METHOXYCHLOR

DRAFT RISK MANAGEMENT EVALUATION

First Draft

9 April 2021

Contents

Executive Summary

1. At the sixteenth meeting the Persistent Organic Pollutants Review Committee (POPRC) reviewed and adopted the draft risk profile on methoxychlor. The POPRC concluded that methoxychlor is likely, as a result of its long-range environmental transport, to lead to significant adverse human health and environmental effects such that global action is warranted. A risk management evaluation is therefore required that includes an analysis of possible control measures for methoxychlor in accordance with Annex F of the Convention. Parties and observers were invited to submit to the Secretariat the information specified in Annex F by 1 March 2021.

2. Responses regarding the information specified in Annex F of the Stockholm Convention have been provided by Australia, Republic of Belarus, Canada, Columbia, Costa Rica, Egypt, Hungary, Mexico, Monaco, Norway, Peru, Republic of Korea, the Russian Federation, Sweden, UK and by Pesticide Action Network (PAN) and International Pollutants Elimination Network and Alaska Community Action on Toxics (IPEN-ACAT). The risk management evaluation is based on these responses, on additional literature sources, including cited references in the risk profile on methoxychlor, and on the risk management evaluation of dicofol, which had similar uses to methoxychlor and was also used as a replacement for DDT.

3. Methoxychlor is an organochlorine pesticide (OCP) which has been used as an insecticide effective against a wide range of pests on, for example field crops, vegetables, fruits, ornamentals, livestock and pets, as well as for general nuisance pests such as mosquitos and flies. Metoxychlor had been used both in commercial agricultural settings, as well as in domestic environments. Based on information from the U.S. where the production of methoxychlor peaked in the late 1970s to early 1980s, it has been estimated that the maximum global production around this time was 8 000 tons/year (Götz et al., 2008). Like in the U.S., where production of methoxychlor steadily decreased up until it being banned in 2004, many countries have phased out production and usage for almost 20 years. As a result, the global use is believed to have declined sharply. In response to the call for information (Annex F, 2021), only one Party (the Russian Federation) has indicated current production and use of methoxychlor. No information on the current production or use of methoxychlor at a global scale has been found in the public domain.

4. Possible control measures, some of which are currently applied by several nations, cover a broad spectrum including the prohibition and restriction of production, use, import and export; the establishment of exposure limits and requirements for Personal Protective Equipment (PPE) in workplaces; the environmentally sound management of obsolete stock; the clean-up of contaminated sites and the establishment of maximum residue limits in water, soil, sediment and food and feed.

5. An analysis of possible control measures demonstrated that a restriction on the production, use, import and export of methoxychlor would be less effective at protecting the environment and human health than a full prohibition. It could be possible to limit the use of methoxychlor to only key critical uses, which would limit the release and exposure, however, no critical uses have been identified. A restriction on specific uses of methoxychlor would likely result in similar economic impacts as a full prohibition, although at a more limited scale. It is important to highlight that information on the scale of economic costs arising from a restriction on methoxychlor, or from other control measures, could not be identified, mainly because the manufacturing and use has declined since almost 20 years.

6. It would be technically possible to limit further occupational exposure by technical means and by imposing restrictions on workers’ activities. To protect workers during formulation and manufacture, occupational exposure could be reduced by ensuring that (if present) production facilities use closed-systems only. For professional uses in agriculture and at production facilities, when exposure likely occurs, PPE should be worn at all times to better protect workers, particularly farm workers during preparation and application of methoxychlor. Concerted efforts working with farming communities and other end users would likely be beneficial to help manage the collection and safe destruction of any obsolete stock to prevent loss to the environment due to mismanagement. However, the effectiveness of these measures, particularly the use of PPE, has not been demonstrated and they would likely be difficult to implement and monitor worldwide. Therefore, these measures would be less effective in reducing exposure and releases as a prohibition or restrictions would be.

7. Establishment of maximum residue limits for methoxychlor are predominantly focused on food, feed and drinking water. Some countries have monitoring programs in place for controlling pesticide residues in food, but such monitoring is likely lacking in many parts of the world. Further data on development of environmental limits for the natural environment would be needed to draw more complete conclusions on the feasibility of development and implementation of monitoring programs as a method by which to control the risks associated with methoxychlor. The effectiveness of residue limits and monitoring as control measures to reduce human and environmental exposure globally would likely be more limited than the effects of a prohibition or restrictions.

8. A prohibition on production and use would be the most effective control measure at protecting the environment and human health. A prohibition is considered technically and economically feasible considering that many nations have already applied this control measure for a long time, the global level of production and use appear

to be limited and because no specific examples of critical uses were provided by the Parties and observers submitting information under Annex F.

9. Alternatives to methoxychlor have been identified by considering the historic uses of methoxychlor for specific pests (e.g., chiggers, mosquitos and elm bark beetles) and for specific applications (e.g. crops and livestock), as well as by investigating which current practices are commonly used for these purposes. The widespread use of many chemical alternatives to methoxychlor suggests technical and economic feasibility of substituting methoxychlor globally. For each chemical alternative presented there are human health and environmental concerns regarding their use, which need to be considered carefully when choosing alternatives.

10. Non-chemical alternatives are widely available. The efficacy of some botanical preparations and Integrated Pest Management (IPM) methods is supported by academic studies. There is less information evaluating the use of biological control agents, although their widespread use is documented. Non-chemical alternatives are often used in conjunction with chemicals to reduce dependence, rather than to entirely substitute them.

11. A direct comparison of these alternatives to methoxychlor, in terms of costs, technical feasibility, efficacy, and availability is constrained by the lack of information on the use of methoxychlor. However, the widespread use of alternatives suggests that at least some options will be effective, available, and feasible in all parts of the world. The choice of alternatives may vary by country due to regulations, types of pests, market dynamics or other variables such as climatic conditions. As methoxychlor is banned or not used in many countries, substitution with alternatives is assumed both technically feasible and of little economic impact.

12. As conclusion and in accordance with paragraph 9 of Article 8 of the Convention the POPRC recommends to the Conference of the Parties to the Stockholm Convention to consider listing methoxychlor and specifying the related control measures under the Stockholm Convention in Annex A without specific exemptions.

1. Introduction

13. In May 2019, the European Union submitted a proposal to list methoxychlor in Annex A to the Stockholm Convention (UNEP/POPS/POPRC.15/4). The proposal was considered by the Persistent Organic Pollutants Review Committee (POPRC) at its fifteenth meeting held in October 2019, where the Committee concluded that methoxychlor fulfilled the screening criteria in Annex D.

14. At the sixteenth meeting of the POPRC in January 2021 the Committee, having reviewed the risk profile on methoxychlor, decided (POPRC-16/2), that methoxychlor is likely, as a result of its long range environmental transport, to lead to significant adverse human health and environmental effects such that global action is warranted. The Committee also established an intersessional working group to prepare a risk management evaluation that includes an analysis of possible control measures for methoxychlor.

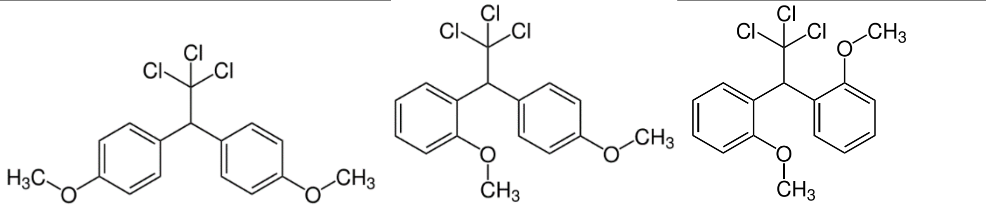
15. Parties and observers were invited to submit to the Secretariat the information specified in Annex F by 1 March 2021. The submitted information and other relevant information are considered in this document.

1.1 Chemical identity of methoxychlor

16. Pure methoxychlor is a pale-yellow powder that has a slightly fruity or musty odour (Agency for Toxic Substances and Disease Registry (ATSDR, 2002).

Table 1 Information pertaining to the chemical identity of methoxychlor

Common name IUPAC	Methoxychlor* 1,1'-(2,2,2-trichloroethane-1,1-diyl)bis(4-methoxybenzene) 1-methoxy-2-[2,2,2-trichloro-1-(4-methoxyphenyl)ethyl]benzene 1,1'-(2,2,2-trichloroethane-1,1-diyl)bis(2-methoxybenzene)
CAS registry number (non-exhaustive list) EC number	72-43-5; 30667-99-3; 76733-77-2; 255065-25-9; 255065-26-0; 59424-81-6; 1348358-72-4 200-779-9
Synonyms and Trade name	Please refer to the to the risk profile (UNEP/POPS/POPRC.16/9/Add.1)

Abbreviations	MXC
Molecular formula	$C_{16}H_{15}Cl_3O_2$
Molecular mass	345.65 g/mol
Structural formulas examples	

*Methoxychlor refers to any possible isomer of dimethoxydiphenyltrichloroethane or any combination thereof.

1.2 Production and uses

Production

17. According to ATSDR (2002), methoxychlor was first synthesised in 1893 by the reaction of chloral hydrate with anisole in the presence of acetic acid and sulfuric acid. It is produced commercially by the condensation of anisole with chloral in the presence of an acidic condensing agent (the International Agency for Research on Cancer (IARC), 1979; Sittig, 1980 as cited in ATSDR, 2002). Commercial production of methoxychlor in the United States (U.S.) was first reported in 1946. In 1975, three U.S. companies produced methoxychlor (IARC, 1979 as cited in ATSDR, 2002). According to Götz et al. (2008), the peak production of methoxychlor in the U.S. was in the late 1970s to early 1980s. After that period, production of methoxychlor continuously decreased over time. U.S. production in 1975 was 2500 tonnes (IARC 1979, as referenced by ATSDR 2002), decreasing to 193 tonnes in 1991 (Kincaid Enterprises 1992, as referenced by ATSDR 2002). After 1992, production of methoxychlor in the U.S. was further reduced until its ban in 2004 (U.S. EPA, 2004).

18. Based on the WWF (2001) report for OSPAR (as cited in OSPAR, 2004), no existing producers or importers of methoxychlor have been identified in Europe since it has been phased out in 2002.

19. According to submitted information, specified in Annex F (2021), Norway, Australia, Canada, Egypt, Republic of Korea, Monaco, Costa Rica and Peru do not currently produce methoxychlor. Furthermore, methoxychlor has never been manufactured in Belarus. There is no current production of methoxychlor in the UK and no evidence has been found of historical production. The Russian Federation submitted information (Annex F, 2021) that based on the results of an inventory carried out in the period 2019-2020 within the formation of the register of chemical substances and mixtures of the Russian Federation, methoxychlor was submitted to the "Unified List of Chemical Substances”[1]. Information on the manufacturers and tonnage is confidential according to the register rules.

20. In addition, according to information submitted (Annex E, 2019) Qatar, State of Palestine and Thailand do not produce methoxychlor. CropLife International stated in December 2020 that CropLife International member companies do not produce or trade methoxychlor or methoxychlor containing products.

21. Australia, Canada, Columbia, Costa Rica, Egypt, Hungary, Monaco, Norway, Peru, Republic of Belarus, Republic of Korea, Sweden, nor the UK have stockpiles of methoxychlor, nor do they import or export the substance (Annex F, 2021).

Uses

22. Methoxychlor is an organochlorine pesticide (OCP) and it has been used as a replacement for DDT, a structural analogue. In veterinary practices, methoxychlor was used as an ectoparasiticide (U.S. EPA, 2000). Methoxychlor has been used as an insecticide against a wide range of pests, including houseflies and mosquitos, cockroaches, chiggers (a type of mite which has been targeted by methoxychlor in the past), and various arthropods commonly found on field crops, vegetables, fruits, stored grain, livestock, and domestic pets (U.S. EPA, 1988b and Verschueren, 1983 as cited in ATSDR, 2002). Methoxychlor was also used against the elm bark-beetle vectors of Dutch elm disease (U.S. EPA, 2000). Methoxychlor may be applied to large areas such as beaches, estuaries, lakes, and marshes for control of fly and mosquito larvae by aerial application (U.S. EPA, 1988b as cited in ATSDR, 2002). Other uses include the spray treatment of barns, grain bins, mushroom houses, and other agricultural premises and the spraying or fogging of garbage containers, sewer manholes, and sewage disposal areas (U.S. EPA, 1988b as cited in ATSDR, 2002). In the U.S., approximately 28% of methoxychlor was used for home and garden purposes, 15% for

[1] https://gisp.gov.ru/cheminv/pub/app/search/

industrial and commercial purposes, and 57% for agricultural purposes (Kincaid Enterprises, 1992 as cited in ATSDR, 2002). Pesticide workers usually dissolve methoxychlor in a petroleum-based liquid and apply it as a spray, or they mix it with other chemicals and apply it as a dust (ATSDR, 2002). Methoxychlor has been formulated as wettable powders, dusts, emulsifiable concentrates, ready-to-use products (liquids), and pressurised liquids (U.S. EPA, 2004).

23. According to Götz et al. (2008), methoxychlor was used extensively from 1974–1985 as a replacement product for DDT in the U.S. Between 1986 and 1992, the usage of methoxychlor in the U.S. continuously decreased and after 1992, the use of methoxychlor was heavily reduced. For modelling purposes, Götz et al. (2008) estimated the worldwide use of methoxychlor to be three times higher than the use in the U.S. (i.e. worldwide maximum of 8,000 tonnes/year), based on extrapolation factors used for other pesticides, such as trifluralin or DDT. Methoxychlor has been phased out in the U.S. on since 2003 (U.S. EPA, 2004).

24. Methoxychlor use as a plant protection product and as an active substance in biocidal products has been phased out in the European Union since 2003 and 2006 respectively, with some Member States having put bans in place prior to this. It is reported that the use of methoxychlor as a pesticide ceased in most EU countries between the 1970s and 2000 (OSPAR, 2004). The European Agency for the Evaluation of Medicinal Products (EMEA) reported in 2004 that methoxychlor was not used in veterinary medicines in the EU Member States (OSPAR, 2004).

25. According to Annex F (2021) submission information, methoxychlor is no longer registered for use in Norway, Australia, Canada, Costa Rica, Egypt, Republic of Korea, Republic of Belarus, Monaco, Sweden, Hungary or in the UK. Annex E (2019) information already indicated that methoxychlor is not approved in New Zealand and that Qatar, State of Palestine and Thailand do not use methoxychlor (Annex E, 2019). According to the PAN International Consolidated list of Banned Pesticides, methoxychlor is banned in the following countries: Guinea, Indonesia, Mauritania, Oman and Saudi Arabia (Annex E, 2019). The only current use reported via Annex F submission is the use as insecticide in agriculture and in veterinary practice in the Russian federation. Hungary has reported that based on the notifications in accordance to Regulation (EC) No 1272/2008 ("CLP Regulation"), there are four companies in Hungary which use methoxychlor. The exact quantities, uses and environmental releases remain unknow (Annex F, 2021).

26. According to communication with a stakeholder from Turkey, methoxychlor has not been manufactured, imported, or used over the last 10 years. There is no plant production product registered and licensed in Turkey that contains methoxychlor as the active substance. According to information gathered during the risk profile the use of OCPs such as methoxychlor has been discontinued for several years in Ghana, but there is no official data of methoxychlor use in Ghana (UNEP/POPS/POPRC.16/9/Add.1). China indicated during the commenting phases of the risk profile that they have stopped the registration of methoxychlor as a pesticide since the 1990s and that there is currently no evidence of use either legally or illegally. Furthermore, information received from Mexico, indicates that since the implementation of the "Regulation on the registrations, import and export authorizations, and export certificates for pesticides, fertilizers and toxic or dangerous substances and materials" on 28 March 2005, Mexico does not have data about any application for a registration of pesticides for their environmental evaluation, related to active ingredient methoxychlor. A commercially available registration database was consulted by CropLife International in January 2021 and based on this database, methoxychlor is registered in one country, namely Mexico (results short survey (see section 1.2.2). In a study carried out to determine residues of methoxychlor and other organochlorine pesticides in peri-urban bovine milk samples in India, it was mentioned that there has been a ban by the government of India on the use of organochlorine pesticides in crop protection for the last three decades (Gill et al., 2020).

27. Some relatively recent findings of methoxychlor in food and environmental samples may be an indication of potential ongoing use of methoxychlor in some parts of the world. Residues of methoxychlor have been detected in coffee beans from Africa and South America (EFSA, 2020a, EFSA personal communication, May 2020) and buffalo milk and vegetables from Africa (Adeleye et al., 2019, Bolor et al., 2018, Shaker and Elsharkawy, 2015). Methoxychlor was measured in disinfectants and in washing products in an African study (Adekunle et al., 2018). Methoxychlor detected in sediment, in pine and in soil samples has been attributed to potential ongoing uses by the authors (Castañeda-Chávez et al., 2018, Cindoruk et al., 2020 and Thiombane et al., 2018). These studies are discussed in the risk profile of methoxychlor (UNEP/POPS/POPRC.16/9/Add.1). However, most of the countries in which these studies were conducted have communicated that methoxychlor is not currently used and/or is not registered in that country. According to information submitted by the Russian Federation (Annex F, 2021) 'scientific publications indicate the presence of methoxychlor in environmental objects in the regions of the Russian part of the Arctic, including air samples at Arctic monitoring stations in 2000-2003, snow, ice core, biota samples of the terrestrial, air and marine environment, as well as terrestrial species, marine invertebrates and fish'.

1.3 Conclusions of the POPs Review Committee regarding Annex E information

28. At its fifteenth meeting in October 2019 (decision POPRC-15/3), the Committee concluded that the proposal by the European Union to list methoxychlor fulfilled the screening criteria specified in Annex D. The Committee also

decided to establish an intersessional working group to review the proposal further and prepare a draft risk profile in accordance with Annex E of the Convention.

29. After having considered the draft risk profile for methoxychlor (UNEP/POPS/POPRC.16/3), comments and responses relating to the draft risk profile (UNEP/POPS/POPRC.16/INF/5) and additional information on methoxychlor (UNEP/POPS/POPRC.16/INF/16) in its sixteenth meeting in January 2021, the Committee adopted the risk profile for methoxychlor (UNEP/POPS/POPRC.16/9/Add.1) and decided (POPRC-16/2) in accordance with paragraph 7(a) of Article 8 of the Convention, that methoxychlor is likely as a result of its long range environmental transport to lead to significant adverse human health and environmental effects such that global action is warranted; established an intersessional working group to prepare a risk management evaluation that includes an analysis of possible control measures for methoxychlor in accordance with Annex F to the Convention; and invited Parties and observers to submit to the Secretariat the information specified in Annex F before 1 March 2021.

1.4 Data sources

1.4.1 Overview of data submitted by Parties and observers

30. This Risk Management Evaluation is based on information that has been provided by parties and observers to the Convention. Responses regarding the information specified in Annex F of the Stockholm Convention have been provided by the following countries and observers:

31. Parties: Australia, Republic of Belarus, Canada, Columbia, Cost Rica, Egypt, Hungary, Mexico (to be included in second draft of the risk management evaluation), Monaco, Norway, Peru, Republic of Korea, the Russian Federation, Sweden and the UK.

32. Observers: Pesticide Action Network (PAN) and IPEN-ACAT.

1.4.2 Other data sources

33. In addition to the above-mentioned references and comments received from Parties and observers, information has been used from open information sources as well as scientific literature (see list of references). The following key references were used as a basis to develop the present document: the risk profile on methoxychlor (UNEP/POPS/POPRC.16/9/Add.1) and the risk management evaluation of Dicofol (UNEP/POPS/POPRC.13/7/Add.1). In addition to these references, a short survey was sent to CropLife International, PAN, Egypt, Turkey, India, Mexico and China to obtain additional information on use and production of methoxychlor. No additional information was obtained from India, Mexico or China (January 2021).

1.5 Status of the chemical under International Conventions

34. The OSPAR Commission included methoxychlor in the List of Chemicals for Priority Action in 2000.

1.6 Any national or regional control actions taken

35. Methoxychlor is not approved for use as an active substance in plant protection products (PPP) in the European Union (EU) under Regulation (EC) No 1107/2009. The authorisations of PPP containing methoxychlor were withdrawn by 25 July 2003 (Commission Regulation (EC) No 2076/2002). Methoxychlor is no longer approved for use in veterinary (Regulation (EC) No 726/2004) and biocidal applications (Regulation (EU) No 528/2012 and Commission Regulation (EC) No 2032/2003).

36. Methoxychlor is listed in Annex II of Regulation (EC) No 396/2005 on maximum residue levels (MRLs) of pesticides in or on food and feed of plant and animal origin (amending Council Directive 91/414/EEC). Establishment of MRLs for methoxychlor in water, soil, sediment, or food have also been set in Peru under regulation "Water Quality Regulation for human consumption" approved by Supreme Decree N° 031-2010-SA. In Korea there are MRL values for methoxychlor set for 36 agricultural products (Annex F, 2021). The Extraneous Residue limit (ERL) in food and animal feedstuff for methoxychlor has been set in Australia by the Australia Agricultural and Veterinary Chemicals Code (MRL Standard) Instrument, 2019. The U.S. EPA also limits the amount of methoxychlor present in agricultural products and drinking water (ATSDR, 2020).

37. The Occupational Safety and Health Administration (OSHA) of the United States Department of Labor has set a Permissible Exposure Limit (PEL) for methoxychlor.

38. The use of methoxychlor as a pesticide was banned in the United States in 2003 (U.S. EPA, 2004).

39. According to the risk profile (UNEP/POPS/POPRC.16/9) and Annex F (2021) submissions, national and/or regional regulations related to methoxychlor comprise the following:

a) Methoxychlor used as a pesticide has been banned in the Republic of Belarus since 1999;

b) Norway reported the use of methoxychlor as a pesticide to be expired since 1987;

c) The use of methoxychlor was banned mid 1970s in the UK and was banned Hungary since 1974. Both countries were subject to further EU regulations of methoxychlor;

d) In Canada, the registration of methoxychlor as a pesticide was voluntary withdrawn in 2002 and subsequently completely phased out in 2005;

e) Methoxychlor is not produced in Australia, imports were prohibited in 1987 without written permission and uses of methoxychlor were phased out in November 1997;

f) Methoxychlor is not registered as pesticide in the Republic of Korea;

g) In Egypt methoxychlor had been banned in accordance to the decision of Minister of Trade no. 55 of 1996, whether for trade, production, private use or personal use for the purpose of trading in Egypt or using it as a pesticide for agricultural practices;

h) Methoxychlor is no longer used in Costa Rica since the permits for the use of this substance were cancelled in 2013;

i) Methoxychlor is not approved in New Zealand under the Hazardous Substances and New Organisms Act 1996 (HSNO Act);

j) According to communication with Mexico, since August 1991, methoxychlor is a restricted pesticide than can only be used under the supervision of trained and authorized personnel, and since the implementation of the "Regulation on the registrations, import and export authorizations, and export certificates for pesticides, fertilizers and toxic or dangerous substances and materials" on 28 March 2005, Mexico does not have data about any application for a registration of pesticides for their environmental evaluation, related to active ingredient methoxychlor;

k) China indicated that they have stopped the registration of methoxychlor as a pesticide since the 1990s.

2. Summary of information relevant to the risk management evaluation

2.1 Identification of possible control measures

40. Identification of potential control measures should address the potential direct exposure of humans to methoxychlor in occupational settings (manufacture and use in agriculture), but also indirect exposure from residual levels in food and as a result of exposure via the environment, as well as environmental releases. Based on the nature of methoxychlor production and use, the following control measures are potentially available: (1) Prohibition of production, use, import and export; (2) Restriction of production, use, import and export (3) Establishment of exposure limits and PPE requirements in workplaces (including agriculture); (4) Environmentally sound management of obsolete stock and clean-up of contaminated sites and (5) Establishment of maximum residue limits in water, soil, sediment and/or food.

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

2.2.1 Technical feasibility

Prohibition of production, use, import and export

41. Prohibition of the production, use, import and export of methoxychlor has already been successfully implemented in a wide number of countries, with further details provided in section 1 of this dossier. Based on the data available it appears that production, sale and use of methoxychlor now only occurs in a small number of nations globally. The only indication of production, sale and use submitted through the Annex F survey is by the Russian Federation, stating that manufacturing takes place and methoxychlor is used in agriculture as an insecticide and at veterinary practice (Annex F, 2021). No quantitative information is provided due to the confidentiality.

42. The prohibition of the production, sale and use of methoxychlor by a number of nations, from a variety of geographical and climatic regions that grow a diverse range of crops indicates that viable chemical and non-chemical alternatives do exist and are already in use. Information provided by UK (Annex F, 2021) shows that a range of chemical alternatives is already actively in use and PAN and IPEN/ ACAT (Annex F, 2021) have identified a range of non-chemical alternatives. The specific alternatives to methoxychlor that are available are further discussed in Section 2.3. However, available context on the process of phase-out and the potential technical implications for substituting

methoxychlor specifically is limited and as a result more general studies which looked at feasibility of using alternative pesticides have been included.

43. The risk management evaluation for the chemically related pesticide, dicofol (UNEP/POPS/POPRC.13/7/Add.1), provides some further insight to the main issues facing agricultural communities when transitioning from pesticides more generally. It is assumed in this RME these insights are also relevant for methoxychlor.

44. Wang *et al*. (2015) provide a perspective on the technical feasibility of prohibition and switch to alternatives. Wang noted that many farmers in China continued to make use of specific pesticides even when restrictions were implemented, and safer alternatives were available. Based on a survey of 472 Chinese farmers on farming practices and their perspectives on the use of chemical pesticides, Wang *et al*. (2015) highlighted that due to economic constraints and fear of failing crops, many farmers were reluctant to change from their preferred choice of pesticides to untested alternatives;.

45. Eyhorn (2007) reports a study (Maikaal bioRe sustainability study) concerning organic cotton farming in India. In this study Eyhorn (2007) noted that the economic margins for the farmers were particularly tight, meaning that many farmers had a reliance on specific pesticides and were reluctant to change farming practices due to fear of failing crops and economic impacts resulting from such failures. Eyhorn states that due to 10-20% lower production costs and a 20% price premium for organic products, average gross margins from organic cotton fields were, depending on the year, 30-40% higher than in the conventional production system.

46. Prohibition would likely represent the most effective means to protect human health and the environment from the risks associated with methoxychlor. Data provided through the Annex F survey suggests that a number of chemical alternatives are already widely available, although data on price and efficacy was not sufficient to provide a critical review. Non-chemical alternatives are also available as options should a prohibition be implemented.

Restriction of production, use, import and export

47. As an alternative to a full prohibition, a restriction on the production, use, import and export of methoxychlor could be used to limit the potential release and exposure of methoxychlor in countries where the pesticide is still being used. Information on reduced exposure and socioeconomic impacts of restrictions are very limited due to a number of countries already having phased out the use of methoxychlor. Only one party (The Russian Federation) has indicated current use of methoxychlor although no quantitative information is provided (Annex F, 2021). Data on existing restrictions across different nations globally is very limited, with most countries having opted for a full prohibition.

48. Uses of methoxychlor cited in the risk profile include as a broad-spectrum insecticide which has been used on crops, but also livestock and domestic pets, for example in dog shampoo. In addition to professional uses, domestic uses may also occur. Manual application of products to livestock and domestic pets could also result in significant human exposure during treatment.

49. Two key pathways exist for release and exposure, firstly during the manufacture and/or application of methoxychlor as a direct pathway (inhalation/ingestion/dermal contact); and secondly via contamination of food and water as an indirect pathway. Therefore, a restriction could address these pathways by implementing either restriction on use of methoxychlor for certain food crops and/or on specific professional and consumer uses. The risk management evaluation of dicofol (UNEP/POPS/POPRC.13/7/Add.1) discusses the use of restriction on specific food crops with potential high uptake of pesticide (i.e., tea), use of labelling schemes, special permissions for use of named pesticides where risk is considered high for non-target species, and use of restricted entry intervals (REI) to protect workers. Similar restrictions could be adopted for methoxychlor, which would limit the risk of release and exposure. There are important economic considerations that should be considered for how such systems are implemented and enforced, including available resources to manage such restrictions.

50. For veterinary applications restrictions on specific applications could be included where the risk of release to humans and the environment is high. For example, the restriction could limit the use of methoxychlor to specific settings where release is controlled (i.e., use over open soil is prohibited). This may mean that new equipment or infrastructure would be needed where methoxychlor is used. This could in turn carry additional costs, particularly for less developed nations.

51. A restriction on production and specific uses, with exemptions for potential critical uses, would be less effective than a full prohibition in reducing human health and environmental risks, but it would further reduce remaining releases to the environment and the level of exposure to humans, leading to decreased risks. In developing the type of restriction that could be needed, it is necessary to establish the key processes employed during the manufacture and use of methoxychlor, and also identify any critical uses.

Establishment of exposure limits and requirements for PPE in workplaces

52. Data from a public health statement for methoxychlor from the ATSDR (2002) highlighted concerns over populations living in close proximity to hazardous waste sites, those working or living near farms where methoxychlor is used on crops or occupational workers employed in factories making methoxychlor or products containing methoxychlor. The National Occupational Exposure Survey of 1981–1983 in the U.S. estimated that approximately 3,418 workers (agricultural services and personal services) were exposed to methoxychlor in the United States in 1980 (ATSDR 2002). A publication from 2013 mentions one study of 199 households in the U.S. state of North Carolina, which found that 26% of households had methoxychlor in their house dust (Watts, 2013).

53. Exposure to methoxychlor can occur through pathways such as inhalation, dermal absorption, and ingestion. Exposure routes differ for occupational workers and the general population, with inhalation and dermal exposure being increasingly likely in occupation settings and exposure via ingestion more likely in the general population. Standard occupational exposure limits (OEL) for the use of methoxychlor have previously been identified. OSHA has set a Permissible Exposure Limit (PEL) of 15 milligrams per cubic meter of air (mg/m^3) for the average amount of methoxychlor that may be present in air during an 8-hour workday. The American Conference of Governmental Industrial Hygienists (ACGIH) recommends a Threshold Limit Value (TLV) of 10 mg/m^3 (ATSDR 2002). American Conference of Industrial Hygienists (2018) recommend a time-weighted average (TWA) of 10 mg/m^3 , concluding that at this concentration a worker will absorb up to 1.4 mg/kg/day, which is less than the dose (2 mg/kg/day) shown to be without adverse health effects in humans.

54. Methoxychlor has been formulated as wettable powders, dusts, emulsifiable concentrates, ready-to-use products (liquids), and pressurised liquids[2]. PPE such as impervious clothing, gloves, and face shields should be used when working with methoxychlor-based products. For both liquid emulsion-based products and wettable powders this includes the need to ensure that skin, face, and head be covered, and that chemical-resistant protection should be worn at all times. However, it is suggested that, in developing countries, highly hazardous pesticides may pose significant risks to human health or the environment, because risk reduction measures such as the use of personal protective equipment or maintenance and calibration of pesticide application equipment are not easily implemented or are not effective (FAO)[3].

55. Many barriers to using PPE as a control measure for general pesticides have been documented., For instance, it is often reported that farmers do not use PPE due to lack of supplies, time, or discomfort. The most common barrier reported by Walton et al. (2017) was wetness (caused by irrigation, sweat, and rain) which was associated with health concerns and also reduced effectiveness of protective clothing. Wet PPE may even increase dermal absorption of pesticides.

56. One study in Burkina Faso reported that masks and boots were sometimes used by farmers for protection but only a small proportion (0.93%) of farmers used “full protection”, with many (even those most experienced) under the impression that pesticide handling incurred no risks (Toe et al., 2013). Increased risks of pesticide poisoning in Burkina Faso have previously been attributed to inadequacy of PPE, alongside other factors including frequent and repeated pesticide use, illiteracy of most workers, and unawareness of the delayed effects of pesticides (Ouédraogo et al., 2009).

57. In northern Greece, knowledge of pesticide use and beliefs regarding pesticide hazard control correlated with the adoption of safety practices (including PPE and other control measures) (Damalas and Koutroubas, 2017). Furthermore, a number of studies indicate that the level of use and awareness of PPE in certain developing countries is insufficient to ensure the safety of farm workers dealing with hazardous pesticides (Banerjee et al., 2014; Gesesew et al., 2016; Neupane et al., 2014). As such, using PPE as a methoxychlor control measure may be limited by the observed problems with current practices.

58. Potential for exposure and impacts on human health during the manufacture of methoxychlor depends upon the manufacturing process. However, apart from an indication by the Russian Federation (Annex F, 2021) that manufacturing is taking place, it is unclear whether any other countries are still manufacturing methoxychlor and whether this process is open or closed. To protect workers during formulation and manufacture, occupational exposure could be reduced by ensuring that (if present) production facilities use closed systems only. Guidelines prepared by the U.S. Department of Health and Human Services (ATSDR, 2002) highlighted the need for specific PPE when working with methoxychlor during manufacture or use. There is no evidence that the identified PPE is in use for all required situations. It should be noted that while PPE limits the risks to workers from direct exposure, they may do little to limit environmental exposure during manufacture and may not limit long range transport of methoxychlor.

59. Exposures to humans can be reduced by various means. Firstly, to protect workers during formulation and manufacture, occupational exposure should be reduced by ensuring that (if present) production facilities use closed

[2] https://archive.epa.gov/pesticides/reregistration/web/html/methoxychlor_red.html

[3] http://www.fao.org/agriculture/crops/thematic-sitemap/theme/pests/code/hhp/en/

systems only. Secondly during manufacturing and professional uses, PPE should be worn at all times to better protect farm workers, particularly during preparation and application. The effects of using PPE and pesticide application equipment as control measures to reduce human exposure could be limited considering the observed problems with current practices, especially in agriculture. Furthermore, the monitoring of such measures would impose challenges, especially in a global context.

Environmentally sound management of obsolete stock; Clean-up of contaminated sites

60. Global production and use of methoxychlor has undergone significant reductions due to regulatory restrictions, however there may potentially be stock of methoxychlor remaining in a number of locations across the globe.

61. The management of obsolete stock of methoxychlor presents a challenging issue due to the limited information available on the supply chain and possible end users. Products containing methoxychlor were designed for use in both larger scale farm settings (including pastoral and arable farming) but also for home gardening. The Pesticide info database[4] lists over 2,000 products containing methoxychlor however it gives no indication of whether any product is currently in use. This highlights the need for education campaigns and concerted efforts to help farmers and other consumers to reclaim remaining obsolete products for safe management. It also highlights a potential risk for the mismanagement of obsolete stock and potential release to environment either intentionally, or unintentionally, for example, from the loss of containment during storage or handling. Financial support from GEF projects such as “Sustainable Management of POPs” Project in Egypt (Annex F, 2021) and "Environmentally sound management of PCBs, mercury and other toxic chemical substances in Peru” can help achieve elimination of POP pesticides. The latter project in Peru offers different amounts of money per management goal, and with respect to the elimination of 100 tons of pesticides, corresponds to a financing amount of $ 500,000 (Annex F, 2021).

62. One option for disposal of methoxychlor products is through thermal destruction/incineration in hazardous waste treatment facilities. The U.S. EPA Handbook for Hazardous waste (U.S. EPA,1981) indicates that methoxychlor is a candidate for incineration by rotary kiln with a temperature range of 820-1600 °C and that exhaust gases should be controlled (although no specifics regarding control measures are listed). Thermal destruction of methoxychlor does not pose a technical problem, however access to appropriate incineration facilities is limited in some countries. Information on quantities of methoxychlor that has been destroyed is scarcely reported, however a search of the U.S. EPA TRI explorer database[5] indicates that 1,567 pounds (equivalent to 710kg) of methoxychlor were reported disposed of or otherwise released (On-site and Off-site) in 2019, with a peak of 14,000 pounds (equivalent to 6,350 kg) disposed of or otherwise released in 2017 (see Figure 1 in Appendix). However, the TRI data should be used with caution since only certain types of facilities are required to report; therefore, the information may not be exhaustive. Egypt (Annex F, 2021) has also indicated that they dispose of 1,000 tons of obsolete pesticides out of country but give no further details on where or how these are destroyed. Alternate means of destruction of methoxychlor that have been deployed at full scale are not publicly available.

63. Methoxychlor is known to have been produced in the U.S. until its suspension in 2000 but no further information on other production sites has been identified. According to EPA TRI, three processing facilities in the U.S. reported that no methoxychlor was released to soil in 1999 but reported the release of 13 kg of methoxychlor to the air (ATSDR, 2002). Methoxychlor has been identified in 46 soil and 11 sediment samples collected from 58 of 1,613 National Priorities List (NPL) hazardous waste sites (HazDat, 2002 as cited in ATSDR, 2002). The link between manufacturing of methoxychlor and emissions to the environment has not been documented and it is released to the environment mainly as a result of its application to crops and livestock as a pesticide. Remediation of contaminated sites could be necessary where methoxychlor has been used widely as a pesticide which could have high associated costs, however, no information has been found or provided to indicate the extent or number of such sites globally.

64. To summarise, while there has been a major decline in the production and use of methoxychlor, it has been used in products available to professional and consumer end users. This, as well as the lack of information on potential old and current production sites, represents a challenge for the identification, collection, and safe destruction of any obsolete stocks of methoxychlor that may exist. Concerted efforts working with farming communities and other end users would likely be beneficial to help manage the collection and safe destruction of any obsolete stock to prevent mismanaged loss to the environment.

[4] provided by PAN https://www.pesticideinfo.org/chemical/PRI4098

[5] United States Environmental Protection Agency. (2021). TRI Explorer (2019 Updated Dataset (released October 2020)) [Internet database]. Retrieved from https://enviro.epa.gov/triexplorer/, (March 04, 2021).

Establishment of maximum residue limits in water, soil, sediment or food

65. Based on the information reviewed and provided, no maximum environmental thresholds have been set for methoxychlor. The substance has, however, been monitored across environmental compartments (air, soil, water, food) and these results are discussed further both within the Risk Profile and Section 2.5.2.

66. Maximum residue limits (MRLs) for methoxychlor have been set by the EU (Regulation (EC) No 396/2005) and are set out Table 3 (see Appendix) [6]. Under both the UK and European Union regimes a limit has been set for methoxychlor of 0.01 mg/kg covering a wide range of fresh fruit, vegetables, nuts, fungi, and sugar. For teas (and other infusions), hops and spices, a limit of 0.1 mg/kg applies. Additionally, for meat products (all types) the 0.01 mg/kg threshold applies (UK, Annex F 2021). However, rather than being based on specific risks, the EU MRL for methoxychlor is based on the default lowest limit of analytical determination in EU law. Establishment of maximum residue limits in water, soil, sediment, or food have also been set in Peru (Annex F, 2021) under regulation "Water Quality Regulation for human consumption" approved by Supreme Decree N° 031-2010-SA, which specifies in Annex III, the maximum permissible limit for methoxychlor as 0.020 mg/L. In Korea there are 38 maximum residue limit (MRL) values (1.0-14.0 mg/kg) of methoxychlor set for 36 agricultural products (Annex F, 2021). Additionally, data from Australia also provide guidelines for limits set on residual concentrations in food and feed. The Extraneous Residue limit (ERL) in food and animal feedstuff for methoxychlor is 1.0 mg/kg in Australia (Australia Agricultural and Veterinary Chemicals Code (MRL Standard) Instrument, 2019). In 1996 the WHO published guidelines for drinking water quality which included a guideline value of 20 µg/litre (rounded figure) but this threshold has not been updated since. According to the ToxFAQs^{TM} for Methoxychlor (ATSDR, 2020) the U.S. EPA limits the amount of methoxychlor that may be present in drinking water to 0.04 ppm. The Food and Drug Administration (FDA) limits the amount of methoxychlor in bottled water to 0.04 ppm. The U.S. EPA also limits the amount of methoxychlor present in agricultural products to 1-100 ppm.

67. Monitoring results of methoxychlor concentrations in food were reported previously in the risk profile. Based on the analysis of the 2018 pesticide monitoring results in the EU (including Iceland and Norway) (EFSA, 2020a, EFSA personal communication, May 2020), methoxychlor was quantified in one animal product sample (in equine fat) and in four coffee bean samples (imported from outside the EU: Brazil, Ethiopa, Peru and Uganda) at concentrations in the range of 0.01-0.05 mg/kg (LOQ of 0.01 mg/kg). Bolor et al. (2018) reported mean concentrations of methoxychlor in lettuce, onion and cabbage in the range of 9.02–184.1 µg/kg (or 0.009–0.184 mg/kg). Based on concentrations found for methoxychlor in these products the authors suggest that short- and long-term dietary exposures are unlikely to pose a concern to human health. Exposure to methoxychlor via food is discussed further in Section 2.4 but given the low levels of detection of methoxychlor in food products (see Table 4 in Appendix) is difficult to conclude how effective restrictions on application to specific crops would be in limiting human exposure

68. Establishment of maximum residue limits for methoxychlor are predominantly focused on drinking water, food and feed. Some countries have monitoring programs in place for controlling pesticide residues in food, but such monitoring is likely lacking in many parts of the world. Further data on development of environmental limits for the natural environment would be needed to draw more complete conclusions on the feasibility of development and implementation of monitoring programs as a method by which to control the risks associated with methoxychlor. The effectiveness of residue limits and monitoring as control measures to reduce human and environmental exposure globally would likely be more limited than the effects of a prohibition or restriction.

2.2.2 Identification of critical uses

69. Methoxychlor has been used as pesticide for the treatment of pests and mites in a wide range of crops, on livestock and domestic animals and in veterinary practices as an ectoparasiticide (U.S. EPA, 2000). However, prohibitions and restrictions have been established by many countries globally growing different crops in different geographies and climatic conditions, which have successfully transitioned to the use of alternative options (both chemical and non-chemical). No examples of critical uses have been identified by Parties or Observers in their responses to the Annex F (2021) request for information, or through the review of literature. It is therefore unknown whether there are remaining uses that can be defined as critical.

70. Possible critical uses could arise in a country where there are specific crop-pest combinations where a chemical and/or non-chemical alternative is not available. However, the evidence reviewed suggests that chemical and/or non-chemical alternatives are technically feasible and are currently being used for methoxychlor. It is also possible that there may be cases where there are technical and financial obstacles which make transition to alternative

[6] It should be noted that MRLs are established for 'in use' registered/regulated chemicals and will be therefore be relevant during the phase-out of methoxychlor and less relevant once it is banned.

options more difficult. This could be managed with technical and financial assistance under the auspices of the Convention with a time-limited exemption for transition.

71. The use of methoxychlor as a means to control the spread of malaria could be a critical use in some parts of the world, but it has not been established to what extent, if any, methoxychlor has been used for malaria control. Furthermore, no Party or observer to the Convention has raised the need for methoxychlor use against malaria and mosquitoes as a critical use.

2.2.3 Costs and benefits of implementing control measures

72. Possible costs related to the prohibition of methoxychlor and the associated uses of chemical and non-chemical alternatives include: (1) enforcement costs for governments and authorities (negative), (2) costs accruing to companies that still manufacture methoxychlor and potential impacts on their staff (negative), (3) costs accruing to farmers using methoxychlor (from switching to alternatives and due to possible initial changes in volumes and quality of yields) (negative and/or positive), (4) costs accruing to consumers of products containing methoxychlor (negative); (5) impacts stemming from costs for management of obsolete pesticides, waste disposal costs and remediation of contaminated sites (negative) and (6) impacts as a result of reducing the risk of environment pollution and human health effects (positive). No data has been identified / provided to calculate the scale of these possible costs.

73. A restriction on specific uses of methoxychlor would likely cause similar economic impacts as a prohibition, although at a more limited scale. It could be possible to limit the use of methoxychlor to only key critical uses, which would limit potential economic impacts. However, no critical uses have been identified.

74. No data was provided by Annex F respondents related to the longer-term economic impact of restrictions or bans that have been implemented for methoxychlor by many nations, nor is there any information on costs relating to transition from methoxychlor to other alternatives. Information provided by the UK indicates that low-cost alternatives are available such as cypermethrin which is widely used in the UK and available at £5 per kg (equivalent to 7 $/kg) of product (Annex F, 2021). Many countries have already completed the transition, so the costs are therefore not seen as prohibitive, but will depend on the alternatives that are accessible in each country. However, short term economic losses due to, for example, reduced crop yields, loss of jobs within manufacturing and formulation industries and training costs for farm workers to adopt new approaches are possible. This should be considered as part of the POPs Review Committee assessment and technical assistance programme of the Convention. Prohibition and restrictions on the production, use, import and export of methoxychlor has already been completed by many countries globally, each with different crops, geographies, and climatic conditions, demonstrating that it is technically and economically feasible. The cost impacts of any control measure will naturally vary significantly for those countries which are already regulating methoxychlor, as oppose to those that are not and where the use of methoxychlor may still be on-going.

2.3 Information on alternatives (products and processes)

2.3.1 Overview of alternatives

75. A range of alternatives to methoxychlor have been identified based on the supporting information provided by the UK, PAN, IPEN and ACAT (Annex F, 2021), through a review of the available literature, as well as based on the risk management evaluation of dicofol, which had many similar uses to methoxychlor (UNEP/POPS/POPRC.13/7/Add.1). Methoxychlor has historically been used across a broad range of crops, vegetables, fruits, ornamentals, livestock, pets and general nuisance pests such as mosquitos in an equally broad set of geographical regions (see section 1). Different types of alternatives are available, including chemical alternatives, biological controls, botanical preparations, agroecological practices, organic farming, and integrated pest management (IPM).

76. Based on the information provided by the Parties and observers (Annex F, 2021) one clear caveat is that many of the responding parties highlight that methoxychlor has been banned in their nation for almost 20 years. This means that comparison of chemical and non-chemical alternatives to methoxychlor in terms of costs and effectiveness is very challenging beyond stating that alternatives clearly exist. The UK has provided details of chemical alternatives based on an analysis of insecticides used against the same named target pests as methoxychlor from the risk profile (such as elm bark beetle). The UK also highlights that a range of non-chemical alternatives likely exist. PAN and IPEN have provided further details on the likely non-chemical options which they assert could readily supplant the use of methoxychlor (see Section 2.3.3.). PAN suggested a read-across to the risk management evaluation of endosulfan (UNEP-POPS-POPRC.8-INF-14-Rev.1.English) to identify both chemical and non-chemical alternatives to methoxychlor.

2.3.2 Chemical alternatives

77. The main chemical alternatives to methoxychlor identified can be grouped by chemical family into pyrethroids, neonicotinoids, avermectins, organophosphates and other organochlorines. Each of these groups contains a vast number of substances which are available for crop, veterinary, medicinal, and other applications. Furthermore, the World Health Organisation recommends certain types of pyrethroids, organochlorines, organophosphates, and carbamates for mosquito control (WHO, 2012). Additional information on the potential chemical alternatives to methoxychlor has been identified through a review of the available literature and covers a range of crops and veterinary applications, demonstrating that alternatives do exist and are already in active use.

78. Any transition to alternative substances must be mindful of the health and environmental hazard profiles of the alternatives under consideration. To ensure that a potential alternative is safer, leading to the protection of human health and the environment, the risk of the chemical being considered should be fully assessed. It should be confirmed that the alternatives do not exhibit POPs properties as defined in Annex D of the Stockholm Convention.

79. The UK Annex F (2021) response included a list of chemical alternatives (pyrethroids and neonicotinoids), which are detailed in the appendix (Table 2), alongside their hazard classification.

Pyrethroids

80. Pyrethroids are a large family of insecticides which work as a contact poison to affect the nervous system of insects. They have a broad range of applications (spanning different climatic conditions), including plant protection, control of pests in cattle farming, and mosquito control. This group includes permethrin, cypermethrin, esfenvalerate, fluvalinate, tefluthrin, and deltamethrin, among others (FAO, 2014).

81. Permethrin, bifenthrin, cyfluthrin, and esfenvalerate containing insecticide sprays can be used on lawns to reduce chiggers (Texas A&M Agrilife Extension, 2014). Permethrin, cypermethrin, fluvalerate, and esfenvalerate have been found to be more effective pesticides against European elm bark beetles relative to methoxychlor (Pajares & Lanier, 1989). COWS (2014) highlight the use of pyrethroids in treating cattle lice and controlling flies in cattle farming, however, pyrethroid resistance of lice has been reported in the UK. Additionally, insecticide use in fly control is often not recommended due to effects on non-target invertebrates.

82. Cypermethrin and permethrin have shown greater mortality and longer effective residual times in mosquitos compared to methoxychlor and are reportedly ‘the main insecticides currently used to control mosquitos’ (Stoops et al., 2019). Fenvalerate can also be used in treating mosquitos (Helson and Surgeoner, 1983). One issue arising from the popular use of pyrethroids is resistance of mosquitos (Bajunirwe, 2020; Amelia-Yap et al., 2018; Bustamante Gomez et al., 2016). There is more evidence for increasing pyrethroid resistance relative to other insecticide classes (WHO, 2018; Kuri-Morales et al., 2018).

83. Permethrin is not approved in the EU as a pesticide (Regulation (EC) No 1107/2009). The biocidal use of permethrin as insecticide, acaricide and products to control other arthropods is authorized in the EU (Regulation (EC) No 528/2012). Under harmonised classification and labelling, permethrin is classified as acutely toxic, skin sensitising, and very toxic to aquatic life with long lasting effects (Regulation (EC) No 1272/2008). The PBT properties of permethrin has been assessed in the EU in the context of the work programme for the examination of existing biocidal active substances contained in biocidal products. Permethrin could be considered potentially persistent due to the *cis* constituent of permethrin (as the isomeric mixture 25:75 *cis:trans*) being persistent in the sediment compartment (half-life was 180 days (at 12 °C))(ECHA, 2014). According to the assessment permethrin fulfils the Annex D screening criteria of the Stockholm Convention for adverse effects based on ecotoxicity due to chronic toxic effects in Daphnia at very low concentration. Furthermore, permethrin was found to be toxic to bees (ECHA, 2014). On the other hand, the U.S. EPA concluded that the benefits of the use of permethrin outweigh the risks, particularly with regard to its use in mosquito control. They also suggest that control measures can be implemented to mitigate risks (U.S. EPA, 2019). Nevertheless, based on the identified hazards permethrin does not appear to be a safe alternative.

84. Cypermethrin is approved in the EU for use as an insecticide, with the condition that Member States must pay particular attention to the protection of aquatic organisms, bees, and non-target arthropods, and to the operator safety, and must ensure that risk mitigation measures are included where appropriate (Commission Implementing Regulation (EU) 540/2011; Commission Implementing Regulation No (EU) 2020/1511). The biocidal use of cypermethrin as a wood preservative is authorized in the EU (Regulation (EC) No 528/2012). Under harmonised classification and labelling, alpha-cypermethrin is found to be acutely toxic, it may cause respiratory irritation, it may cause damage to organs after repeated or prolonged exposure, and it is very toxic to aquatic life with long lasting effects. The UK further comment in their Annex F response, that on the UK market cypermethrin is a low-cost treatment valued at around £5/kg of product (equivalent to 7 U.S. dollars/kg).

Avermectins

85. Avermectins are systemic antibiotic insecticides isolated from the fermentation of the soil bacterium *Streptomyces avermitilis*. The effectiveness of avermectins, including abamectin, ivermectin, doramectin, eprinomectin and moxidectin, in treating a range of pests (mostly for livestock, horticultural crops, or general nuisance) has been documented for a long time (Strong and Brown, 1987). Avermectins were also identified as key chemical alternatives to the chemically related pesticide dicofol (already listed as a POP) (UNEP/PO PS/PO PRC.13/7/Add.1).

86. Abamectin acts as an acaricide, nematicide and insecticide for use in a wide variety of crops. It is used to control insect and mite pests of a range of agronomic, fruit, vegetable, and ornamental crops. Abamectin used as a spray treatment was proven effective for the control of the red palm mite on coconuts in Florida (Rodrigues and Peña, 2012).

87. Abamectin residues in or on crops are very low, resulting in minimal exposure to humans from harvesting or consumption of treated crops. In addition, abamectin does not persist or accumulate in the environment and has limited bioavailability in non-target organisms. Abamectin can have adverse impacts on pollinators and biological control organisms (Khan et al., 2015; Broughton et al., 2013; Jin et al., 2014).

88. Avermectins have been considered to diversify malaria control options in order to overcome issues of resistance to other insecticides (Dreyer et al., 2019; Meredith et al., 2019).

Neonicotinoids

89. Examples of neonicotinoids include imidacloprid, clothianidin, thiamethoxam, acetamiprid, nitenpyram, dinotefuran, and thiacloprid. They have been used against fleas, mites, whiteflies, termites, the Colorado potato beetle, and other insects.

90. In Europe, the risks to bees from neonicotinoids, namely imidacloprid, clothianidin and thiamethoxam, have been deemed unacceptable for many years. In 2013, the vast majority of uses of the substances have been banned by Commission Implementing Regulation (EU) No 485/2013. In 2018, their use has been further restricted by prohibiting all outdoor uses of the substances (Commission Implementing Regulation (EU) 2018/783; Commission Implementing Regulation (EU) 2018/784; Commission Implementing Regulation (EU) 2018/785). Thereafter, the approval of these neonicotinoids expired in 2019 and 2020, meaning they are no longer approved for placing on the market in the EU (under Regulation (EC) No 1107/2009). The biocidal uses of imidacloprid, clothianidin and thiamethoxam as insecticides, acaricides and products to control other arthropods are authorized in the EU (Regulation (EC) No 528/2012). Neonicotinoids are an undesirable alternative due to concern about their impacts on pollinators, although they may have critical uses, which has been deemed the case in 10 EU Member States where 21 emergency authorisations have been granted (EFSA, 2020b).

91. Acetamiprid is approved for use in the EU, after the risk assessment based on the use of acetamiprid in aphid and Colorado beetle control in fruit, tomato, and potato crops demonstrated that the approval criteria are satisfied, including risks to bees (EFSA, 2016).

92. The U.S. EPA (2020) assessed acetamiprid to be highly toxic to mammals, birds, and bee larvae, and moderately toxic to adult bees. However, they concluded these risks are unlikely to translate into colony-level impacts for bees. The risks to aquatic life were deemed to be low. It was suggested that risks of acetamiprid to workers and wildlife can be mitigated by improving PPE standards for workers applying acetamiprid and using spray drift mitigation and buffer zones to limit the movement of acetamiprid into the environment.

Ngufor et al. (2017) suggested combining clothianidin (a neonicotinoid) and deltamethrin (a pyrethroid) to more effectively control mosquito populations showing pyrethroid resistance.

Other alternatives

93. Organophosphates are among the most used pesticides globally (Maggi et al., 2019) and have been used to treat crops, mosquitos, and cockroaches (similar to methoxychlor). For mosquito control, organophosphates are more expensive than pyrethroids and organochlorines and they have shorter residual activity (WHO, 2012). However, they are highly effective and have less frequently been linked to resistance (WHO, 2016). One study in Western Kenya showed some degree of resistance to pyrethroids and DDT but none to organophosphates (Wanjala et al., 2015).

94. Pyrrole insecticides including chlorfenapyr have been used to control leafminers, mites, cockroaches, flies, and other insects. Chlorfenapyr disrupts cell metabolic pathways and consequently respiration, leading to insect death (Oxborough et al., 2015). Chlorfenapyr is used in Brazil, Australia, Japan, Mexico, and the U.S.A (FAO/WHO, 2017). Furthermore, it has been used for mosquito control in insecticide-treated bed nets[7] and has potential to improve control of mosquitos showing resistance to other insecticides (Ngufor et al., 2016; N'Guessan et al., 2007). There are

[7] https://www.cdc.gov/malaria/malaria_worldwide/reduction/itn.html

concerns regarding the persistence and bird reproductive effects of chlorfenapyr (U.S. EPA, 2001) and its high toxicity to aquatic organisms (Regulation (EC) No 1272/2008).

95. Non-insecticide insect control methods are also available. DEET (N,N-diethyl-m-toluamide) is used to repel insects (mosquitos, ticks, fleas, chiggers, leeches) rather than kill them, so is not similar in the mechanism of action to methoxychlor but provides similar desired results. DEET is on the U.S. EPA high production volume list. DEET has the advantage of low risks to both humans and the environment (ECHA, 2010; Chen-Hussey et al., 2014), with its high degradation rates and low potential for bioaccumulation (Weeks et al., 2012). There is some concern regarding neurotoxic effects on children, although the risks are thought to be low (ECHA, 2010).

2.3.3 Non-chemical alternatives

96. The non-chemical alternatives to methoxychlor discussed below include integrated pest management (IPM), sustainable and organic agricultural practices, biological control systems and botanical preparations, as well as physical barriers and hygiene practices.

97. As part of the Annex F responses, PAN has provided many examples of potential non-chemical alternatives for methoxychlor, which are derived from the assessment of non-chemical alternatives for the pesticide endosulfan (POPRC-8/INF/14/Rev.1). Some of these are discussed in the sections below.

98. The Conference of the Parties by decision SC-6/8 (UNEP/POPS/COP.6/33) encouraged Parties when choosing alternatives to give priority to ecosystem-based approaches to pest control. Furthermore, the fourth session of the international conference on chemicals management (ICCM4) recommended that when phasing out highly hazardous pesticides (which include POPs), emphasis should be placed on agroecological practices. With regards to the UN Sustainability Development Goals, an indicator for target 2.4 concerning sustainable agricultural is pesticide management, which largely consists of minimizing pesticide use through non-chemical alternatives, including crop rotation, biological control, and inter-cropping (FAO, 2020).

Integrated Pest Management (IPM) and organic and agroecological practices

99. IPM involves combining a range of practices which work synergistically to control pests. Common practices involved include crop rotation, cultivation techniques, use of balanced fertilization, liming, irrigation/drainage practices, hygiene measures, and use of ecological infrastructure at production sites. Pest control is implemented when monitoring gives warning of harmful organisms and when scientifically sound thresholds (specific to the region and crops) have been exceeded. Non-chemical methods are used over pesticides if they provide adequate control. Furthermore, in the instance that pesticides are used, they must have minimal effects on humans and the environment. Pesticides should be applied at reduced doses to minimise risks[8].

100. In the Annex F request for information, UK mentions the use of integrated crop management (ICM) as a non-chemical alternative to methoxychlor. They say that it was not possible to further analyze whether specific applications of methoxychlor could be replaced by ICM because the use of methoxychlor ceased more than 40 years ago in the UK. ICM, like IPM, integrates a range of measures to discourage the development of weeds, pests, and disease populations.

101. In the Annex F request for information, PAN submitted information describing community managed sustainable agriculture (CMSA), a type of IPM where no pesticides are used. Specific actions are recommended for various purposes, e.g., stemborers on maize may be controlled through application of neem cake during ploughing, by spraying with neem seed kernel extract or chili-garlic solution. Neem products are extracted from the South Asian plant *Azadiracta indica*, which contains insecticidal compounds. Neem has been recommended for many applications, including control of leaf miners on cow pea and thrips on tea leaves.

102. Beyond Pesticides recommends organic farming as an alternative to methoxychlor (Beyond Pesticides 2021a), claiming it represents an economic opportunity for premium products (Beyond Pesticides, 2021b). Eyhorn (2007) showed that organic agroecological approaches on cotton fields improved the longer-term economic position relative to chemical approaches. However, there may be economic risk associated with transition to organic farming, which may limit the accessibility of it for some farmers.

103. Methoxychlor is used for a wide variety of target pests, indicating a broad and non-descript range of functionalities of methoxychlor. Therefore, the range of agricultural practices (including IPM) which may be adopted to perform the function of methoxychlor is exhaustive and it is not possible to detail each of them in this report. From a high-level perspective, IPM is gaining traction globally as a more sustainable approach and economic benefits have

[8] https://ec.europa.eu/food/plant/pesticides/sustainable_use_pesticides/ipm_en

been documented in various regions (Pretty and Bharucha, 2015; Cuyno *et al.*, 2001; Del Fava *et al.*, 2017). However, there is some contention about the economic feasibility of IPM (Onstad and Crain, 2019).

Biological control systems and botanical preparations

104. PAN, IPEN and ACAT in their response to the Annex F request for information has asserted that various biological control systems and botanical preparations are available as potential alternatives to methoxychlor. These imply the control and reduction of pest populations by natural enemies or plant extracts. When transitioning to biological control systems or botanical preparations, consideration must be given to national and regional assessment outcomes for specific uses.

105. Samish et al. (2020) showed effective control of cat fleas using nematodes and fungi, although the effectiveness depended on temperature and humidity, therefore effectiveness may vary between climatic regions.

106. Bti (*Bacillus thuringiensis,* subspecies *israelensis*) has been used in the U.S. for over 30 years as a larvicide to reduce the risk of mosquito vector-borne diseases. When mosquito larvae consume bti, it kills them by producing toxins. Bti is non-toxic to both humans and the environment, and most effective when used in integrated mosquito management plans (CDC, 2017). Efficacy of bti has also been demonstrated in Kenya (Mwangangi *et al.*, 2010).

107. Other relevant biological controls include larvivorous fish *Tilapia nilotica* and *Gambusa affinis*. These have been used in North America and to eliminate malaria from Palestine, Israel, and Italy (CEAG Africa, 2006). The soil fungus *Metarhizium anisopliae,* is used to attack many insects, including cockroaches, flies, and mosquito larvae (UNEP/POPS/POPRC.8/INF/14/Rev.1).

108. The naturally occurring entomopathogenic fungus, *Beauveria bassiana,* is used to control foliar pests, such as mites, aphids, Colorado potato beetle, leaf-feeding insects, thrips, whiteflies, and other insects (Caldwell et al., 2013). *Beauveria bassiana* is available in many commercial formulations in various countries and can be applied by standard spray equipment. These products are generally non-toxic to non-target organisms although some, such as ladybirds, may be affected. Beauveria products should not be applied to water, as they are potentially toxic to fish. When and how often to apply depends on the pest being targeted, as well as on the temperature (UNEP/POPS/POPRC.8/INF/14/Rev.1).

109. Tea tree oil (TTO) is said to be effective in the management of equine lice (COWS, 2014) and showed 100% reproductive inhibition and some biocidal effects on female ticks (*Rhipicephalus microplus*), which are pests to cattle (Pazinato et al., 2014). Liquid crystal-based TTO has shown repellent activity against mosquitos (Fonseca-Santos et al., 2019). However, in regions where vector-borne diseases from mosquitos are prevalent, insecticide use may be considered critical and botanical preparations are therefore not recommended.

110. Talbert and Wall (2012) showed high levels of toxicity of TTO, as well as of lavender, peppermint, eucalyptus, and clove bud to ectoparasitic lice (*Bovicola (Werneckiella) ocellatus*). These plant-based substances are natural and biodegradable, and therefore pose little or no environmental or human health risks.

Physical barriers and improving hygiene practices

111. To prevent the effects of chiggers on humans, measures such as wearing protective clothing at times of potential exposure, washing skin thoroughly after being exposed, and keeping grass cut short can prove to be effective controls (Texas A&M Agrilife Extension, 2014).

112. Managing organic waste where cattle are kept eliminates breeding sites for cattle pests, e.g. flies. Measures include removing manure, covering manure with plastic sheets and controlling the temperature and moisture of manure (Ratnasari, 2013). Biological control in the form of dung beetles can help eliminate fly breeding grounds (Wise et al., 2020).

113. The WHO also recommend that improving sanitation and hygiene is the preferred approach to controlling houseflies, rather than using insecticides. This involves, for example, reduction or elimination of fly breeding sites, reduction of sources that attract flies, prevention of contact between flies and disease-causing germs and protection of food (WHO, 1991).

2.3.4 Summary of alternatives

114. Alternatives to methoxychlor have been identified by considering the historic uses of methoxychlor for specific pests (e.g., chiggers, mosquitos and elm bark beetles) and for specific applications(e.g. field crops and livestock), as well as investigating which current practices are commonly used for these purposes.

115. The widespread use of many chemical alternatives to methoxychlor suggests technical and economic feasibility of substituting methoxychlor globally. For each chemical alternative presented there are human health and environmental concerns regarding their use. Therefore, adoption of alternatives should only be undertaken after risk assessments have been conducted for the substances Only moderately or slightly hazardous pesticides (e.g.

acetamiprid) is recommended by the FAO for sustainable farming practices (WHO, 2019) which contribute to the UN Sustainable Development Goal Target 2.4 (sustainable agriculture) (FAO, 2020).

116. Non-chemical alternatives are widely available. The efficacy of some botanical preparations and IPM is supported by academic studies. There is less information evaluating the use of biological control agents, although their widespread use is documented. Non-chemical alternatives are often used in conjunction with chemicals to reduce dependence, rather than to entirely substitute them.

117. A direct comparison of these alternatives to methoxychlor, in terms of costs, technical feasibility, efficacy, and availability is limited due to lack of detailed information on methoxychlor uses. However, the already globally widespread use of alternatives suggests that at least some options will be effective, available, and feasible in all parts of the world. The choice of alternative may vary by country due to regulations, types of pests, market dynamics or other variables such as climatic conditions.

118. As methoxychlor is banned or not used in many countries as listed in section 1.2, substitution with alternatives is assumed both technically feasible and of little economic impact.

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

2.4.1 Health, including public, environmental, and occupational health

119. Several Parties and observers state that the use of methoxychlor gives rise to adverse health and environmental effects and expect that the control of methoxychlor will positively impact health and the environment (Annex F, 2021). The continued use of methoxychlor may present a risk to human health for workers in the agricultural and industrial sectors, for consumers using methoxychlor products on pets or in gardens, as well as for the general public potentially being indirectly exposed via food and drinking water.

2.4.2 Agriculture, aquaculture, and forestry

120. Methoxychlor can have a broad spectrum of use in agriculture, both as an insecticide for the protection of a range of agricultural crops and as a veterinary ectoparasiticide for external use on a range of livestock (cows, pigs, horses, and sheep). Based on the data provided by Parties and observers to the Convention under Annex F (2021), the range of both chemical and non-chemical alternatives (see section 2.3) are sufficiently broad so that any changes in agricultural practices due to prohibition or restriction of methoxychlor could be expected to have limited negative impacts for agriculture and farmers. It is further noted that no Party or observer to the Convention has identified any critical agricultural uses of methoxychlor.

2.4.3 Biota (biodiversity)

121. The risk profile highlights that methoxychlor meets the Annex D criteria to be considered a persistent organic pollutant. In addition to being bioaccumulative, methoxychlor is highly toxic to aquatic species, covering both fish and invertebrates (U.S. EPA, 2004). The risk profile [UNEP/POPS/POPRC.16/9/Add.1] states that LC50 values for fish were mostly below 10µg/L and for invertebrates were below 1µg/L). Furthermore, the Annex F (2021) response from Peru, states that under the Andean Community of nations, LC50 of methoxychlor to fish is 0.052 mg/l, LD50 for birds is > 2,000 mg/kg and for bees LD50 >23.6 µg/bee, which means that methoxychlor is classified as extremely toxic for fish, non-toxic to birds and slightly toxic to bees. As part of their Annex F (2021) submission, the Russian Federation has stated that scientific publications indicate the presence of methoxychlor in environmental objects in the regions of the Russian part of the Arctic, including air samples at Arctic monitoring stations from 2000-2003 and snow, ice core and biota samples of the terrestrial and marine environment, as well as in terrestrial species, marine invertebrates and fish. Given that methoxychlor persists and bioaccumulates in the environment and is toxic to a range of species, it is very likely that a transition to safer alternatives would have a positive impact for biota and biodiversity.

2.4.4 Economic aspects

122. Very limited data on economic aspects has been provided through the Annex F responses. The majority of responding Parties and observers highlight that in their territory use of methoxychlor use ceased quite some years ago, with any transition to alternatives already completed and therefore, no economic impacts following a listing in Annex A, B and/or C of the Convention are expected. The extent of potential on-going manufacturing and use of methoxychlor is unknown and only one Party reported the production and use of methoxychlor. It is possible that there would be additional administrative costs incurred to help enforce and regulate a listing of methoxychlor under the Convention for nations still using it. Furthermore, there could be additional costs incurred for the management and safe destruction of any remaining stockpiles of methoxychlor. It has not been possible to develop details on the

magnitude of these costs against current global usage rates. It is proposed that there would be limited negative economic impacts expected from the listing of methoxychlor under the Convention.

123. Based on the fact that the use has already been eliminated in many countries and the assumption that the remaining global use of methoxychlor is limited, as well as due to the existence of viable alternatives, it seems that there would only be limited negative economic impacts from listing methoxychlor in Annex A, B and/or C of the Convention. On the contrary, economic impacts are likely to be positive in the longer term due to reduced costs of treating health effects and environmental pollution.

2.4.5 Movement towards sustainable development

124. Elimination of methoxychlor is consistent with the United Nations sustainable development plans that seek to reduce emissions of toxic chemicals. The elimination of methoxychlor is relevant to a number of the Sustainable Development Goals under the 2030 Agenda, in particular Goal 2 (end hunger; achieve food security and improved nutrition and promote sustainable agriculture), Goal 3 (ensure healthy lives and promote well-being at all ages), Goal 12 (responsible consumption and production) and Goal 15 (protect, restore, and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss).

125. The Strategic Approach to International Chemicals Management (SAICM)[9] is arelevant global plan to consider. SAICM aimed to ensure, that by 2020, chemicals or chemical uses that pose an unreasonable and otherwise unmanageable risk to human health and the environment based on a science-based risk assessment and considering the costs and benefits as well as the availability of safer substitutes and their efficacy, are no longer produced or used for such uses. An independent evaluation (SAICM/IP.3/INF/3) that had assessed the progress towards the achievement of the 2020 objective concluded that some progress has been made but that overall progress had been uneven, with significant work still needed to develop and implement safer chemical and waste management practices globally[10]. The fourth session of the international conference on chemicals management (ICCM4) initiated the process to prepare a global framework for the management of chemicals and waste beyond 2020.

126. Additionally, the FAO (2007) has agreed to facilitate the phase out of Highly Hazardous Pesticides,[11] the definition of which includes those pesticides that are deemed to be POPs including, therefore, methoxychlor.

127. The assessment of non-chemical alternatives within section 2.3.3 has highlighted a range of options which could be used in combination with or instead of chemical alternatives to provide a more sustainable solution to the continued use of methoxychlor. Sustainable or organic farming not only protects the environment and biodiversity,but can also increase the profits and self-sufficiency of farmers and strengthen farming communities. PAN has highlighted the example of Community Managed Sustainable Agriculture (CMSA) in the Indian state of Andra Pradesh where these types of positive socioeconomic impacts have been demonstrated (Annex F, 2021)

2.4.6 Social costs (employment etc.)

128. As for economic aspects, there is limited information on the social costs associated with the listing of methoxychlor under the Stockholm Convention. For many nations in which the use of methoxychlor has already ceased years ago, there will be no social impacts and costs arising from a global ban or restriction.

129. For nations still manufacturing and using methoxychlor a series of positive and negative impacts can be identified. There could be possible negative impacts related to loss of employment for workers at facilities producing methoxychlor, but it is unclear whether production could be switched to other products to limit impact. This recognises that while production of methoxychlor would cease/reduce, there could be an increase in the production of chemical alternatives. Assuming replacement with non-chemical alternatives, new jobs within agriculture could be created to help manage pests using IPM and/or agroecological practices with consequent societal benefits from limiting the impacts of chemical use. Such compensatory effects, if and where they take place, will not be immediate and frictional impacts on employment could still occur.

130. The negative social impacts (e.g., employment) of listing methoxychlor in the Annexes of the Convention are likely limited. There may, however, be social benefits in terms of avoided costs associated with the negative impacts of methoxychlor on human health and the environment. However, to fully achieve these benefits, care is needed in the selection of alternatives, noting that other pesticides may have their own human health and environmental impacts.

9 https://www.saicm.org/

10 http://www.saicm.org/Portals/12/Documents/Publications/SAICM-Factsheet.pdf

11 New Initiative for Pesticide Risk Reduction. COAG/2007/Inf.14. FAO Committee on Agriculture, Twentieth Session, Rome, 25-28 April 2007. http://www.fao.org/tempref/docrep/fao/meeting/011/j9387e.pdf

2.5 Other considerations

2.5.1 Access to information and public education

131. Information on access to information and public education specifically for methoxychlor is extremely scarce, with one Party to the Convention providing data under Annex F (2021). Hungary has commented that information and research has been presented at a series of workshops on obsolete pesticides, covering in particular DDT and the relationship between DDT and methoxychlor. Information is also publicly available through a bespoke webpage on DDT and methoxychlor through the ministry website.[12] Other information on pesticides more generally is provided by several Parties to the Convention. Australia provides information and guidance through the official gazette of the Australian Pesticides and Veterinary Medicines Authority (APVMA)[13], Canada provided details of information which can be found on Health Canada's Pest Management Regulatory Agency website[14]. The U.S. EPA provides detailed information on registered pesticide products via its website [15]. The European Union has a dedicated website for pesticides, including a database of approved active substances[16].The UK provides detailed information on pesticide usage statistics[17]. Furthermore, PAN Germany provides an on-line service for non-chemical pest management in tropical crops[18] and the FAO provides an agroecology knowledge hub[19].

2.5.2 Status of control and monitoring capacity

132. Within the European Union under Article 32 of Regulation (EC) No 396/2005, the European Food Safety Authority (EFSA) provides an annual report on analysis of pesticide residues in foods on the European market. This spans analysis completed by all 27 EU Member States plus Iceland and Norway (and for the period before the 1 January 2021 the UK). Data taken from the reports covering the period 2013-2018 are provided in **Table 4** (see Appendix). This illustrates that based on annual sampling of all food types (dairy, meats, vegetables, fruits, and grains) spanning 51,000 – 57,000 samples annually, methoxychlor is detected annually in very few samples above the limits of quantification. Key food types where methoxychlor has been detected include honey, milk, and meats (primarily pork products).

133. In the U.S., the Department of Agriculture has carried out a national pesticide residue monitoring program since 1992[20]. This sampling programme covers sampling of a wide range of vegetables and fruits, with between 2,600 and 3,300 samples taken annually. The last recorded detection of methoxychlor above the limits of detection (0.0019 mg/kg) was in 2004 in two samples of apples (out of 3,300 samples) at a maximum concentration of 0.53 mg/kg. In the prior years from 2000 – 2003 methoxychlor was detected in between 2 – 11 samples per annum (out of 3,300) with a maximum concentration of 0.38 mg/kg, noting methoxychlor was banned in the U.S. in 2000. The data for pre-2000 detects methoxychlor more frequently (around 120 samples per annum above LOD) with a maximum concentration of 1.4 mg/kg with the key crops being apples, cherries, and cucumbers.

134. In Peru (Annex F, 2021), a regulatory framework for pesticide management has been established under Decreto Supremo No.12-2009-MINAM. The original POP pesticides were already banned under this decree, but subsequent additions of POP pesticides under the Stockholm Convention have subsequently been added. The framework includes a National System of Pesticides (SENASA), and guidelines on management of chemical and material risks. This includes controls on the import, manufacture, formulation, packaging, and distribution of banned pesticides in Peru.

135. According to information submitted by the Russian Federation (Annex F, 2021,), analysis of information on the pollution of the environment by methoxychlor in the regions of the Russian part of the Arctic showed that this substance has a limited amount of monitoring data from a number of separate studies, because this area is not part of the Arctic Monitoring and Assessment Program (AMAP, 1998).

[12] Klórozott szénhidrogén típusú növényvédõszerek | Környinfo (bme.hu)
[13] https://apvma.gov.au/
[14] http://www.hc-sc.gc.ca/cps-spc/pest/index-eng.php.
[15] Pesticides | U.S. EPA
[16] EU Pesticides Database | Food Safety (europa.eu)
[17] PESTICIDE U.S.AGE STATISTICS - PU.S. STATS (defra.gov.uk)
[18] http://www.oisat.org/
[19] http://www.fao.org/agroecology/en/
[20] https://www.ams.usda.gov/datasets/pdp/pdpdata

3. Synthesis of information

136. Prohibiting or restricting methoxychlor would positively impact human health and the environment by decreasing releases and subsequently human and environmental exposure.

137. Methoxychlor is an organochlorine pesticide (OCP) which has been used as a replacement for DDT. Methoxychlor has been used as an insecticide effective against a wide range of pests on, for example field crops, vegetables, fruits, ornamentals, livestock and pets, both in agricultural and domestic settings. Many countries have phased out production and usage for almost 20 years. As a result, the global use is believed to have declined sharply. No information on the current production or use of methoxychlor at a global scale is publicly available. In response to the call for information (Annex F, 2021), only one Party has indicated current production and use of methoxychlor.

138. At the sixteenth meeting of the POPRC in January 2021, the Committee adopted the risk profile on methoxychlor (UNEP/POPS/POPRC.16/9/Add.1) and concluded that methoxychlor is likely, as a result of its long range environmental transport, to lead to significant adverse human health and environmental effects such that global action is warranted (POPRC/16/2).

139. Currently applied control measures cover a broad spectrum of control measures including the prohibition and restriction of production, use, import and export; the establishment of exposure limits in workplaces; the use of PPE; the environmentally sound management of obsolete stock; the clean-up of contaminated sites and establishment of maximum residue limits in food and water. A prohibition on production and use would be the most effective control measure at protecting the environment and human health. A prohibition is considered technically and economically feasible considering that many nations have already applied this control measure for a long time, the global level of production and use appear to be limited and because no specific examples of critical uses were put forward by the Parties and observers submitting information under Annex F. It could be possible to limit the use of methoxychlor to only key critical uses, however, no critical uses have been identified.

140. The prohibition on the production, sale and use of methoxychlor by a wide number of nations growing different crops and keeping livestock within different geographies and climatic conditions indicates that viable chemical and non-chemical alternatives do exist, however, the available information is not sufficient to demonstrate that this is true in all cases. Available alternatives comprise of other pesticides, biological controls and botanical preparations, as well as various alternative agricultural practices (IPM and organic farming). A direct comparison of these alternatives to methoxychlor, in terms of costs, technical feasibility, efficacy and availability is limited, constraint by the lack of information on the use of methoxychlor. The already globally widespread use of alternatives suggests that at least some options will be effective, available and feasible in all parts of the world. The choice of alternatives may vary by country due to regulations, types of pests, market dynamics or other variables such as climatic conditions. As methoxychlor is banned or not used in many countries substitution with alternatives is assumed both technically feasible and of little economic impact. Some of the chemical alternatives have properties of concern and the alternatives chosen will need to be less hazardous than methoxychlor to human health and the environment, and not possess POP-like characteristics.

141. Potential socioeconomic costs associated with the implementation of a global ban on the production and use of methoxychlor could arise for countries which do not already regulate the substance. These could, for example, be costs to governments to implement the ban, to investigate and implement appropriate alternatives and to provide training. Furthermore, workers, producers and farmers could be impacted due to loss and/or changes in economic opportunities. The socioeconomic costs are believed to be limited and short-term, particularly when considering that the current global use appears to be relatively limited. Therefore, the socioeconomic benefits associated with eliminating releases and human and environmental exposure, which consequently reduce the potential costs of treating detrimental health effects and environmental pollution, are believed to outweigh the negative socioeconomic impacts.

142. In accordance with paragraph 9 of Article 8 of the Convention the POPRC recommends to the Conference of the Parties to the Stockholm Convention to consider listing methoxychlor and specifying the related control measures under the Stockholm Convention in Annex A without specific exemptions.

4. Concluding statement

143. Having concluded that methoxychlor is likely, as a result of long-range environmental transport, to lead to significant adverse effects on human health and/or the environment such that global action is warranted and having prepared a risk management evaluation and considered the management options, the Persistent Organic Pollutants Review Committee recommends, in accordance with paragraph 9 of Article 8 of the Convention, that methoxychlor be considered by the Conference of the Parties to the Stockholm Convention for listing and specifying the related control measures under the Stockholm Convention in Annex A without specific exemptions.

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Appendix

Note: This Appendix contains additional information to chapter 2 of the risk management evaluation for methoxychlor.

1. Introduction

1.1 Chemical identity of methoxychlor

Table 2. Synonyms and trade names of methoxychlor

Synonyms and Trade name	1,1-Bis(*para*-methoxyphenyl)-2,2,2-trichloroethane 2,2-Bis(*para*-methoxyphenyl)-1,1,1-trichloroethane 2,2-Di-*para*-anisyl-1,1,1-trichloroethane *para,para'*-Dimethoxydiphenyltrichloroethane Dimethoxy-DDT Dimethoxy-DT Di(*para*-methoxyphenyl)trichloromethyl methane DMDT *para,para'*-DMDT ENT1716 Higalmetox Methoxychlore Maralate Marlate OMS 466 *para,para'*-Methoxychlor Metox Methoxy-DDT Prentox 1,1,1-Trichloro-2,2-bis(*para*-methoxyphenyl)ethane 1,1,1-Trichloro-2,2-di(4-methoxyphenyl)ethane 1,10-(2,2,2-Trichloroethylidene)bis(4-methoxy-benzene) Ethane, 1,1,1-trichloro-2-(*o*-methoxyphenyl)-2-(*p*-methoxyphenyl)- 2,4'-Methoxychlor *o,p*-Methoxychlor *o,p'*-Methoxychlor Benzene, 1,1'-(2,2,2-trichloroethylidene)bis[2-methoxy- Benzene, 1-methoxy-3-[2,2,2-trichloro-1-(4-methoxyphenyl)ethyl]- Benzene, 1,1'-(2,2,2-trichloroethylidene)bis[3-methoxy-

2. Summary of information relevant to the risk management evaluation

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

2.2.1 Technical feasibility

Table 3. Maximum residual concentration for methoxychlor in food (all values as mg/kg) under Reg. (EC) No 149/2008

Product	**Pesticide residue(s) and maximum residue levels (mg/kg)**
Fruits, fresh or frozen; tree nuts	0.01
Vegetables, fresh or frozen	0.01
Pulses	0.01
Oilseeds and oil fruits	0.01
Cereals	0.01
Teas, coffee, herbal infusions, cocoa and carobs	0.1
Hops	0.1
Spices	0.1
Sugar plants	0.01

Table 4 Summary of data from EFSA Annual Reports on Pesticide Residues[21]

Year	Number of samples	Number of participating countries	No. of detects for methoxychlor above LOQ	Food types where methoxychlor was found (number of samples above LOQ reported when available)
2013	51,555	28	10 (0.02% of total samples)	Milk (2), honey (3), animal fat (2)
2014	53,769	29	8 (0.01% of total samples)	Honey (3), milk (2), other products (2)
2015	56,329	29	17 (0.03% of total samples)	Honey (11), milk, muscle, egg
2016	57,141	30	2 (0.003% of total samples)	Honey
2017	57,491	30	2 (0.003% of total samples)	n.a.
2018	56,428	30	5 (0.01% of total samples)	Animal fat

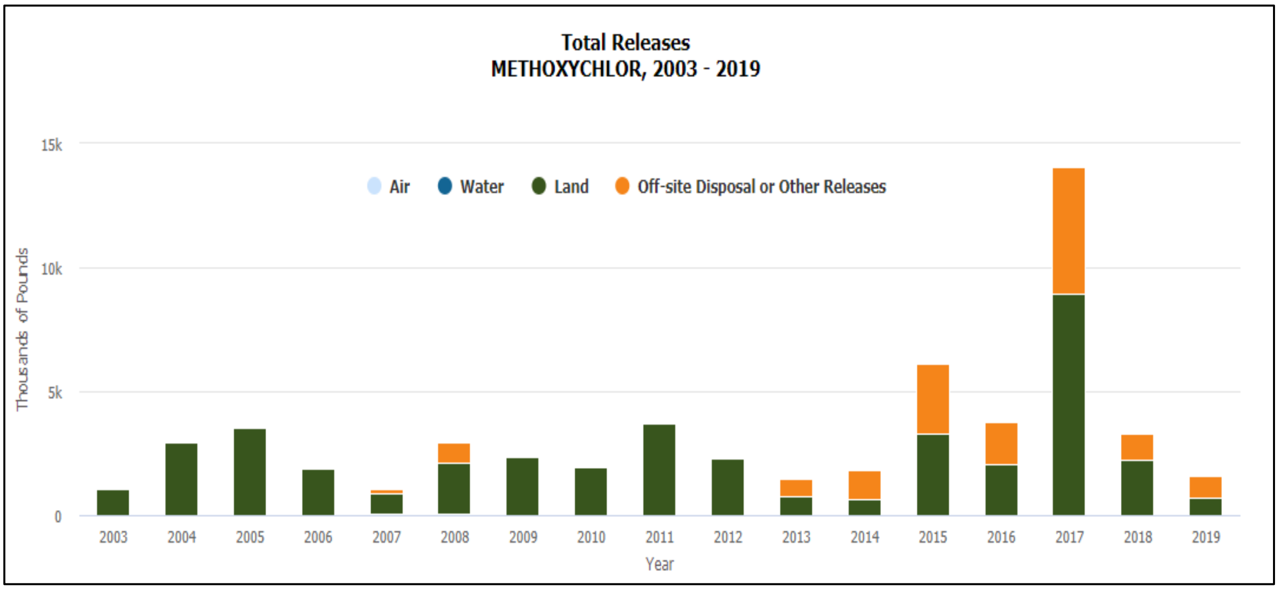

Figure 1 Total releases/disposal of methoxychlor in the U.S. from 2003 onwards[22]

[21] Reports available at https://efsa.onlinelibrary.wiley.com/doi/toc/10.1002/(ISSN)1831-4732.CHEMICALRESIDUES-DATA#heading-level-1-2

[22] https://enviro.epa.gov/triexplorer/chemical.html?pYear=2019&pLoc=000072435&pParent=TRI&pDataSet=TRIQ1

2.3 Information on alternatives (products and processes)

2.3.2 Chemical alternatives

Establishment of maximum residue limits in water, soil, sediment or food

Table 5. Chemical alternatives suggested by the United Kingdom in the Annex F response.

Pesticide	Regulatory status under Regulation (EC) No 1107/2009 of the European Parliament and of the Council of 21 October 2009 concerning the placing of plant protection products on the market	Hazard classification (under CLP)	Comments
Permethrin	Not Approved (00/817/EC)	H302 – Acute Tox.4 H317 – Skin Sens. 1 H332 – Acute Tox 4 H400 - Aquatic Acute 1 H410 – Aquatic Chronic 1	Renewal year: 2000. Only partial data was provided to the rapporteur (Ireland) for renewal of the approval in late 1999 with the main license holder (Zeneca Agrochemicals) withdrawing. Concerns over aquatic toxicity highlighted by the rapporteur. Some possible use for forestry, but license not approved pending more data. License never renewed.
Cypermethrin	Approved (Expiry 31/10/2021)	H302 – Acute Tox.4 H332 – Acute Tox 4 H335 – STOT SE 3 H400 - Aquatic Acute 1 H410 – Aquatic Chronic 1	Request for renewal of the approval was submitted in March 2019. Approval in the UK has been extended.
Esfenvalerate	Approved (Expiry 31/12/2022)	H301 – Acute Tox3 H317 – Skin Sens. 1 H331 – Acute Tox3 H400 – Aquatic Acute 1 H410 – Aquatic Chronic 1	Approval last renewed in 2015 with approval granted. Co-rapporteurs were UK and Portugal. The approval identified the following possible issues: • Possible risk of bioaccumulation • Risk to honeybees and non-target arthropods • Possible risk to ground water in vulnerable regions.
Fluvalinate	Approved (Expiry 31/08/2024)	H302 – Acute tox4 H315 – Skin irrit.2 H400 – Aquatic acute 1 H410 Aquatic chronic 1	Approval last renewed in 2009 with approval granted. Rapporteur was Denmark. No unacceptable risks identified, only point for consideration was risk to non-target species.
Clothianidin	Not approved (Expired 31/01/2019)	H302 – Acute Tox4 H400 – Aquatic acute 1 H410 – Aquatic Chronic 1	The approval for clothianidin was reviewed in 2018 over concerns for risks to bees in particular. The conclusion of the review was that risks cannot be ruled out and as such all outdoor use was prohibited.
Thiamethoxam	Not approved (Expired 31/01/2017)	H302 – Acute Tox4 H400 – Aquatic acute 1 H410 – Aquatic Chronic 1	The approval for thiamethoxam was reviewed in 2018 over concerns for risks to bees in particular. The conclusion of the review was that risks cannot be ruled out and as such all outdoor use was prohibited.
Imidacloprid	Not approved (Expired 01/12/2020)	H302 – Acute Tox4 H400 – Aquatic acute 1 H410 – Aquatic Chronic 1	The approval for imidacloprid was reviewed in 2018 over concerns for risks to bees in particular. The conclusion of the review was that risks cannot be ruled out and as such all outdoor use was prohibited.
Tefluthrin	Approved (Expiry 31/12/2024)	H300 – Acute Tox2 H310 – Acute Tox2 H330 – Acute Tox1 H400 – Aquatic acute 1 H410 Aquatic chronic 1	Approval last renewed in 2009 with approval granted. Rapporteur was Germany. The approval identified the following possible issues: • the operators and workers must use adequate personal protective equipment as well as respiratory protective equipment. • The risk to birds and mammals. Risk mitigation measures should be applied to achieve a high degree of incorporation in soil and avoidance of spillage. • Ensure that the label of treated seed includes the indication that the seeds were treated with tefluthrin and sets out the risk mitigation measures provided for in the authorisation