Stockholm Convention on Persistent Organic Pollutants

Persistent Organic Pollutants Review Committee (POPRC)

DRAFT RISK MANAGEMENT EVALUATION

for

<u>Alpha hexachlorocyclohexane</u>

Draft prepared by:

The ad hoc working group on alpha and beta hexachlorocyclohexane

April, 2008

Draft Risk Management Evaluation for Alpha hexachlorocyclohexane

Note:

In accordance with the procedure laid down in Article 8 of the Stockholm Convention, this draft was prepared by the Persistent Organic Review Committee (POPRC) during its intersessional work. Please note that the risk management evaluation for alpha hexachlorocyclohexane covers the same contents as that for beta hexachlorocyclohexane and therefore the two drafts are identical.

Parties and observers to the Stockholm Convention are invited to provide technical and substantive comments on this draft. Comments received will be considered by the ad hoc working group and the revised draft will be made available for the fourth meeting of the POPRC (13-17 October 2008 in Geneva). Please submit your comments to the Secretariat of the Stockholm Convention preferably by e-mail no later than **18 May, 2008** to:

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Executive summary

Mexico, a Party to the Stockholm Convention, proposed lindane as well as alpha- and beta-hexachlorocyclohexane (HCH) to be included in Annex A, B or C of the Stockholm Convention. After the evaluation of the risk profiles by the Persistent Organic Pollutants Review Committee (POPRC) at its third meeting in November 2007 the Committee concluded that alpha-HCH and beta-HCH are likely, as a result of their long range environmental transport, to lead to significant adverse human health and environmental effects such that global action is warranted. Also at that meeting the risk management evaluation on lindane was adopted and its inclusion in Annex A of the Stockholm Convention was recommended.

Technical HCH (including alpha-HCH and beta-HCH) is subject to two international regulations and prohibitions: the Protocol on Persistent Organic Pollutants of the Convention on Long-Range Transboundary Air Pollution and the Rotterdam Convention. Also national and regional legislation and projects focus on effective control measures for alpha- and beta-HCH: the North American Regional Action Plan on Lindane and Other Hexachlorocyclohexane Isomers, the Commission for the Protection of the Marine Environment of the Northeast Atlantic, the EU POP Regulation (EC) No 850/2004 and the European Water Framework Directive 2000/60/EC, amongst others.

After almost forty years of extensive worldwide use, there has been a gradual replacement of technical HCH by lindane. No significant current uses of alpha- and beta-HCH (as constituents of technical HCH) have been reported by Participants to the Stockholm Convention in 2008.

Alpha- and beta-HCH control measures currently implemented in several countries include: production, use, sale and import/export prohibition, establishment of inventories, clean-up of contaminated sites, access to disposal facilities for hazardous waste, management of obsolete stocks.

Nowadays the primary source of alpha- and beta-HCH is the manufacture of lindane (as high-volume by-products). In this respect control measures for lindane also affect alpha- and beta-HCH because for the production of one ton of lindane approximately up to eight tons of alpha- and beta-HCH are generated. Past production in connection with inappropriate handling of these HCH residuals as well as existing stockpiles have generated huge amounts of waste spread into the environment in developed and developing countries.

The usage of waste HCH residuals from lindane production for the synthesis of other chemicals such as trichlorobenzene are unlikely to be an economic and technically successful option.

The assessment of the efficacy and efficiency of control measures is country dependent; however, while all countries consider that control measures currently implemented are technically feasible access to suitable disposal facilities and financial resources for remediation of contaminated sites are limited in some countries.

Hence hazardous waste management and disposal, and remediation of contaminated sites could be costly for countries and financial and technical assistance to developing countries might be needed. Therefore international mechanisms of co-financing to establish incentives would be crucial to induce a progress in reducing the environmental legacies of obsolete HCH-stockpiles and contaminated soils.

The implementation of control measures is expected to reduce the risks from exposure of humans and the environment to alpha- and beta-HCH. Positive impacts can especially be anticipated for human health, including reduced risks to Arctic Indigenous Peoples, agriculture, and biota. No negative economic impact is expected.

Several countries reported that alpha- and beta-HCH are part of their national and international monitoring programmes.

A thorough review of existing control measures, which have already been implemented in several countries including control measures for lindane, shows that risks from exposure of humans and the environment to alpha- and beta-HCH can be reduced significantly. Control measures are also expected to support the goal agreed at the 2002 Johannesburg World Summit on Sustainable Development of ensuring that by the year 2020, chemicals are produced and used in ways that minimize significant adverse impacts on the environment and human health.

In accordance with paragraph 9 of Article 8 of the Convention, the Committee recommends that the Conference of the Parties to the Stockholm Convention considers listing alpha- and beta-HCH in Annex A.

As elaborated in the Risk Management Evaluation of Lindane (UNEP, 2007c) the Conference of the Parties may wish to consider allowing a specific transitional exemption for alpha- and beta-HCH concerning the production of lindane for control of head lice and scabies as a human health pharmaceutical only. The high ratio of alpha- and beta-HCH wastes to lindane product along with the availability of efficacious and cost-effective lindane alternatives should be reflected in these considerations.

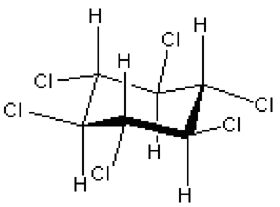
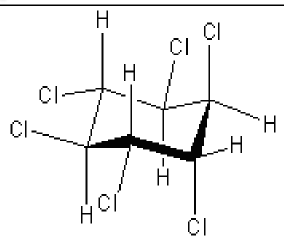
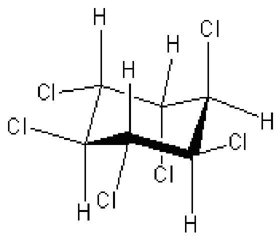
Further consideration may also be given to control measures regarding the production of lindane such as prevention and sound management of generated waste including alpha- and beta-HCH.

1. Introduction

1.1 Chemical identity of the proposed substances

Alpha-HCH and beta-HCH are produced as the main constituent of technical HCH by photochemical chlorination of benzene. The yields of the five stable isomers vary due to technical differences in the production process. The reported ranges are: alpha-HCH (55 - 80%), beta-HCH (5 - 14%), gamma-HCH (8 - 15%), delta-HCH (6 - 10%) and epsilon-HCH (1 - 5%) (Breivik et al., 1999). The chemical characterisation of alpha- and beta-HCH is compiled in table 1.1.

Table 1.1: Chemical identity

Chemical name:	**Beta-hexachlorocyclohexane (beta-HCH)**	**Alpha-hexachlorocyclohexane (alpha-HCH)**
IUPAC name:	(1-alpha, 2-beta, 3-alpha, 4-beta, 5-alpha, 6-beta)-Hexachlorocyclohexane	(1-alpha, 2-alpha, 3-beta, 4-alpha, 5-beta, 6-beta)-Hexachlorocyclohexane
CAS number	319-85-7	Racemic: 319-85-6, (+) alpha-HCH: 11991169-2 (-) alpha-HCH: 119911-70-5
Chemical formula:	$C_6H_6Cl_6$	$C_6H_6Cl_6$
Molecular weight:	290.83	290.83
Chemical structure (modified from Buser et al.,1995)	 beta-HCH	 (+)-alpha-HCH  (-)-alpha-HCH

The physico-chemical properties (see table 1.2 for selected properties) of both isomers allow for long-range transport and "cold condensation", an enrichment of the substance in cold climates compared to concentrations near sources, on altitudinal and latitudinal scales as well as for bioaccumulation in aquatic and terrestrial species (UNEP, 2006a).

Table 1.2: Physico-chemical properties[1]

	Beta-HCH	**Alpha-HCH**
Melting Point (K)	588 $_2$	431 $_2$
Boiling Point (K)	333 at 0.5 mmHg	561
Water solubility (mol*m^{-3} at 25°C)	1.44	0.33
Vapour pressure (Pa at 25°C)	0.053	0.25
Henry's Law Constant (Pa m^3 mol^{-1})	0.037	0.74
Log Kow (25°C)	3.9	3.9
Log Koa (25°C)	8.7	7.5

[1]All data taken from Xiao et al. (2004) except boiling points from ATSDR (2005)

1.2 Conclusions of the Review Committee

Mexico submitted proposals for listing the alpha and beta isomers of hexachlorocyclohexane (HCH) in Annexes A, B and/or C to the Convention on 26th July 2006, as contained in documents UNEP/POPS/POPRC.2/INF/7 and UNEP/POPS/POPRC.2/INF/8. The Committee concluded that alpha- and beta-HCH met the screening criteria listed in Annex D to the Convention (decision POPRC-2/9 and POPRC-2/10).

On its third meeting the Review Committee evaluated in accordance with Annex E the draft risk profiles for both isomers. After adoption of the risk profiles (UNEP/POPS/POPRC.3/20/Add.8 and UNEP/POPS/POPRC.3/20/Add.9) the Committee decided (decisions POPRC-3/9 and POPRC-3/10) that alpha-HCH and beta-HCH are likely, as a result of long-range environmental transport, to lead to significant adverse human health and/or environmental effects such that global actions are warranted.

Therefore an ad hoc working group was established with the mandate to prepare a risk management evaluation that includes an analysis of possible control measures for alpha- and beta-HCH in accordance with Annex F to the Convention.

The risk management evaluation of lindane (gamma-HCH) was also evaluated by the Committee during POPRC 3 and the decision for listing lindane in Annex A of the Convention was taken (POPRC-3/4). Because of the production process and the linkage of the HCH isomers this decision is also relevant for the risk management evaluation of alpha- and beta-HCH.

1.3 Data sources

The draft risk management evaluation is based on the following data sources:

- Information submitted by Parties and observers according to Annex E of the Convention: Armenia, Bahrain, Croatia, Czech Republic, Mozambique, Myanmar, Republic of Moldova, Principality of Monaco, Netherlands, Qatar, United States of America and the International POPs Elimination Network (IPEN). This information is available on the Convention's website. (http://www.pops.int/documents/meetings/poprc/AnnexF_submission_2008.htm)

- Risk profiles for alpha- and beta-HCH (UNEP/POPS/POPRC3./20/Add.8 and UNEP/POPS/POPRC3./20/Add.9), 2007.

- Toxicological profile of hexachlorocyclohexanes, United States of America Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry, 2005. (http://www.atsdr.cdc.gov/toxprofiles/tp43.html)

- The North American Regional Action Plan (NARAP) on Lindane and Other Hexachlorocyclohexane (HCH) Isomers. 2006. North American Commission for Environmental Cooperation (http://www.cec.org/pubs_docs/documents/index.cfm?varlan=english&ID=2053)

- Assessment of lindane and other hexachlorocyclohexane isomers, USEPA, 2006. http://www.epa.gov/oppsrrd1/REDs/factsheets/lindane_isomers_fs.htm

- In addition to these information sources, supplementary literature was obtained from free Internet based databases by a literature search of the public data base Pubmed (http://www.ncbi.nlm.nih.gov /entrez/query.fcgi?DB=pubmed). In general search terms include the chemical name or CAS number and/or a combination of technical terms because of the multiplicity of entries.

  The information submitted by Parties or observers and the reports listed above contained individual references which have not been listed specifically in this draft risk management evaluation.

1.4 Status of the chemical under international conventions

Alpha-HCH and beta-HCH are constituents of technical HCH, which is regulated by at least two international agreements.

The first one is the 1998 Aarhus Protocol on Persistent Organic Pollutants under the Convention on Long-Range Transboundary Air Pollution. Technical HCH is listed in Annex II of the Protocol which restricted its use to an intermediate in chemical manufacturing only.

The second agreement is the Rotterdam Convention on the Prior Informed Consent (PIC) Procedure for Certain Hazardous Chemicals and Pesticides in International Trade. HCH (mixed isomers) is subject to the PIC Procedure and is listed in Annex III of the Convention.

1.5 Any national or regional control action taken

Canada, Mexico and the United States signed the North American Regional Action Plan[1] (NARAP) on Lindane and other Hexachlorocyclohexane isomers in 2006. The goal of the NARAP is to reduce the risks associated with the exposure of humans and the environment.

HCH (including Lindane) is listed as a Level II substance in the Great Lakes Binational Toxics Strategy[2] between the United States and Canada, which aims to reduce toxic substances in the Great Lakes Basin Ecosystem by pollution prevention activities.

In the European Union, the production and use of technical HCH as an intermediate in chemical manufacturing was phased out by the end of 2007 at the latest (Regulation (EC) No 850/2004)[3]. It also includes provisions for the management and notification of existing stockpiles. Regulation (EC) No 1196/2006 and Regulation (EC) No 172/2007 deal among others with concentration limits for HCH (sum of alpha-, beta- and gamma-HCH) in waste. HCH is also among the priority substances (Decision No 2455/2001/EC) of the adopted EU Water Framework Directive 2000/60/EC.

Hexachlorocyclohexane isomers, including the alpha isomer, are on the List of Chemicals for Priority Action under the OSPAR Commission for the Protection of the Marine Environment of the Northeast Atlantic[4]. The objective is the prevention of pollution of the maritime area by continuously reducing discharges, emissions and losses of hazardous substances.

In Armenia alpha- and beta-HCH as constituents of technical HCH are not allowed for plant protection purposes. Also the country approved appropriate measures to improve the ecological situation in the vicinity of the burial place of obsolete pesticides, including Organochlorine. Also a national programme was adopted to strengthen capacities as well as to enhance chemicals and waste management including obsolete pesticides and (submitted Annex F information by Armenia, 2008).

Bahrain takes control action for all kind of hazardous chemicals but there are no specific measures on alpha- and beta-HCH (submitted Annex F information by Bahrain, 2007).

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[1] Commission for Environmental Cooperation. November 2006. The North America Regional Action Plan (NARAP) on Lindane and Other Hexachlorocyclohexane (HCH) Isomers. http://www.cec.org/files/PDF/POLLUTANTS/LindaneNARAP-Nov06_en.pdf

[2] Great Lakes Binational Toxics Strategy. http://www.epa.gov/glnpo/gls/index.html

[3] Regulation (EC) No 850/2004 of the Europena Parliament and of the Council of 29 April 2004 on persistent organic pollutants and amending Directive 79/117/EEC; OJ L 158, 2004-04-30, p.1.

[4] Convention for the Protection of the Marine Environment of the North-East Atlantic (OSAPR). http://www.ospar.org/eng/html/welcome.html

The Netherlands performed monitoring in food from polluted soil and remediation of contaminated sites (submitted Annex F information by the Netherlands, 2008)

The Republic of Moldova reported use prohibition for technical HCH and concentration limits for the workplace and environmental standards (submitted Annex F information by Moldova, 2008).

2. Summary information relevant to the risk management evaluation

2.1 Identification of possible control measures

Alpha- and beta-HCH are isomers of HCH, a mixture that was used as agricultural and non agricultural pesticide and as a pharmaceutical until the 1990s. In this respect no production and/or use was reported by Armenia, Bahrain, Croatia, Czech Republic Mozambique, Myanmar (no import/export), Republic of Moldova, Principality of Monaco, Netherlands, Qatar and the United States (submitted Annex F information, 2008)

Usage of technical HCH was banned in most western countries and Japan in the 1970s followed by China, Russia, India and Mexico. Since 2000 technical HCH is virtually no longer in use worldwide (Li and Macdonald, 2005).

Thus effective control measures (e.g. ban, prohibitions) have provoked replacement of technical HCH usage for insecticidal purposes by suitable alternatives mainly by lindane and other insecticidal active substances (UNEP, 2007a).

Nowadays the primary source of alpha- and beta-HCH is the manufacture of lindane (as by-products) (Annex F information submitted by Untied States and IPEN, 2008). To yield 99% pure lindane the mixture of technical HCH is subject to fractional crystallization and concentration. For the production of one ton lindane approximately up to eight tons alpha- and beta-HCH (six to ten tons of other isomers) are generated (CEC, 2006). Though investigations were undertaken it was not possible to achieve an optimization of the production process concerning to yield higher contents of gamma-HCH (than up to 14-15%) in the original HCH mixture (Vijgen, 2006).

In this respect lindane production, use, sale and imports prohibition, use restrictions, registrations and use cancellations as prescribed in the Risk Management Evaluation of Lindane (UNEP, 2007c) are also possible control measures for alpha- and beta-HCH. In addition control measures for alpha- and beta-HCH will affect the mixture that comprises technical HCH.

However, even though there is no known current intentional usage of alpha- and beta-HCH they may still be produced or used in some countries (submitted Annex F information by IPEN, 2008). Thus prohibitions of import, production and use have been stated as major control measures by all responding parties (submitted Annex F information, 2008).

Another measure mainly applied in the past was the usage of waste HCH residuals from lindane production for the synthesis of other chemicals like trichlorobenzene (submitted Annex F information by the United States, 2007).

The HCH isomers including alpha- and beta-HCH are likely to be released into the environment from hazardous waste sites, obsolete stocks which are not always controlled or maintained safely or contaminated sites (UNEP, 2007a). Control measures implemented in several countries include the establishment of an inventory, the clean-up of contaminated sites, access to disposal facilities for hazardous waste, and management of obsolete stocks (submitted Annex F information by the Czech Republic, Republic of Moldova and the Netherlands, 2008).

A ban on production and use of alpha- and beta-HCH would also affect waste issues. Listing a substance under the Stockholm Convention implies a ban on recycling and reuse of stockpiles of alpha- and beta-HCH and to treat contaminated sites. Article 6 in the Convention requires that wastes and stockpiles are handled in a safe, efficient and environmentally sound manner, so that the content is destroyed or irreversibly transformed, taking into account international rules, standards and guidelines. The article also bans disposal operations that lead to recovery, recycling, reclamation, direct use or alternative use of POPs material.

Also monitoring activities were reported by a Party as a control measure e.g. for meat from cattle from sites close to former production sites (submitted Annex F information by the Netherlands, 2008).

Other possible control measures taken by countries include amongst others occupational exposure limits, maximum residues limits in food and environmental standards (e.g. limit for water quality) for alpha- and beta-HCH are well established in several countries including the United States and Europe (HSDB, 2006; submitted Annex F information by the Republic of Moldova, 2008)

2.2 Efficacy and efficiency of possible control measures in meeting risk reduction goals

The efficacy and efficiency of implemented control measures is country dependent and is influenced by factors such as complete legal and government administrative systems, surveillance measures, risk communication and public participation and access to safe disposal techniques. Also, scientific involvement is needed to ensure that the technology proposed is appropriate and efficient (this has direct impact on costs).

Information provided by Parties and observers regarding this section was limited.

2.2.1 Technical feasibility

Alpha- and beta-HCH are not longer intentionally released to the environment by pesticidal usage of technical HCH indicating that technically feasible alternatives have already been identified and used (UNEP, 2007a). Chemical and non-chemical alternatives for lindane have been compiled in the Risk Management Evaluation on Lindane and are efficient, available and technically feasible (UNEP, 2007c).

For the United States the prohibition of the production of HCH to make lindane is a technically feasible control measure (submitted Annex F information by the United States, 2007).

For the Republic of Moldova it is not possible to destroy all obsolete stocks and remediate all contaminated sites at the same time. Currently no disposal plant for hazardous waste, including POPs pesticides, is available in Moldova. Environmentally sound disposal of obsolete stocks is possible in the frame of the GEF/WB project.

For the Czech Republic destruction of obsolete waste and remediation of contaminated sites such as soils, sediments and industrial hot spots is technically feasible (submitted Annex F information by the Czech Republic, 2008). They successfully finished the remediation of a former production facility Spolana Neratovice by application of the Base-catalyzed decomposition (BCD) technology.

Also technical guidelines for the environmentally sound management of POPs waste are available and efficacy (cf. work accomplish under the Basel Convention). Disposal and remediation techniques concerning HCHs have been extensively studied (Ukisu and Miyadera, 2005; IHPA, 2007).

Depending on the occurrence of pollution and possible remediation measures the intensity of the contamination is a general dividing line for management strategies. Obsolete stocks and intensively contaminated soils ('hot spots') are still a primary source for emissions and therefore would be worth to employ ex-situ- and off-site-treatment strategies involving excavation, regionally centralised intermediate storage and treatment plants. Treatment itself can involve thermal and extraction techniques.

For polluted soils with a low intensity of HCH more extensive strategies for on-site and in-situ-treatment and reduction are probably more appropriate. The degradation processes (preferably anaerobic) taking place in soil are described for alpha-, and beta-HCH and the principles for ex-situ biological treatment techniques (e.g. slurry reactors, landfarming, composting systems) are established. Any of the available extensive bioremediation techniques should be adapted re-gionally with respect to soil properties as well the available materials for stimulating degradation.

To reduce alpha- and beta-HCH residuals during lindane production one management option reported by industry is to transform the waste isomers into the solvent trichlorobenzene (CEC, 2006) and hydrochloric acid, but this has been discontinued since the 1970s. Trichlorobenzene is made nowadays by direct chlorination of benzene (Euro Chlor, 2002). Vijgen (2006) describes chemical methods for the conversion of HCH isomers to trichlorobenzene, trichloro-phenoxyacetic acid, HCl, hexachlorobenzene, sodium pentachlorophenolate and trichlorophenol. However at that time it was discovered that during dehydrochlorination of HCH and during further processing of chlorinated derivatives of benzene, trace amounts of polychlorodibenzodioxins can be created, among them 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD).

In addition, indications exist that China and Russia still manufacture PCP (pentachlorophenol) from HCB (hexachloro-benzene), which utilizes the alpha-HCH from lindane manufacture (Vijgen, 2006). However HCB can also be synthe-sised by other pathways e.g. by chlorination of benzene or from tetrachlorohydrochinone in presence of phosphor tri-chloride and pentachloride (Fiedler et al., 1995).

2.2.2 Identification of critical uses

Alpha-HCH and beta-HCH do not have any critical uses as final end products. Regarding critical uses of lindane some countries have expressed their worries about the availability and efficacy of alternatives for control of head lice and scabies as a human health pharmaceutical despite the availability of efficacious, cost-effective, alternative methods for treatment of lice and scabies (UNEP, 2007c).

As previously stated, the mixture of HCH isomer including alpha-HCH as main isomer as well as beta-HCH are by-products of the manufacture of lindane by physical processes (i.e. fractional crystallization). Thus the only use identified for alpha- and beta-HCH is linked to the production of lindane. Except for lindane, no other products are made from technical HCH in the UNECE region (UNECE, 2005).

2.2.3 Costs and benefits of implementing possible control measures, including environmental and health costs and benefits

Due to no reported usage of alpha- and beta-HCH in technical HCH for pesticidal purposes, major costs of possible control measures will arise from environmentally sound management of hazardous waste and stockpiles of HCH residuals, as well as from the remediation of contaminated sites.

Since the production of one ton lindane generates approximately up to eight tons alpha- and beta-HCH, past production in connection with inappropriate handling of these HCH residuals as well as existing stockpiles have generated huge amounts of waste spread into the environment in developed and developing countries.

Reasons for improper management of these waste isomers during past production were the underestimation of the hazards of alpha- and beta-HCH, a lack of control measures during production and illegal transport and dumping. Uncontrolled spreading of HCH residuals into the environment from production facilities and dumping grounds especially raised the remediation costs. E.g. the Basque Region spent 50 million EUR for clean-up (Vijgen, 2006).

Also the Dutch government spent approximately 27 million EUR to clean up soil contaminated with waste HCH isomers in the eastern region of the Netherlands. Currently there are additionally 200 000 tons for less contaminated soils remaining that may need remediation in the future (submitted Annex F information by the Netherlands, 2008).

The Czech Republic estimated the remediation cost of a former lindane production site is 100 million EUR. For contaminated sites exact estimates are not available and usually also other types of contaminants are concerned. In the absence of exact data, costs can be in the order of tens of millions EUR (submitted Annex F information by the Czech Republic, 2008).

Under the Arctic Council Action Plan a project was initiated for the environmentally sound management of obsolete pesticides stockpiles in the Russian Federation to protect the Arctic environment from pesticide emissions. In 2007 US$500,000 were spent for several activities (ACAP, 2007).

In the United States over 65,000 tons of HCH wastes are estimated. Alpha- and beta-HCH have been identified in at least 146 and 159 of the 1662 hazardous waste sites that have been proposed for inclusion in the Environment Protection Agency National Priorities List (ATSDR, 2005). Some of the former lindane production sites in the US are now designated as Superfund sites, meaning that they are uncontrolled or abandoned places where hazardous waste is located, possibly affecting local ecosystems or people. According to data of the International HCH and Pesticides Forum (IHPA) the cost of cleaning up HCH waste is US$ 2,000 to 3,000 per ton (Fitzgerald, 2005). The removal of obsolete pesticides costs around US$ 3,000 to 4,000 per ton (UNIDO, 2002; FAO, 1998). Costs for the collection of hazardous waste are difficult to estimate, because they depend highly on the number and geographical distribution of waste sources.

Benefits of the collection and decontamination of waste, containing alpha- and beta-HCH, are that their release and thus their impacts on human beings and the environment, is avoided. The generation of additional contaminated sites is prevented, so that costs for their remediation are saved. Health impacts on staff of production companies and on citizens, living in the vicinity of companies and of contaminated sites, are prevented. A monetary assessment of these benefits is not possible due to lack of data.

Although the exact amounts of HCH-residuals are not known, estimates are in the range of 1.6 to 4.8 million tons worldwide. The extent of this problem is thereby far beyond present estimates on obsolete pesticides in Africa (55,000 tons) and in the Eastern European region (500,000 tons) (Vijgen, 2006).

Concerning costs of possible control measures associated with lindane production at least 52 countries have banned this pesticide, as evidence that the environmental, social and health costs of continued lindane production outweigh benefits. Furthermore the phase-out of the intentional uses of alpha- and beta-HCH has already occurred indicating that costs of alternatives have not inhibited their substitution (submitted Annex F information by IPEN, 2008)

For the United States there would be no additional costs to prohibit the production of HCH to make lindane. Official records indicate that production of HCH in the United States ceased in 1976 (submitted Annex F information by the United States, 2007).

Costs are also associated with the pharmaceutical use of lindane concerning the management of alpha- and beta-HCH residuals. Usage estimates from the United States account for 272.8 kg or 600 pounds which represents 0.4% of the 150,000 pounds reported to have been used for seed treatment in the United States in 2006 according to the Lindane Risk Management Evaluation (UNEP, 2007c). If not spent from existing stocks, this would result in the generation of approximately 2,200 kg HCH residuals per year due to use in the United States alone (estimate based on the lindane usage multiplied by a factor of 8), dominated by alpha-HCH, which have to be disposed.

Based on the conclusions of the risk profiles on alpha- and beta-HCH (UNEP, 2007a; UNEP 2007b), their ubiquitous occurrence and high levels in biota and humans, and the urgent need to manage waste isomers and obsolete stocks in developed and developing countries, benefits of globally implemented control measures for human health and the environment can be expected. However environmentally sound management of these HCH residuals is costly and financial and technical assistance to developing countries might be necessary.

Concerning costs for the replacement of alpha-HCH for the production of HCB as an intermediate no information was provided by the concerned Participants to the Stockholm Convention.

The benefits of implementing possible control measures include reduction of contaminants in the environment, in food and breast milk with subsequent reduction in environmental and health risks associated with alpha-HCH and beta-HCH. Lindane and other HCH isomers are associated with adverse effects to the environment and human health, including neurotoxicity, increased cancer risk, reproductive harm, and immune suppression (UNEP, 2007a; UNEP, 2007b; UNEP, 2007c).

A recent study on lindane quantifies the ecological and health benefits in the United Sates stemming from reduced water pollution by following a ban of pharmaceutical lindane with consequent beneficial implications for the elimination of alpha- and beta-HCH waste by-products inextricably linked to lindane production (Humphreys et al., 2008).

2.3 Information on alternatives (products and processes) where relevant

Alpha and beta isomers of HCH are by-products of the production of lindane. These by-products have no registered uses (submitted Annex F information by the United States, 2007).

Also there are no alternative processes for the production of lindane available (Vijgen, 2006).

There are alternative pathways for the manufacture of PCP from HCB, which utilizes alpha-HCH from lindane production available (cf. section 2.2.1).

2.4 Summary of information on impacts on society of implementing possible control measures

2.4.1 Health, including public, environmental and occupational health

Due to extensive use over the past 50 years, persistence and long-range transport alpha- and beta-HCH can be detected in all environmental media including humans (USEPA, 2006). Human exposure to alpha- and beta-HCH results mostly from ingestion of contaminated plants, animals and animal products. High exposure is expected in contaminated areas due to extensive use, former production, disposal sites and stockpiles. Also high levels are found in Arctic marine mammals (UNEP, 2007a; UNEP, 2007b).

One important benefit is the reduced risk to human health and the environment due to the prevention of releases at the workplace and the reduction of uncontrolled exposure and releases from adequate management of hazardous waste,

contaminated sites and stockpiles. Due to the adverse effects in wildlife and human health in contaminated and remote regions including the Arctic region (UNEP, 2007b) the elimination of production and reduction of emissions is of great importance. Decontamination is connected with strong control, including monitoring (submitted Annex F information by the Czech Republic, 2008).
In 2006, a U.S. EPA risk assessment indicates potential risks from dietary exposure to the alpha- and beta-HCH isomers to communities in Alaska and others in the circumpolar Arctic region who depend on subsistence foods, such as caribou, seal and whale (USEPA, 2006).

A listing in Annex A would prevent further production and put into force measures to manage stockpiles and waste and contaminated sites. The listing of lindane in Annex A without exemptions would contribute to prevent further HCH waste residuals.

The implementation of control measures is expected to reduce the risks from exposure of humans and the environment to alpha- and beta-HCH. Especially the health of workers, local communities in the proximity to local high exposure such as production facilities and vulnerable groups such as children and people with compromised immune system should be prevented from unnecessary harm caused by HCH contamination (submitted Annex F information by IPEN, 2008). Also the risk for Arctic indigenous people gives another reason for the quick control and elimination of all HCH isomers from traditional foods (UNEP, 2007a).

2.4.2 Agriculture, including aquaculture and forestry

Usage of alpha- and beta-HCH for agriculture ceased in 1990s (Li and Macdonald, 2005). Prohibition of further production and waste site cleanups could benefit agriculture by decreasing alpha- and beta-HCH soil and water contamination (submitted Annex F information by IPEN, 2008).

2.4.3 Biota (biodiversity)

Elimination of any further production of alpha- and beta-HCH will ensure that the levels of HCH isomers found in biota, especially in the Arctic from long-range transport, decrease over time. Thus the health impacts for humans and other mammals as well as the environmental impacts associated with exposure to these isomers will be reduced (submitted Annex F information by IPEN, 2008).

It can be anticipated that reduced releases to the environment may have benefits to biota because it was shown that HCH isomers negatively affect wildlife in field investigations. Impacts on biota may include neurotoxicity, hepatotoxicity and carcinogenicity. Also, reproductive and immunosuppressive effects and effects on fertility were seen in laboratory animals (UNEP, 2007b).

Inappropriate storage, handling and transportation of obsolete pesticides and waste (including alpha- and beta-HCH) may result in spreading of these isomers over considerable areas. Thus the prevention of local pollution will also have global effects (Wei et al., 2007).

2.4.4 Economic aspects, including costs and benefits for producers and consumers and the distribution of costs and benefits

No negative economic impact is apparent for the suggested usage prohibition of alpha- and beta-HCH as a pesticide or pharmaceutical. Costs of control measures for lindane including alternatives were evaluated in the Risk Management Evaluation on Lindane (UNEP, 2007c). However in addition any ongoing production would include costs for safe disposal of alpha- and beta-HCH.

Also the set up of an appropriate system for collection and treatment of hazardous waste is connected with remarkable costs. In the first instance, the producers of waste will have to bear these costs, but subsequently will pass them on to the consumers via an increased product price. However, costs for an appropriate waste management are still much lower than costs for remediation of contaminated sites.

Information regarding costs of implementing possible control measures is also provided in this document in section 2.2.3

2.4.5 Movement towards sustainable development

A prohibition of alpha- and beta-HCH production would contribute to sustainable development in a way that existing usages can effectively be replaced by alternatives that pose less risk to human health and the environment. Reducing health damages may be essential in the future in order to reduce overall cost incurred by the society which thus renders those resources free for other areas of interest. (This was also stressed in the EU strategy Cleaner Air for Europe[5]).

It may also raise governmental and public awareness to the existing waste problems that can have positive impact to waste avoidance.

As the persistent, bioaccumulative and toxic properties of alpha- and beta-HCH as well as their potential for a long-range transboundary transport were proved under the UNECE Protocol and by the POP Review Committee of the Stockholm Convention, a positive impact on globally sustainable development from a ban/restriction of these chemicals is to be expected.

Reduction and elimination of alpha-HCH and beta-HCH are consistent with sustainable development plans that seek to reduce emissions of toxic chemicals. A relevant global plan is the Strategic Approach to International Chemicals Management (SAICM) that emerged from the World Summit on Sustainable Development.[6] The Global Plan of Action of SAICM contains specific measures to support risk reduction that include prioritizing safe and effective alternatives for persistent, bioaccumulative, and toxic substances (SAICM, 2006)[7].

2.4.6 Social costs (employment, etc.)

Usually waste management practices can and should cause a positive stimulating effect for employment and hence have overall positive economic effects. One may also infer positive scale effects for other waste management practices due to the implementation of such practices as well as the introduction of new technologies.

HCH isomer control and waste management measures will also be beneficial for the Arctic native peoples by reducing contamination of their traditional foods. Alaskan Native peoples rely on traditional foods because of cultural importance, availability, preferences in taste and nutrition to store-bought foods. Any steps taken to reduce exposure of Arctic native peoples to alpha- and beta-HCH will have beneficial social outcomes, since their traditional foods are an integral part of their social and cultural identity (submitted Annex F information by IPEN, 2008).

2.4.7 Other impacts

No information received.

2.5 Other considerations

2.5.1 Access to information and public education

In the Republic of Moldova a campaign to promote and facilitate access to information, public education and awareness was conducted within the GEF/WEB Project "POPs Stockpiles Management and Destruction" by 2007 (submitted Annex F information by the Republic of Moldova, 2008).

Armenia reported the availability of the national electronic database on legislative documents as well as a journal where the normative legislative documents are published (submitted Annex F information by Armenia, 2008)

The Czech Republic has an education and awareness POPs campaign (SC/UN ECE CRLTAP) based on the Czech National Implementation Plan (Annex F information provided by the Czech Republic, 2008).

The North America Regional Action Plan on Lindane and Other Hexachlorocyclohexane (HCH) Isomers (NARAP) has laid down outreach and education steps for the parties of the North America Agreement on Environmental Cooperation (NAAEC), i.e. Canada, Mexico and United States of America. The focus of the steps is especially on lindane as the parent chemical. For alpha- and beta-HCH the Parties will ensure that indigenous populations are suitably advised in a culturally acceptable manner on the possible risks associated with the use of lindane, with the presence of lindane and/

[5] http://ec.europa.eu/environment/air/cafe/
[6] http://www.chem.unep.ch/saicm/

or HCH isomers in the environment, with the risk of exposure through traditional foods, and on the use of available alternatives as applicable (CEC, 2006).

2.5.2 Status of control and monitoring capacity

In Armenia alpha-HCH is monitored in surface water (submitted Annex F information by Armenia, 2008).

Control and monitoring institutions in the Czech Republic include: RECETOX MU for monitoring in ambient air, surface waters, sediments, soils, mosses and needles: Water Research Institute for monitoring of surface and ground waters and sediments, Central Institute for Supervising and Testing in Agriculture (CISTA), Research Institute of Amelioration and Soil Conservation (RIASC), State Veterinary Inspection and Czech Food Inspection for food control, and National Institutes of Public Health for human exposure and dietary studies (Annex F information provided by the Czech Republic, 2008).

The Principality of Monaco reported no environmental or bio-monitoring (submitted Annex F information by the Principality of Monaco, 2008)

In the Republic of Moldova the Monitoring Division on Environmental Quality of the State Hydrometeorological Service effectuates alpha- and beta-HCH monitoring in surface water, atmospheric precipitations, soil, fish, and sediments. The Laboratory of Sanitary-Chemical Researches of the National Scientific Practice Centre of Preventive Medicine (Ministry of Health) effectuates POPs monitoring, including alpha- and beta-HCH in soil, water, animal and vegetal food products. Biological liquids including breast milk are monitored, but not on a regular base (submitted Annex F information by the Republic of Moldova, 2008).

The Netherlands reported for alpha- and beta-HCH a downward trend based from extrapolation of monitoring data from lindane concentrations in precipitation (submitted Annex F information from the Netherlands, 2008).

Also within the North America Regional Action Plan on Lindane and Other Hexachlorocyclohexane the parties take actions on environmental and human monitoring for lindane and other HCH isomers (CEC, 2006).

In the United States alpha- and beta-HCH are not registered for use as a pesticide under the Federal Insecticide, Fungicide and Rodenticide Act. Official records indicate that production of HCH in the United States ceased in 1976 (Annex F information provided by the United States of America, 2008).

3. Synthesis of information

The hazard profiles of alpha- and beta-HCH exhibit persistent, bioaccumulative and toxic properties as well as long-range transport. High exposure is expected in polluted areas, which are still present around the globe and the Arctic region. Alpha- and beta-HCH are present in the terrestrial and the aquatic food chains and concentrations are a human health concern.

Alpha- and beta-HCH are themselves not effective against insects and the widespread use of technical HCH in the past was due to its low cost, which is a benefit that does not outweigh the risks as evident by already implemented worldwide control measures.

Therefore all responding parties suggested prohibition of production and use as a technically feasible and efficient control measure for alpha- and beta-HCH noting its link to lindane production as by-products.

One major source of alpha- and beta-HCH pollution was the production of lindane with only a few producing countries remaining, but former production and the inefficient production process over the years have left an enormous amount of waste products in developed and developing countries.

Listing of alpha- and beta-HCH in Annex A would also mean that the provisions of Article 3 on export and import and of Article 6 on identification and sound disposal of stockpiles and waste would apply.

Based on the conclusions of the risk profiles on alpha- and beta-HCH (UNEP, 2007a; UNEP 2007b), their ubiquitous occurrence and high levels in biota and humans, the urgent need to manage waste isomers and obsolete stocks by globally implemented control measures can be expected to result in benefits for human health and the environment.

However, environmentally sound management of these HCH residuals is costly, and financial and technical assistance to developing countries might be necessary. Also a joint effort in tackling this hazardous waste legacy among international bodies (e.g. Food and Agriculture Organization, Organization for Economic Co-Operation and Development, Global Environmental Facilities), Authorities, Industry and Non Governmental Organizations is needed.

Consideration should be given to establishing a date for phase out for pharmaceutical uses of lindane. This date would thus also effect the total phase-out of alpha- and beta-HCH production and should be given when listing the chemicals in the convention.

In conclusion alpha- and beta-HCH control measures have shown to be technically feasible, efficient and accessible and include: production, use, sale and imports prohibition, establishment of national inventories, monitoring, disposal of waste including stockpiles, clean-up of contaminated sites and prohibition of lindane production. Therefore, they may be appropriate for consideration as potential control measures to be implemented by countries.

4. Concluding statement

The POPs Review Committee of the Stockholm Convention has decided that alpha- and beta-HCH are likely, as a result of long-range transport, to lead to significant adverse effects on human health and the environment such that global action is warranted. After preparation of the risk management evaluation and evaluation of the risk profile, possible control measures were identified and deemed effective and acceptable to Parties of the Convention represented at the POPRC.

A thorough review of existing control measures that have already been implemented in several countries, shows that risks from exposure of humans and the environment to alpha- and beta-HCH can be reduced significantly. Control measures are also expected to support the goal agreed at the 2002 Johannesburg World Summit on Sustainable Development of ensuring that by the year 2020, chemicals are produced and used in ways that minimize significant adverse impacts on the environment and human health.

In accordance with paragraph 9 of Article 8 of the Convention, the Committee recommends that the Conference of the Parties to the Stockholm Convention considers listing alpha- and beta-HCH in Annex A.

As elaborated in the Risk Management Evaluation of Lindane (UNEP, 2007c) the Conference of the Parties may wish to consider allowing a specific transitional exemption for alpha- and beta-HCH through the production of lindane for control of head lice and scabies as a human health pharmaceutical only. However, the high ratio of alpha- and beta-HCH wastes to lindane production along with the availability of efficacious and cost-effective lindane alternatives should be reflected in these considerations.

Further consideration may also be given to control measures regarding the production of lindane such as prevention and sound management of generated waste including alpha- and beta-HCH.

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