Implementing the Stockholm Convention on Persistent Organic Pollutants: Summary of a Workshop in China (Series: Strengthening Science-Based Decision Making in Developing Countries)

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STRENGTHENING SCIENCE-BASED DECISION MAKING IN DEVELOPING COUNTRIES

Implementing the Stockholm Convention on Persistent Organic Pollutants

Summary of a Workshop in China

Yonglong Lu, John Giesy, and Laura Holliday, Rapporteurs

Science and Technology for Sustainability Program
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For the workshop featured in this proceedings "Strengthening Science-Based Decision-Making to Reduce Risks from Persistent Organic Pollutants in China" workshop co-chairs Dr. John Giesy, Distinguished Professor of Zoology, Michigan State University, and Dr. Yonglong Lu, Research Center for Eco-Environmental Sciences, and Secretary-General, SCOPE-China, were instrumental in designing the workshop agenda and ensuring productive discussions. Helpful insights were also provided by Luo Gaolai, Deputy Director-General, Stockholm Convention Implementation Office of SEPA, Dr. Jiang Guibin, Research Professor and Deputy Director, Research Center for Eco-Environmental Sciences, CAS, and members of the steering committee for the workshop series (see roster on previous page). We also wish to acknowledge Yajuan Shi, Tieyu Wang, Hong Zhang, and Ying Xing for their contributions to this volume.

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This volume has been reviewed in draft form by several individuals chosen for their technical expertise, in accordance with procedures approved by the National Academies' Report Review Committee. The purpose of this independent review is to provide candid and critical comments that will assist the institution in ensuring that the report is as sound as possible and meets institutional standards for quality. The review comments and original draft manuscript remain confidential to protect the integrity of the process.

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Yonglong Lu, John Giesy, and Laura Holiday

PREFACE

During the 2002 World Summit on Sustainable Development (WSSD), the U.S. National Academies, the U.S. Environmental Protection Agency, and the American Chemistry Council announced a new initiative to facilitate better communication among scientists, policymakers, and other decisionmakers so that scientific knowledge more effectively informs public policy and private sector decisions relating to sustainability in developing countries. More specifically, the goals of the initiative are:

- Foster improved understanding of the science and decision-making process, including national and local policy, industrial design and planning, and public choices;
- Establish dialogue in which decisionmakers use science to inform their decisions and scientists consider the needs of decisionmakers in their choice of research;
- Identify gaps between the needs of decisionmakers and scientific research priorities and strategies for bridging these gaps, including ways to increase the professional connection between scientists and decisionmakers, and;
- Share workshop results, via summaries and briefings, with a broader audience of scientists and decisionmakers in the host country and internationally.

To achieve these objectives, the organizations involved (see list below) provided support for a series of "strengthening science-based decision-making workshops" in developing countries on key issues of particular concern to the host country such as water and sanitation, persistent organic pollutants, and biodiversity. The workshops convened representatives from host country and U.S. scientific institutions, government, industry, nongovernmental organizations, academic institutions, and other relevant organizations. Crosscutting themes addressed in the workshops include monitoring and data evaluation; elements of good science advice; facilitating the flow of scientific information; and the roles of institutions that link scientists and decisionmakers.

Workshop topics were proposed by science organizations in developing countries. A steering committee established by the U.S. National Academies reviewed proposals and provided general oversight for the series. Steering Committee members included: Chairman Michael Clegg, University of California, Riverside; Thomas Lovejoy, H. John Heinz III Center for Science, Economics and the Environment; Whitney MacMillan, Cargill, Inc.; Perry McCarty, Stanford University; Roger McClellan, Chemical Industry Institute of Toxicology; and F. Sherwood Rowland, University of California, Irvine.

The workshop co-chairs--one from the respective developing country and one from the United States--designed each workshop with input from the steering committee and contacts from their respective countries. Each of the workshops was organized in a collaborative process involving the U.S. National Academies and one or more science organization from the partnering country.

The workshops in the series included:

- *Strengthening Science-Based Decision Making for Sustainable Management of Ground Water in Mexico* was a joint workshop between the U.S. National Academies and the Mexican Academy of Sciences. It was held February 8-10, 2004, in Mérida, Mexico.

The workshop was co-chaired by Dr. Luis Marin, Professor of Geology at the Universidad Nacional Autonoma de Mexico (UNAM-- National Autonomous University of Mexico) and Dr. Henry Vaux, Professor of Resource Economics and Associate Vice President Emeritus of the University of California, Berkeley. The workshop addressed science-based decision making in a regional (Yucatan peninsula) and topical (sustainable ground water management) context.

- *Strengthening Science-Based Decision Making---Implementing the Stockholm Convention on Persistent Organic Pollutants,* featured in this workshop summary, was held June 7-10, 2004, in Beijing, China. The workshop was co-chaired by the Secretary General of SCOPE-China, Professor Yonglong Lu, and Distinguished Professor of Zoology at Michigan State University, John P. Giesy. Through presentations and discussions, participants exchanged views regarding: types of scientific information necessary to make informed decisions to eliminate the production and use of Persistent Organic Pollutants (POPs) banned under the Stockholm Convention, sources of information; scientifically informed strategies for eliminating POPs, elements of good scientific advice, such as transparency, peer review, and disclosure of conflicts of interest; and information that decisionmakers dealing with POPs need from the scientific community, including next steps to make such science available and ensure its use on a continuing basis.

- *Strengthening Science-Based Decision Making for Sustainable Management of Scarce Water Resources for Agricultural Production*, the initiative's third workshop, was held June 4-9 in Tunisia. Workshop co-chairs Dr. Sihem Benabdallah, Professor of Geochemistry Physics and Chemistry of Water at the National Institute of Scientific and Technical Research and Dr. Henry Vaux, Professor of Resource Economics and Associate Vice President Emeritus of the University of California, Berkeley were instrumental in designing the workshop agenda and ensuring productive discussions. Participants, including scientists, decisionmakers, non-profit organization representatives, and a farmer, came from the United States and several countries in North Africa and the Middle East. Participants examined insufficient agricultural production as it relates to water scarcity; focusing on 1) the state of the science regarding water management for agricultural purposes in the Middle East and North Africa 2) how science can be applied to better manage existing water supplies to optimize the domestic production of food and fiber. The presentations and discussions explored, in the context of water resource management for agriculture, such questions as “Where and in what form do decisionmakers get scientific advice? What are some elements of good science advice? What information do decisionmakers need from international and domestic scientific communities? What can be done to improve communications, build trust? What does the science community need to understand about decisionmakers?”

The following organizations were involved with the initiative at various stages of the program:

- U.S. National Academies
- Inter-Academy Panel
- U.S. Environmental Protection Agency
- American Chemistry Council
- Mexican Academy of Sciences
- State Environmental Protection Administration of China
- Chinese Academy of Sciences
- China Association for Science and Technology (CAST)
- Islamic-World Academy of Sciences (IAS)
- Scientific Committee on Problems of the Environment
- National Council for Science and the Environment
- National Oceanic and Atmospheric Administration
- H. John Heinz Center for Science, Economics, and the Environment
- TWAS, The Academy of Sciences for the Developing World

More information about the program "Strengthening Science-Based Decision Making in Developing Countries" and about the Science and Technology for Sustainability Program is available online at *www.nationalacademies.org/sustainability*. This workshop summary is available online at *www.nap.edu*.

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INTRODUCTION

The workshop "Strengthening Science-Based Decision Making--Implementing the Stockholm Convention on Persistent Organic Pollutants (POPs)" was held June 7-10, 2004, in Beijing, the People's Republic of China (PRC). The design of the workshop benefited from the insights of individuals affiliated with several organizations, including the U.S. National Academies, the Chinese Academy of Sciences (CAS), the State Environmental Protection Administration of China (SEPA), the U.S. Environmental Protection Agency, the Scientific Committee on Problems of the Environment (SCOPE), the American Chemistry Council, the Society of Environmental Toxicology and Chemistry, the China Association for Science and Technology (CAST), and others.

The meeting was co-chaired by the Secretary General of SCOPE-China, Professor Yonglong Lu, and Distinguished Professor of Zoology at Michigan State University, John P. Giesy. The co-chairs emphasized the potential for enhancing environmental stewardship by building on China's strong scientific capability and by fostering systems of decision making and environmental management that are based on strong science and communication. At the time of the workshop China was preparing to ratify the Convention and preparing a national implementation plan. Therefore, the workshop offered an important and timely opportunity to address science-based decision making for POPs reduction.

One important step in developing strategies to reduce the production and use of POPs is to build strong linkages between scientists with relevant expertise and decisionmakers from the government, industry, and NGOs. The workshop was designed to enhance those linkages. The workshop was attended by 95 delegates from academia, government agencies, businesses and industries, and nongovernmental organizations (NGOs). Although the majority of the participants were from academia and the federal government of China, very deliberate efforts were made to ensure that the perspectives of other relevant sectors including industry and non-governmental organizaqtions were presented and discussed (see agenda in Appendix A). Participants came from several regions in China, including Beijing, Nanjing, Hong Kong, and Wuhan; the United States; and New Zealand. This diverse group was brought together to share strategies and lessons learned from their various perspectives, whether from different sectors, different countries, or both. Several participants reported that the opportunity to share perspectives with people from other sectors was a rare opportunity for them.

The workshop featured many technical presentations, related to topics such as: risk assessments for POPS, risk communication, sources of exposure to POPs, monitoring techniques, POPs distribution in surface waters and effluents in Beijing, research needs, and occurence and behavior of POPs in selected areas of China. A number of the technical papers from the workshop were published in the August, 2005, issue of Chemosphere (the titles of these papers are included in Appendix E). Other presentations provided background or a policy perspective, including topics such as: international sources and inventories of POPs, alternatives to POPs, implementation of the Stockholm Convention in China, POPs regulation in China, the management of POPs in the United States, environmental management of chemicals in China, options for phasing out POPs, consideration of the addition of new substances to the list of POPs chemicals under the Stockholm Convention, and barriers to the implementation of the Stockholm

Convention in China. Several presentations were devoted to considering how to enhance scientific input into decision making and institutions that attempt to do so, including topics such as: the role of science in decision making, sources of science advice in the United States, improving the quality of science in regulatory decision making and science advice in the United States, private sector environmental management systems, roles of environmental NGOs in China, and scientific organizations that connect scientists and decisionmakers.

Although numerous presentations were made, one of the most important features of the workshop was its discussion sessions. Workshop participants were divided into working groups and, drawing from their expertise and experience with POPs management, discussed at length questions such as: Where do decisionmakers get scientific advice? In what form do policy-makers receive scientific advice? How can the decision-making process be facilitated through scientific input? Are there existing "bridging or boundary" organizations that can help create effective interface between scientists and decisionmakers, and provide "reliable and timely translations of information and views between the two communities"? What are some elements of good science advice? What can be done to improve communications, build trust? What do decision makers need from the science community? And, what does the science community need to understand about decisionmakers? Because many of the technical papers from the workshop were already published in Chemosphere and many of the workshop presentations are available via the Internet[1], this workshop summary focuses primarily on issues that were highlighted during the workshop discussions, which coincide with the major themes of the "Strengthening Science-Based Decision Making" workshop series.

Additional "Strengthening Science-Based Decision Making in Developing Countries" project information is available at: http://www.nationalacademies.org/sustainability/type2.

General Background on POPs and the Stockholm Convention

According to the United Nations Environment Program (UNEP), POPS are defined as follows:

> POPs are chemical substances that persist in the environment, bioaccumulate through the food web, and pose a risk of causing adverse effects to human health and the environment. With the evidence of long-range transport of these substances to regions where they have never been used or produced and the consequent threats they pose to the environment of the whole globe, the international community has now, at several occasions called for urgent global actions to reduce and eliminate releases of these chemicals. (http://www.chem.unep.ch/pops/)

In 2001, more than 90 countries signed an international treaty, the Stockholm Convention, agreeing to reduce or eliminate the production, use and release of 12 POPs. Both China and the

[1] See http://www7.nationalacademies.org/sustainabilityroundtable/Beijing_Workshop_Presentations.html

U.S. were actively involved in the negotiations and were signatories to the treaty. The Convention was formally ratified by the National People's Congress of China on June 25, 2004, and came into force on November 11th, 2004. As of December 2006, the United States had not ratified the treaty.

POPS currently regulated under the Convention include: pesticides such as aldrin, chlorodane, DDT, dieldrin, endrin, heptachlor, mirex and toxaphene; chemicals with industrial applications such as polychlorinated biphenyls (PCBs)[2] and chemical byproducts such as dioxins and furans; and hexachlorodbenzene, which fits in all three categories.[3]

Human Exposure and Health Effects

Humans can be exposed to POPs through diet, occupational exposures (for example, farmworkers may be exposed to POPs through pesticides), industrial accidents and the environment (including indoor exposure). Exposure to POPs, either acute or chronic, can be associated with a wide range of adverse health effects, including illness and death (L. Ritter *et al*., 1995). Laboratory animal studies and wildlife studies have associated POPs with endocrine disruption, reproductive and immune dysfunction, neurobehavioral disorders and cancer. More recently, some POPs have also been connected to reduced immunity in infants and children and a concomitant increase in infections. Other studies have linked POPS concentrations in humans with developmental abnormalities, neurobehavioral impairment and cancer and tumor induction or promotion.[4]

The POPs Situation in China: Current Production and Use, Related Polices, and Specific Plans for Implementation of the Stockholm Convention

A workshop participant reported that China has phased out the production and use of five of the POPs covered by the Stockholm Convention—aldrin, dieldrin, endrin, toxaphene and heptachlor. He explained that chlordane and mirex are still produced in limited quantities for termite protection and hexachlorobenzene (HCB) is still produced for use as a chemical feedstock. Mirex

[2] PCBs can also be chemical byproducts.
[3] Other chemicals may be added to the treaty by in the future based on recommendations from the POPs Review Committee.
[4] See also: Dewailly E, Ayotte P, Bruneau S, et al. Susceptibility to infections and immune status in Inuit infants exposed to organochlorines. Environ Health Perspect 2000;108(3):205-10.
Patandin S, Koopman-Esseboom C, de Riddr MA, et al. Effects of environmental exposure to polychlorinated biphenyls and dioxins on birth size and growth in Dutch children. Pedeatr Res 1998;44(4): 538-45.Kim HA, Kim EM, Park YC, et al. Immunotoxicological effects of Agent Orange exposure to the Vietnam War Korean veterans. Ind Health 2003;41(3):158-66.
Baccarelli A, Mocarelli P, Patterson DG, et al. Immunologic effects of dioxin: new results from Seveso and comparison with other studies. Environ Health Perspect 2002;110(12):1169-73.
Longnecker MP, Rogan WJ, Lucier G. The Human Health Effects of DDT and PCBs and an overview of organochlorines in public health. Ann Review Public Health 1997;18: 211-244.

production is estimated at 15 tons and chlorodane output is about 365 tons. [5] A participant pointed out that the number of facilities producing DDT has declined from 11 to 2 and its use in agriculture has been banned since 1983. Current production is estimated to be about 3250 tons, used primatrily to produce antifouling paint, mosquito repellant incense, and as an intermediate for dicofol production. PCB production has been banned since 1974 but the management and disposal of PCB containing electrical equipment is still a problem. Dioxins and furans (unintentional byproducts) continue to be released by various industrial and combustion processes. (Note-China has filed requests for specific exemptions to the Stockholm agreement for the continued production and use of cholordane, mirex, and DDT.[6])

Comprehensive information on contamination by all of the POPs is not available for China. However, some monitoring information is available. For example, information on PCBs indicates that contamination is greatest in the industrialized areas of the coast. Sediments in the Pearl River and its estuary, Dalian Bay and the Songhua River had relatively high levels of PCBs. There were also some areas, mainly the industrial pollution sites or PCB equipment storage locations, which remain seriously polluted with high PCB residue levels. (Xing et al., 2005; See list of published papers.)

China has promulgated a number of laws and regulations to protect human health and environment and to manage chemicals. However, there is no specific legislation on POPs. There are two different sets of regulations related to POPs and pollutants similar to POPs—one on the management of pesticides and one on wastes and chemicals. There is a comprehensive pesticide law regulating the import and export, registration, production, utilization, management, and transportation of pesticides. The regulations officially prohibit the production, use or trade of chemicals such as HCB, HCH and DDT. There is no integrated system for non-pesticide POPs. Participants suggested that regulations and applicable standards for reduction and control of the POPs contamination and emission need to be established, amended and improved.

In September, 2004 China began drafting a National Implementation Plan for the Stockholm Convention which is expected to be completed in late 2006. The NIP content is expected to include activities to strengthen national coordination and monitoring capacity; presenting national POPs inventories (production, trade, use, disposal and so on); building institutional capacity; a legislative framework for control and management, regulation, enforcement, health and socio-economic aspects; setting priorities and objectives towards compliance, action plans and budgeted investment portfolio. Nearly all the stakeholders are involved including, State Development and Reform Commission, Ministry of Foreign Affairs, Ministry of Finance, Ministry of Commerce, Ministry of Science and Technology, Ministry of Agriculture, Ministry of

[5] Data source: China's National Implementation Plan for the Stockholm Convention on Persistent Organic Pollutants, draft 12 June 2006

[6] www.pops.int/documents/registers/specexempt.htm

Note: At present, there are no cost-effective alternatives or alternative technologies for cholordane and mirex as termiticide, and DDT as the additive of antifouling paint in China. China reportedly plans to eliminate the use and production of chlordane and mirex before 2009 and to elimate the use of DDT as the additive of antifouling paint and as an intermediary in the production of dicofol between 2008 and 2014. (Press release Embassy of the People's Republic of China in the United States, June 22,2006.)

Health, Ministry of Construction, SEPA, Customs General Administration, and State Electricity Regulatory Commission.

In addition, an expert panel, consisting of specialists in the fields of strategy and planning, alternatives, clean-up technologies, remediation, monitoring, social and economic assessment**,** environment and human health impact assessment, etc., was established to provide technical advice and support for Convention implementation activities. A research network affiliated with many institutes and universities was also constructed to conduct POPs related research, such as inventorying pesticide POPs and PCBs, POPs toxicity impact on women and children, clean-up technology, identification and implementation of alternative measures and chemicals. Several demonstration projects have also been started to assess management and disposal options as well as alternatives to POPs currently used in China.

Science and Decision Making

Several presentations were made during the workshop on the general role of science in decision making-- the elements of good science; sources of scientific information; the role of bridging institutions; and approaches to improving communications between scientists and decisionmakers. Barriers to using science were also discussed.

Elements of good science: Several of the presentations focused on the importance of good science in making decisions. Presenters suggested that the quality of science used in developing regulations must be based on its inherent merits no matter the source and that certain minimum requirements should be met. These requirements included; using standard guidelines and protocols, protecting human subjects, disclosure of all potential conflicts of interest (financial, ideological, or other), and implementation of programs to assure transparency and accountability. Specific tools that can be applied include the use of peer reviewed publications to report findings, public access data bases, providing opportunities for input from a variety of stakeholders, and recognition of disagreement and dissent.

Sources of information: Possible sources of scientific information include: advocacy groups, the media, universities or other research organizations, government agencies, contract research, NGOs, and scientific publications. In the case of POPs decisionmakers have gotten scientific advice from international conferences; the internet, and scientific journals. There are also professional organizations such as Stockholm Convention Implementation Office of SEPA (CIO).

Participants suggested that it was important to build trust and to develop open and transparent processes. They emphasized the importance of using risk assessments as way to organize information which is to be communicated to decisionmakers and to the public.

Communications: Participants pointed out that although communication between scientists and decisionmakers clearly could be improved, both in the United States and in China, communication within the scientific community and among decision-making entities also leaves room for improvement. At the present time, several ministries in China have jurisdiction over

POPs management. Better communication and cooperation among the multiple bodies in charge of POPs management, such as the Ministry of Finance, Ministry of Construction, State Environmental Protection Administration, and others can go a long way towards reducing redundancies and ensuring that policies complement one another.

Many of the scientists at the meeting pointed out that a large number of studies are being conducted on POPs in China, but that scientists often are not aware of much of the relevant work and do not communicate consistently with a broad community of scientists. Furthermore, Chinese scientists may not be able to easily access the international scientific literature on POPs since most of the technical information is not translated into Chinese.

Finally, some participants, from both China and especially those from the United States, emphasized that communication among decisionmakers does not mean only intra-governmental communication. Industry (factories) and farmers are key decisionmakers regarding the production and application of POPs. Communication among private sector decisionmakers regarding effective alternatives and management techniques is critical. Communication between government and private sector decisionmakers is also extremely important because it ensures that private sector decisionmakers are aware of the government's POPs management policies and it can ensure that the government takes into account the private sector's concerns and potential for change when developing policies. Finally, ongoing communication among scientists, engineers, and the private sector (including private sector decisionmakers and the scientists and engineers employed in the private sector) can help.

Bridging organizations: In presentations on the functioning of the academies made by Dr. Riesa and Prof. Lu, the National Academies of both the United States and China, were offered as good examples of institutions that link scientists and decision makers. Features that help the Academies maintain credibility and authority include its independence, objectivity, and relevance to decision making.

Barriers: Participants noted many barriers to timely and effective information exchange and suggested approaches for reducing such barriers. For example, information must be provided in a way that is easily understandable. In scientific research, it is generally considered to be important to thoroughly explain the complexity of what is examined and to clarify levels of uncertainty. Technical jargon is used to thoroughly ensure that the complex issues are properly understood by other scientists. In contrast, decision makers tend to want information that is concise, clear, accurate, relevant, transparent, and readily understandable. They can be uncomfortable with uncertainty. Scientists also need to clarify information as to whether it is based on scientific consensus vs. professional opinion.

Scientists and decision makers need to recognize that they have somewhat different goals and determine when and how they can bring these goals closer together. A scientist's primary goal tends to be publication of research in quality journals. In the context of POPs, scientists' studies seek to understand the nature of POPs and their effects on the environment and on humans. In contrast, decisionmakers' goals are to develop appropriate policies to prevent or mitigate harm to humans and the environment. Although those decisions can be informed by scientific research, the information they need from research – "what are the costs and what will be the effects of

these various policy options" – is often different from the type of information that scientists research for publication in journals. In addition, for decisionmakers, scientific information is just one of many factors that they must take into consideration, such as economic, social, and cultural circumstances. Research studies are often rather narrowly focused but the information decision makers need to solve emerging environmental problems is complex and requires extensive integration among disciplines.

Existing Research on POPs in China

During the workshop a number of presentations were made illustrating the wide range of research currently being done. These covered issues such as measurement and assessment of POPs in the Hong Kong and Pearl River Marine Environment, Effects of Selected POPs on Soil Micro fauna, Fate modeling of HCH in Tianjin, and Patterns of Dioxins and Furan Concentrations in the Fly Ash of Municipal Incinerators. A number of the technical presentations are being published in Chemosphere (See list of published papers). [7]

Research interest in POPs appears to be a relatively recent phenomenon with a dramatic increase in the POPs related publications since 1993. Despite a significant number of research studies most of this is limited to studies of field exposure and analytical methods with few studies on risk assessment, alternatives to POPs or management and disposal techniques. Some participants pointed out that there have been few studies in China assessing the long-term effects of POPs on people or critical ecosystems, studies that would be particularly useful for decisionmakers and for increasing public awareness of the problems posed by such chemicals.

Information Needs of decision makers

Based on discussions during the workshop and the results of a questionnaire (See Appendix C) distributed to the participants the following priorities were identified:

Impacts on human health and environmental quality: Participants pointed out that although many studies are being undertaken, there is still little comprehensive understanding of levels of exposures and the impact of such exposures on human health or the specific effects of POPs on ecosystems in China.

[7] The Distribution Pattern of PCDD/Fs in Chlorinated Chemicals, Wu Yongning; Residues of organochlorine pesticides (DDTs and HCHs) in soils from the outskirts of Beijing, China, Xu Xiaobai; Three-dimensional quantitative structure activity relationship (3D-QSAR) analysis for toxicity of chlorophenols on HepG2 cells in vitro, Yu H X; Inhibition Effect of Calcium Oxide on PCDD/Fs Formation from Dioxin Precursors, Zheng Minghui; Synergic effect of calcium oxide and iron (III) oxide on the dechlorination of hexachlorobenzene, Zheng Minghui; Do cadmium and atrazine interact in the uptake processes by rice seedlings (Oryza sativa L.) from nutrient solution?, Zhu Yong-Guan; Classification and Ordination of DDT and HCH in soil samples from the Guanting Reservoir, China, Lu Yonglong; A Spatial Temporal Assessment of Pollution from PCBs in China , Lu Yonglong; Determination of polybrominated diphenyl ethers in soil and sediment from an electronic waste recycling area, Cai Zongwei; Determination of polycyclic musks in sewage sludge using GC-EI-MS, Fu Jiamo; Synergistic Effects of Microwave Assisted Advanced Oxidation Processes on Degradation of 4-Chlorophenol, Lu Xiaohua; A review on the useage of POP Pesticides in China, with emphasis on DDT loadings in Human milk., M. H. Wong, A. Leung, J. Chan and M. Cho

Substitutes and clean technologies: There seems to be little, readily available information on alternatives to POPs in China, although there is some international literature on this subject, not all of the substitutes work in all situations and some are prohibitively expensive. In particular, participants suggested that cost-effective appropriate substitutes of mirex and chlordane are badly needed for application in China.

Policy Needs

Laws and Regulations: Scientists at the symposium pointed to several opportunities for science to inform regulations, standards, and technical norms. To enforce the POPs Convention in China, as in the United States, some existing laws would need to be amended. Some participants listed the following laws in China as the most relevant in that context: 1) Law for Water Pollution Prevention and Control, 2) Law for Air Pollution Prevention and Control, 3) Law for Solid Waste Pollution Prevention and Control, 4) the Regulations on Safe Management of Dangerous Chemicals and 5) Regulations for Pesticide Management. The potential revision of these laws would be an opportunity for scientists to make their POPs research useful to decisionmakers and for decisionmakers to let their decisions be informed by science.

One presenter focused on better integrating POPs control into existing environmental standards and technical norms. For example, he argued that standards for DDT and other relevant POPs be integrated into existing Integrated Emission Standards of Air Pollutants; the discharge standard of DDT and other pertinent POPs could be integrated into existing Integrated Waste Water Discharge Standard; the Rule on Construction Technology of Termite Prevention Engineering for Buildings could be revised according to the assessment on the substitutes and the Chlordane phase out strategy; the indicator of POPs residue content could be included in the existing pesticide quality standards; and the sanitary standards on residue limitation and re-residue limitation of pesticide POPs in foodstuff could be revised to better acknowledge the current state of the science.

Provisions and criteria should be established for the production and management of intermediates containing POPs. The Name List for Hazardous Chemicals Banned and Restricted Strictly should be adjusted to add Mirex and other emerging POPs related toxic chemicals into the controlled substances subject to the Environmental Management Registration System for Import/Export of Toxic Chemicals.

A series of practical actions should be taken for the phase-out of POPs drawing on and exchanging experience from developed countries in POPs management, constituting and implement long and mid term strategies and action plans for POPs control and reduction, preventing and reducing illegal trans-boundary transport and trade in hazardous products, introducing the risk-reduction program for hazardous chemicals, harmonizing classification and labeling of chemicals, developing environmentally sound substitutes, and taking precautionary measures against POPs generation. Development of funding and management mechanisms for the Stockholm Convention implementation is the most important for the near-term decision making and practical actions.

Proposals for Additional Research and Data Collection

Monitoring: The environmental monitoring of POPs is very limited in China, and the nationwide pollution status of POPs is still unclear. A few participants listed the greatest monitoring needs as those for conducting monitoring of both pollution sources and environmental behavior of POPs. Although life-cycle monitoring of chemicals has been applied to chemical management in some developed countries, some participants pointed out that in China it is still at an initial stage. The existing monitoring programs and studies mainly focus on DDT and HCH, rarely on other pesticide POPs. The pollution and risk impacts induced by chlordane, mirex and HCB need to be further studied and the nationwide investigation on the pesticide POPs should be carried out. Some, but not all of the methods for monitoring and analyzing PCBs are less sophisticated in China than in some other more developed countries. While some laboratories are conducting very sophisticated analyses that meet international norms, not all monitoring programs are making use of this specialized expertise. Monitoring programs are less well developed compared with international standards and analytical methods. Statistical designs for ecological monitoring must be improved. It is urgent for China to establish a standard monitoring system in line with international regulations. The monitoring system for dioxins and furans in China has not yet been well developed. The further development of qualified supervisory capabilities to monitor the unintentional by-products, and the exact pollution sources and pollution status of dioxin and furan is encouraged.

Human Health: At present, studies on the impact of POPs on human health are very limited in China. Most of the existing literature is focused on dietary studies, as the food chain is considered a major pathway for POPs to effect human health. Information on human health effects such as body burden and metabolism is insufficient and generally extrapolated from modeling data because few doctors have been involved in research on POPs exposures in China. Other exposures through respiration and skin as well as air and soil are seldom studied. Workshop participants suggested that additional research should be conducted on the human health effects of POPs and that systems be established to promote the standardization of toxicity measurement of chemicals and to assess the qualifications of laboratories for toxicity appraisal. Furthermore, Good Laboratory Practice (GLP) laboratories need to be popularized in China to improve the quality and reliability of monitored data.

Risk assessment: Some participants suggested that further development and validation of appropriate methods to assess the ecological risks of chemical agents are required. Dose-response curves should be established at the community and ecosystem levels. Several participants suggested that when applying for an exemption of chemicals according to the Stockholm Convention, China might need to support its application with risk-based analysis. They explained that improved analysis of exposures and toxicity in non-temperate biomes would be needed for such an exemption.

Ecosystem characterization: Long-term monitoring should continue in order to enable estimation of natural variability, as well as to establish a baseline against which to evaluate the effects of disturbances. Standard environmental risk assessment approaches may not be useful if the components of the ecosystem in question have not been determined. Further research on

characterizing pristine ecosystems is needed to enable scientists to identify and quantify deviations from natural conditions. Accidental discharges of chemicals should be recognized as opportunities to improve our understanding of an ecosystem's inherent resilience and capacity for recovery. Information gained from accidents can be especially valuable in China where ecosystems are generally poorly characterized and where the fate and effects of pollutants are not well-documented. It is particularly important to understand the POPs dose-response relationship in some keystone species in the ecosystem, especially at pollution sites. POPs and their breakdown products should be continually monitored and the incremental environmental and health risk from exposures should be periodically assessed. Studies of synergistic and antagonistic interactions among chemicals should be expanded to allow for assessing the cumulative effects of POPs on ecosystems.

Accessibility: Many participants stressed that in order to avoid duplication of work and to enable scientists and decisionmakers to more readily make use of research results, it would be helpful to develop mechanisms to publish information periodically or share the information among the parties. Datasets should be expanded based on additional baseline environmental sampling programs and stronger quality control. Some Chinese participants explained that data from other sources (e.g. industry bulletin, mass media) are not collected in a standardized way and the data sources are often not made available, resulting in questionable reliability and making it difficult to compare across data sets. Data archiving and management systems should be established for local use. A few participants suggested that it would be especially helpful if existing websites related to POPs, especially the SEPA website, were improved to include information and links that include information on how the data were developed, how they were intended to be used, and the current state of the science. Opportunities for feedback could facilitate ongoing improvements.

The Roles of Key Stakeholders

Industry: Industry is responsible for manufacturing, transporting and using POPs. However, not all industries have taken measures to reduce the use of POPs or to limit exposure. Limited funding, low-level technology, out of date or inadequate facilities, poor training of staff, and focus on other pollutants may limit incentives for action. Participants stressed that POPs reduction can only be effective with the cooperation and leadership of industry. They emphasized that industry needs more support, encouragement, and guidance to build its capacity in this area. Industry can take useful steps of its own accord by employing risk assessment, best engineering practices, and sustainability principles in a prevention-oriented environmental management system. Such systems can lead to continuous performance improvement. One of the examples discussed during the panel sessions showed how Dow Chemical established and implemented a program of 10 year goals to promote emission reductions. The case study also highlighted the role of science in corporate decision making not just in the decision making of governments.

In the action of pollution mitigation, industry should make good use of social science and natural science. For example, large sized package of pesticides often result in excessive pesticide use, in this regard, using the smaller sized package of pesticides is not only economically beneficial, but

also an effective measure to control pollution. Presenting the emission inventory and giving the materials balance analysis are important tasks depending on natural science.

NGOs: Many environmental NGOs in China are committed to promoting sound science and to influencing the development of rational environmental policies, laws, and regulations. However, participants indicated that NGOs in China have had only limited involvement in decisions on POPs control. Participants identified current and potential roles for NGOs, including dissemination of science-based research, improving public awareness, and helping build capacity. They can also build bridges among academia, business, and government. Some participants mentioned that NGOs in China often do not have the resources to employ technical staff, so their science capacity is not as strong as ideal. One NGO representative explained that some NGOs would also like to build their own science capacity in order to better inform the public and decisionmakers.

Other interested parties: In addition to government officials, scientists, plant managers and NGOs, participants pointed out that there are other important interested parties, such as farmers, workers, and the public. Although the workshop did not explicitly focus on such groups, many participants emphasized that these groups are affected by POPs and could benefit from more information about the pollutants. For example, farmers in China tend to be less aware or unaware of the hazards of POPs and do not have the technologies for proper usage of pesticides or substitute chemicals. Workers are not fully informed of or getting used to safety procedures set for hazardous chemicals production, transportation, and disposal. In some cases, the safety procedures are even unavailable for the workers. To date there has been limited involvement of the public in POPs related issues. In part this is because the results of scientific research on the harmful effects of POPs have not been published in mainstream media.

Follow Up

Several suggestions for follow-up activities were discussed by participants. These focused on joint collaboration between the US and China; recommendations to the scientific community, and to the government. A few of these suggestions are noted below:

Joint collaboration: Exchange programs specific to POPs, including exchange of information on POPs, exchanges between POPs experts and personnel charged with convention implementation; a series of smaller workshops to address specific topics such as risk-based analysis, trace analysis, POPs substitutes, exposure and fate, impacts on human health, impacts on ecosystem health; establishment of a virtual center between National Academy of Sciences (NAS) & Chinese Academy of Sciences (CAS); a publication exchange program and collaborative policy-relevant research.

Scientific Community: Scientists should give higher priority to research addressing specific local problems rather than focusing almost exclusively on sophisticated science that is not strongly connected to the needs of decision makers in government or industry responsible for eliminating POPs. For example, several participants emphasized that priority should be given to the development of new methods to control and reduce POPs, and most importantly to find replacements. Many participants pointed out that scientists can play an important role in helping to develop cost-effective tools for reduction and control of POPs.

Scientists should also seek to strengthen their communications with government and other stakeholders. Not only will this assure that decisionmakers have access to good science but it will improve their prospects for financial support.

Industry: Industry associations are increasingly important in China. They should serve their own enterprises, reflect their voices, protect the rights and the interests of their members, assist government to improve industry management, improve technical advancement and industry update by focusing on economic benefits and industry restructuring. Communication and exchange with industry associations in developed countries can help them learn more about fulfilling these roles.

Government: Programs related to dissemination, training, consultation and education should be accorded higher priority, in order to help stakeholders fully understand the adverse impacts of POPs and to encourage the use of alternatives. More emphasis should be given to protecting and reducing POPs exposures for sensitive groups such as infants, fish consumers, and people residing near local sources of contamination.

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APPENDIX A

Sino-US Workshop on Science-based Decision Making -Implementing the Stockholm Convention on Persistent Organic Pollutants (POPs)

Agenda

June 7-10, 2004
Beijing, China

JUNE 7

8:00-18:00 Field Trip
19:00-21:00 Reception

JUNE 8

Plenary Session

9:00-9:20 Welcome, Introductions and charges to delegates
LU Yonglong, CAS
GIESY John Paul, NAS

9:20-10:00 Opening addresses from dignitaries
WANG Jirong, SEPA
LI Jinghai, CAS
BISSELL Richard, NAS
RODAN Bruce, US EPA

Plenary Session: Co-Chair: FU Jiamo, SIMON Robert

10:30-11:00 Review of implementation of POPs Convention in China: Key objectives, country obligations (YUE Ruisheng, China)

11:00-12:00 Experiences on the management of POPs, potential POPs and the chemicals that act like POPs, preparation to implementation POPs Convention (RODAN Bruce, USA)

12:00-12:30 Environmental management of chemicals and hazardous Chemicals in China, and NIP compilation program to POPs Convention (ZANG Wenchao, China)

Plenary Session: Co-Chair: LUO Gaolai, KOSHEL Pat

13:30-13:55 International Sources and inventory of POPS (RODAN Bruce, USA)

13:55-14:20 Source and Fate of Organochlorine Pesticides and Polycyclic Aromatic Hydrocarbons in the Pearl River Delta, South China (FU Jiamo, China)

14:20-14:45 Monitoring of POPs in Environment (KANNAN Kurunthachalam, USA)

14:45-15:10 POPs pollution and environmental management in China (LU Yonglong, China)

15:10-15:35 Measurement and Assessment of Persistent Organic Pollutants in the Hong Kong and Pearl River Delta Marine Environment (LAM Paul, China)

16:00~18:30 Parallel Sessions and working group discussion

When addressing the specific questions please consider the following general issues: What information do decisionmakers in China/USA need from the Chinese/USA and international scientific communities? Understanding the alternatives, technical and financial costs? What scientists can provide to decisionmakers in China for POPs control? Where and in what form do decisionmakers get scientific advice? What are some elements of good science advice? Are there existing "bridging or boundary" organizations that can help create effective interface between scientists and decisionmakers providing "reliable and timely translations of information and views between the two communities"? How can the decision-making process be facilitated through scientific input (Provide illustrations)? What can be done to improve communications, build TRUST? What does the science community need to understand about decisionmakers?

As part of their deliberations the groups should develop proposals for development of the following:

a) Development of science-based policy and implementation plans for POPs control;
b) Appropriate methods of communication between and among policy-makers, scientists, and the public;
c) Plans to develop monitoring and predicting the fates of chemicals in the environment; risk assessment and risk communication
d) Methods to ensure that these decision support systems meet the information needs of decisionmakers

Panel 1:

Improving the communication between scientists and decisionmakers aiming at intentional production control

Workgroup co-moderator: FISCHER Larry, WONG Minghung
Workgroup co-rapporteur: HICKEY Chris, YU Hongxia

16:00~16:30 Reports

1. Policies for regulating the Pesticide POPs in China (ZHANG Shiqiu, China)

2. Evaluation and Selection of alternatives for phasing out pesticidal POPs used in China (ZHANG Jianbo, China)

3. Practical Attempt: Science-Based Framework of POPs Risk Assessment in China (ZHANG Aiqian, China)

17:00~18:30 Discussion

Panel 2:

Improving the communication between scientists and decisionmakers aiming at POPs by-product

Workgroup co-moderator: KANNAN Kurunthachalam, LUO Gaolai
Workgroup co-rapporteur: KLECKA Gary, ZHANG Qingfeng

16:00~16:30 Reports (Each report is given 10 minutes):

1. Dietary exposure of dioxin and source directed measure to reduce its contamination in food (ZHUANG Zhixiong, China)
2. Where do US Decision Makers Get Scientific Advice? (LANDIS Wayne, LESTER Steven, USA)

16:30~18:30 Discussion

18:30-19:00 Panels report back to plenary: discussion

JUNE 9

Plenary Session: Co-Chair: WONG Minghung, LAM Paul

8:30-9:00 The role of science in decision making (HICKEY Chris, USA)

9:00-9:30 Role of Effective Management Systems in Decision Making and Achieving Environmental Performance (KLECKA Gary, Dow Chemical, USA)

9:30-10:20 Perspectives from institutions that serve as bridges between scientists and decisionmakers

1. Perspectives from Institutions that Serve as Bridges Between Scientists and Decisionmakers: US Example of the National Academy of Sciences (BISSELL Richard, USA)
2. The role of Chinese NGOs in the environmental protection (LI Lailai, China)

Plenary Session: Co-Chair: XU Xiaobai, HARRISON Myron

10:50-11:15 Sustainable strategies for monitoring, assessment and management of persistent organic pesticides (WONG Minghung, China)

11:15-11:40 How does a dioxin testing/monitoring program help with solving the contamination problem for the future Hong Kong Disneyland (CAI Zongwei, China)

11:40-12:05 Fate modeling of γ-hexachlorocyclohexane (γ-HCH) in Tianjin, China (TAO Shu, China)

12:05-12:30 Occurrence, Distribution and Source of Organchlorine Pesticides in the surface waters and the effluents in Beijing, China (HUANG Shengbiao, China)

Plenary Session: Co-Chair: Tao Shu, LESTER Steven

13:30-14:00 The framework for implementing POPs Convention in China and focuses (LUO Gaolai, China)

14:00-14:30 The Society of Environmental Toxicology and Chemistry. A global forum for communication between scientists and decision makers in government and industry (HICKEY Chris, USA)

14:30-15:00 How to consider the addition of New Substances to the list of POPs Chemicals under the Stockholm Convention and a case study (RODAN Bruce, USA, WONG Minghung, China)

15:00-15:30 Improving the Quality of Science in Regulatory Decision Making and Science Advise in the United States (HARRISON Myron, USA)

15:30-16:00 Coffee Break

16:00-17:30 Parallel Sessions and working group discussion

Panel 1:
The role of government, industry agencies and Non-Government Organizations (NGOS) agencies in policy development and implementation, Scientists do best provide brainman to decisionmakers in China for POPs control.

Workgroup co-moderator: FISCHER Larry, JIANG Guibin
Workgroup co-rapporteur: HICKEY Chris, LAM Paul

16:00~16:30 Reports (Each report is given 10 minutes):

1. The Situation and the Measures of Pollution Preventions and Control of Polychlorbiphenyl Control in China (SHAO Chunyan, China)

2. Barriers to Implementing the Treaty (business and association representatives), example of Beijing Cement Plant (FU Qiutao, China)

16:30~17:30 Discussion

Panel 2:
Effective environmental management and decision making. Discuss how scientists and decision makers can best develop risk assessment, risk management and risk communication systems to achieve environmental goals. Use the POPs treaty and Chinese obligations under the treaty as an example for which effective management systems can be developed.
Workgroup co-moderator: LANDIS Wayne, ZHU Yongguan
Workgroup co-rapporteur: LESTER Steven, CAI Zongwei

16:00~16:30 Reports (Each report is given 10 minutes):

1. Analysis of γ-hexachlorocyclohexane in lake water using disposable solid-phase microextraction fibers and GC Chromatography (YU Hongxia, China)

2. Occurrence and Behavior of Persistent Organic Pollutants in the Selected Areas, China (ZHANG Zulin, China)

3. Inhibition of CaO on the Formation of PCDD/Fs from Chlorophenols and Chlorobenzenes (LIU Wenbin, China)

16:30~17:30 Discussion

18:40-21:00 Social outing for delegates to meet

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JUNE 10

8:30-10:00 Continue working group discussions

Panel 1:
Workgroup co-moderator: FISCHER Larry, JIANG Guibin
Workgroup co-rapporteur: HICKEY Chris, LAM Paul

Panel 2:
Workgroup co-moderator: LANDIS Wayne, ZHU Yongguan
Workgroup co-rapporteur: LESTER Steven, CAI Zongwei

Plenary Session: Co-Chair: LU Yonglong, GIESY John

10:30-11:30 Reports of Working Groups to the Workshop and discussions

11:30-12:00 Chairman's summary and Concluding Comments

12:00-13:00 Lunch

13:00-15:00 Visit to RCEES

Satellite conference: Co-Chair: LU Yonglong, GIESY John

15:00-17:30 Discussions of the meeting summary and proposed publications

APPENDIX B

List of Workshop Participants

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APPENDIX C

POPs Survey and Results

Several Ph.D. candidates from the Research Center for Eco-Environmental Sciences in China attended the workshop. At the workshop, they distributed the survey included in this appendix to gain greater understanding of participants' views regarding POPs management. Some of their observations on the survey results are included in this appendix although they were not explicitly discussed at the workshop.

Questionnaire

As a by-product of the Sino-US Workshop on Science-based Decision Making – on POPs, this questionnaire is intended to gather some qualitative information on the status quo of POPs management in both USA and China for the purpose of comparative studies. Your contribution is appreciated very much.

Nationality: China( ) USA( ) Others:( )
Profession: scientist( ), governmental officer( ), company manager( ), others( )
Education background: B.Sc( ); M.Sc( ); Ph.D( )
Age: 20-30( ); 30-40( ); 40-50( ); 50-60( ); >60( )
Gender: M( ), F( )
Note: please put a mark (√) by your choice. If you choose more than 2 options please indicate your priorities and mark 1√, 2√ and so on.

POPs Information

1. How did you learn about POPs ?

__Magazine __Literature __TV and Radio __Newspaper __Internet
__Conference __other (please specify):

2. Which kind of information and data related POPs do you most care about?

__Production __Use __Management __substitute __clean technologies __information on "best practices" __impacts on human health and environmental quality __other (please specify):

3. How widely are POPs issues known and understood in your country? By any of the following:

__General public __government __professional __organization
__Scientists __other (please specify):

4. Is the information on POPs easily and quickly available?

__Y __N

Are the information and data on POPs adequate and reliable?

__Y __N

5. What do you expect of the role and the responsibility of scientists in environmental management and policy making?

__Scientists should only report scientific results and leave others to make POPs management /policy decisions

__Scientists should report scientific results and then interpret the results for others involved in POPs management/policy decisions

__Scientists should work closely with managers and others to integrate scientific results in management/policy decisions

__Scientists should actively advocate specific POPs management policies

__Scientists should be responsible for making decisions about POPs management/policy decisions

__Other (please specify):

5. What are the barriers to timely and effective information exchange on POPs management?

__Poor access to information and to computers and/or Internet connection

__Poor computer training (not able to make effective use of Internet)

__Language barrier

__Lack of financial support

__Lack of technical support

__Other (please specify):

6. What solutions do you expect to strengthen the capability of POPs information exchange?

__Drawing attention to the POPs information campaign for the general public;

__Organizing international co-operation on POPs

__Improving the access to new technologies and the latest knowledge on POPs

__Helping strengthen communication between scientists, business leaders, municipal staff and shareholders.

__Development of handbooks about POPs or chemicals management.

__Establishment of a repository to capture and make readily available all information to other users.

__Other (please specify):

POPs Policy

1. Which programs has your country implemented to promote the reduction/ elimination of POPs? Please indicate your choice by Yes, Partially or Not.

__Take the legal and administrative measures to eliminate the production, use, and input/output of POPs
__Develop an action plan to reduce the releases of by-products of POPs
__Take measures to reduce or eliminate releases from stockpiles and wastes
__Develop implementation plans under the Stockholm Convention
__Promote public information, awareness and education with regard to POPs
__Support and further develop appropriate research, development, monitoring and cooperation programs pertaining to POPs and to their alternatives and to candidate POPs.
__Other (please specify):

Have these programs addressed the specific needs of indigenous and local communities? Please specify:

__Yes __No

2. Does your country have any incentives for enterprises or stockholders to voluntarily reduce POPs? __Yes __No

If the answer is yes, please indicate how it is operated?

__Tax rebate __Subsidy __Market entry __Other:

3. Is there any sanction to be applied in case of violation of the regulations?

__Fines __Withdrawal of authorizations __Imprisonment __Other:

4. Who has the responsibility or authority for chemical safety in your country? If you choose more than one options please indicate the order of priority of responsibility.

__Environment __Health __Agriculture __Industry __Finance
__Customs __Labour __Transport __Other (please specify):

5. How is Chemical safety regulation established in your country?

__through separate Act
__through separate Act and executive orders
__through separate ministerial decrees
__through decrees by several ministries
__Other (please specify):

6. Please list the most significant/current problems your country has to face in the field of POPs. Please order in priority 1, 2, 3 etc.

__Improper storage, incineration, or recycling
__Lack of labeling of hazardous chemicals on sale
__Lack of expertise on chemicals training and technology centre
__Ignorance of the dangers among officials associated with chemicals capacity building
__The sector's obsolete technology and equipment
__Lack of an integrated prevention system for major industrial accidents and preparation of an emergency plan of action
__Lack of resources (financial and technical support)
__Other (please specify):

Where possible, please briefly indicate what is needed to solve these problems:

7. What expectations do you have for the implementation of Stockholm conventions in USA and in China in period 2004-2014? Please indicate your expected order of priorities for achievement.

1. Development of funding and management mechanisms for the Stockholm Conventions
2. Exchange of experience in management of pesticides and out-of-date chemicals
3. Development of a Plan of Action for POPs control.
4. Development strategy to reduce illegal trans-boundary transport and trade in hazardous products
5. Development of a strategy to exchange expertise
6. Development of preventive and health-protection methods and safety measures for workers in the chemical and agricultural sectors
7. Introduction of a risk-reduction program for hazardous chemicals
8. Harmonization of classification and labeling of chemicals

For China:

For USA:

THANKS FOR YOUR VALUABLE ADVICE!

APPENDIX D

Summary of Survey Responses

Where do scientists get more reliable data? In principle, there are several possible sources: the scientific literature is the most common source (76.67%) of POPs information followed by conferences (56.67%) and the Internet (43.33%). Mass media, such as magazines, newspapers, TV and radio were cited by only 30% of respondents as a source of information.

Since most pesticide POPs have not been used for many years and significant progress has been made in reducing emissions of POPs byproducts in the USA, many American participants are interested in POPs management policies aiming at new substances identified as POPs.

American participants indicated that the information and data on POPs are easily and quickly available. The Chinese participants noted that information on POPs is not easily available in China.

Participants indicated that POPs issues are not widely understood by the general public in either China or the US. POPs issues are widely understood by US government officials and by professionals and scientists in China.

Chinese respondents indicated that the lack of financial and technical supports are barriers to timely and effective information exchange. Among Chinese respondents, 27% indicated that language is an important barrier to information exchange on POPs but no Americans indicated that language was a barrier.

A complete summary of the survey responses is available in Chinese from the Ph.D. thesis (Zhang Hong, 2005) at the Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences.

APPENDIX E

List of Workshop Papers Published in Chemosphere (Volume 60, Issue 6, August, 2005)

"Science-based decision making to reduce risks from persistent organic pollutants (POPS)." Y.-L. Lua, and J.P. Giesy

"A spatial temporal assessment of pollution from PCBs in China"
Ying Xinga, , Yonglong Lu, Richard W. Dawson, Yajuan Shi, b, Hong Zhang, Tieyu Wang, Wenbin Liu, and Hongchang Ren

"A review on the usage of POP pesticides in China, with emphasis on DDT loadings in human milk" M.H. Wong, A.O.W. Leung, J.K.Y. Chan and M.P.K. Choi.

"Human exposure and health risk of α-, β-, γ- and δ-hexachlorocyclohexane (HCHs) in Tianjin, China" Y. Yang, S. Taoa, P.K. Wong, J.Y. Hua, M. Guoa, H.Y. Caoa, R.M. Coveney, Jr. Q. Zuoa, B.G. Lia, W.X. Liua, J. Caoa and F.L. Xua.

"Classification and ordination of DDT and HCH in soil samples from the Guanting Reservoir, China" Hong Zhang, Yonglong Lu, R.W. Dawsond, Yajuan Shi, and Tieyu Wang.

"Organochlorine pesticides (DDTs and HCHs) in soils from the outskirts of Beijing, China"
Youfeng Zhu, Hui Liu, Zhiqun Xi, Hangxing Cheng and Xiaobai Xu

"Distribution patterns of PCDD/Fs in chlorinated chemicals" Yuwen Ni, Zhiping Zhang, Qing Zhang, Jiping Chen, Yongning Wu and Xinmiao Liang

"Inhibition of PCDD/Fs formation from dioxin precursors by calcium oxide" Wenbin Liu, Minghui Zheng, Bing Zhang, Yong Qian, Xiaodong Ma and Wenxia Liu

"Three-dimensional quantitative structure activity relationship (3D-QSAR) analysis for in vitro toxicity of chlorophenols to HepG2 cells" Y. Liu, J.N. Chen, J.S. Zhao, H.X. Yu, X.D. Wang, J. Jiang, H.J. Jin, J.F. Zhang and L.S. Wang

"Synergic effect of calcium oxide and iron (III) oxide on the dechlorination of hexachlorobenzene"
Xiaodong Ma, Minghui Zheng, Wenbin Liu, Yong Qian, Xingru Zhao and Bing Zhang

"Interaction between cadmium and atrazine during uptake by rice seedlings (*Oryza sativa* L.)" Yu-Hong Su, Yong-Guan Zhu, Ai-Jun Lin and Xu-Hong Zhang

"Determination of polybrominated diphenyl ethers in soil and sediment from an electronic waste recycling facility" Dongli Wang, Zongwei Cai, Guibin Jiang, Anna Leung, Ming H. Wong and Wai Kwok Wong

"Determination of polycyclic musks in sewage sludge from Guangdong, China using GC–EI-MS" Xiangying Zeng, Guoying Sheng, Ying Xiong and Jiamo Fu

"Degradation of 4-Chlorophenol by microwave irradiation enhanced advanced oxidation processes" Ai Zhihui, Yang Peng and Lu Xiaohua