation of the Convention.

These activities should be combined and could possibly present an impulse for establishing POPs research activities.

VII. Contaminated site assessment and management

It has been recognized that for all POPs groups (Pesticides, PCB, UPOPs, PFOS and PBDEs) contaminated sites are present (Pesticides) or likely present (for other POPs group). Currently there are only preliminary assessments for some larger pesticide contaminated sites which have shown severe contamination with related exposure. Therefore it is of high priority to initiate the assessment and mapping of POPs contaminated sites. These activities should be linked with the establishment of a contaminated site database for Sudan.

3.5. Timetable for implementation strategy and measures to success

Estimated or rather suggested timetables for implementation strategy are included in the individual action plan tables in 3.3.

For a large part of the implementation activities Sudan needs international funding. Therefore the time table depends to a large extent on approved projects. The experience of the last 7 years on SC implementation has revealed the challenges to establish projects in SC frame GEF 6 has allocated a larger budget for chemicals. Therefore, Sudan hopes that in this program cycle can get or participate in POPs projects for the implementation of SC. A number of projects were suggested in the original NIP, but none of them was funded or implemented. In a summary, none of obsolete stocks was disposed of or even contained, BAT/BEP for UPOPs was not implemented, and legislation was not revised or enforced since funding of the proposed projects was unsuccessful. Exposure of population to POPs is not known as there are limited monitoring programs in place.

3.6. NIP implementation status

The table 34 below gives an overview of Sudan level of compliance with the SC requirements in respect to “initial POPs” listed in the Convention Annexes. As currently the measures for reduction with the aim of final elimination of the new listed POPs are just to be set, the compliance with the SC provision in respect to new POPs will be carried out and presented in the future NIP updates. The action plans for the new listed POPs and initial POPs is in Chapter 3.

Table 34 - Sudan level of NIP implementation status (compliance with the SC requirements) in respect to initial POPs listed in the Convention Annexes

Convention Article	Level of compliance	Comments
ARTICLE 3 Measures to reduce or eliminate releases from intentional production and use	For POPs pesticides **see *section 2.3.1. Assessment of POPs Pesticides (Annex A, Part I chemicals): historical, current, and projected future production, use, import, and export; existing policy and regulatory framework; summary of available monitoring data (environment, food, humans) and health impacts***	Inventory and assessment has been done. For initial POPs no production and use. Still use of new listed Endosulfan (listing of exemption).
	For PCBs **see *section 2.3.2. Polychlorinated Biphenyls (PCB) (Annex A, Part II chemicals)***	Initial inventory compiled. However no funding for management yet.
	For DDT see ***section 2.3.4. Assessment of DDT (Annex B, Part II chemicals)***	No use since 1998.
ARTICLE 4 Register of exemptions	Sudan is not registered for any specific exemptions, as listed in SC Annexes	Exemptions will be registered.
ARTICLE 5 Measures to reduce or eliminate releases from unintentional production	See section ***2.3.6. Assessment of releases of unintentional produced chemicals (Annex C chemicals)***	Sudan has developed two comprehensive UPOPs inventories. However up to now no funding of BAT/BEP measures.
ARTICLE 6 Measures to reduce or eliminate releases from stockpiles and wastes	For POPs pesticides **see section *2.3.1. Assessment of POPs Pesticides (Annex A, Part I chemicals): historical, current, and projected future production, use, import, and export; existing policy and regulatory framework;***	Inventory of stockpiles and wastes have been compiled.

	summary of available monitoring data (environment, food, humans) and health impacts	However no project and funding for POPs pesticide stockpile securing and management yet.
	For PCBs **see *section 2.3.2. Polychlorinated Biphenyls (PCB) (Annex A, Part II chemicals)***	Preliminary inventory of stockpiles and wastes have been compiled. However no project and funding for POPs pesticide stockpile securing and management yet.
	For DDT see ***section 2.3.4. Assessment of DDT (Annex B, Part II chemicals)***	Inventory of stockpiles and wastes have been compiled. However no project and funding for POPs pesticide stockpile securing and management yet.
	No legal and financial instruments are in place for identification, evaluation, prioritization, management and remediation of (POPs) contaminated sites in Sudan.	A preliminary inventory of POPs contaminated sites has been compiled.
ARTICLE 7 Implementation plans	Sudan submitted its first NIP on 4th of September 2007 Second updated NIP submitted with new listed POPs 2014.	
ARTICLE 8 Listing of chemicals in Annexes A, B and C	Up to now Sudan has not submitted a proposal on the listing of new chemicals in Annexes A, B and C to the COP.	

ARTICLE 9 Information exchange	See ***section 2.3.10. Current level of information, awareness, and education among target groups; existing systems to communicate such information to the various groups***	Sudan had conducted several awareness raising workshops on UPOPs targeting all stakeholders in various states.. Also Sudan has organized conferences on pesticide hazards.
ARTICLE 10 Public information, awareness and education	See ***section 2.3.10. Current level of information, awareness, and education among target groups; existing systems to communicate such information to the various groups***	Sudan aims to continue and increase information and awareness on POPs in the country.
ARTICLE 11 Research, development and monitoring	See ***section 2.3.9. Existing programmes for monitoring releases and environmental and human health impacts, including findings***	While monitoring activities for pesticides have been done, no analytical capacity for other POPs exist which hinders monitoring, research and development. Sudan participated in POPs air and human milk monitoring activities.
ARTICLE 12 Technical assistance	Sudan is a recipient developing country Party. Since the first NIP, Sudan have received technical assistance from the following developed countries/international organizations: Within the frame of the Stockholm Convention only the two NIP updates and a regional project for protection of the Red SEA	Considerable more technical assistance is needed from all perspectives.

	(PERSGA) have been financed. No implementation projects were granted. Sudan received assistance through COMESA\SADC project for awareness raising about POPs in various states.	
ARTICLE 13 Financial resources and mechanisms	As of 30 November 2013, according to the Status of Contribution compiled by the SC Secretariat, Sudan's has no unpaid pledges for 2013 and prior years	
ARTICLE 15 Reporting	Sudan has prepared the report and tried to submit the national report pursuant to Article 15 of the Convention August 2014. The report could not be submit out of technological reasons.	The secretariat was informed of the challenges.
ARTICLE 16 Effectiveness evaluation	Sudan has participated in the 4th WHO human milk survey in 2007. Also Sudan has participated in POPs passive air sampling program.	Sudan is interested in further participation in the human milk survey and air sampling
ARTICLE 17 Non-compliance	As the procedures and institutional mechanisms for determining non-compliance are not yet approved and developed, the countries compliance cannot yet be verified	
ARTICLE 19 Conference of the Parties	Sudan has attended to all Stockholm Convention COPs	

ARTICLE 21 Amendments to the Convention	Sudan has accepted all the Stockholm Convention amendments	
ARTICLE 22 Adoption and amendment of annexes		
ARTICLE 24 Signature	Sudan signed the Stockholm Convention on the 23rd of May 2001	
ARTICLE 25 Ratification, acceptance, approval or accession	Sudan ratified the Convention on 29 August 2006	
ARTICLE 26 Entry into force	The Stockholm entered into force for Sudan on 29August 2008	

3.7 Resource requirements

This subchapter details the projected costs of measures included in NIP. Incremental costs for measures would be identified and potential sources of funding for both incremental costs and baseline costs would be noted. In accordance with Article 13 of the Convention, alternate sources of funding would be considered, as appropriate, by countries that are seeking development assistance.

Estimate resource requirements of the respective activities are included in the individual action plan tables on chapter 3.3.

Sudan is aware that the financial resources from GEF and other international funding organisations are not covering the full implementation and considerable co-funding have to be considered.

Some considerations for co-funding for POPs projects (details on co-funding will be elaborated during the respective project developments) are presented below:

- Sudan aims at an integrated approach in the implementation of SC (coordinated implementation of different conventions and integrated in national programs where feasible). Therefore co-funding might come from other project budgets.
- National projects on waste management have allocated budgets. When projects for municipal waste or waste from industry or institutions with POPs relevance are processed e.g. for WEEE or end of life vehicles then waste fees would cover a part of co-funding.
- Waste with some valuable materials (metals in WEEE or end of life vehicles) can be used as co-funding for the overall management.
- Owners of the PCBs (utility sector) have major responsibility for a large share of the PCB containing transformers.
- For pesticide stockpiles some co-funding might come from Crop-life and from the African stockpile program.
- Extended producer responsibility. Currently extended producer responsibility is not included in Sudanese regulation for e.g. WEEE or end of life vehicles. In the update of regulatory frame such regulations similar to the EU regulatory frame are planned.

Several projects might not necessarily need a particular large budget where only information dissemination or restrictions are needed.

The phase in of alternatives does not necessarily need a large budget if phase in alternatives are available for direct substitution.