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Chemical Events in the International Health Regulations (2005): From Local to Global Health Statecraft

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To all those who still believe that cooperation towards the common good can be the norm, and not the exception, in international relations.
Para todos aqueles que ainda acreditam que a cooperação para o bem comum possa ser a norma e não a exceção nas relações internacionais.

To all those who use their privilege to guarantee that collective rights are sustained.
Para todos aqueles que usam sua posição de privilégio para garantir que o direito coletivo prevaleça.

To my granddaughter Luiza, hoping that she may grow up in a world where "health for all" is a fact, not an ideal.
Para minha neta Luiza, na esperança de que ela cresça em um mundo onde o direito à saúde para todos seja um fato, não um ideal.

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“The unsettling idea of an active, hidden, and malevolent force is reflected in the word we use to describe a newly emerged epidemic – an *outbreak* – which suggests that something dangerous and sinister has broken out of its restraints, like a monster escaped from a dungeon or a madman from a prison for the criminally insane”

Alexandra M. Levitt, in Deadly Outbreaks, 2013

RESUMO

Silva AS da. Eventos químicos no Regulamento Sanitário Internacional (2005): Do Estado da Saúde Local ao Global (Tese). São Paulo: Instituto de Medicina Tropical de São Paulo da Universidade de São Paulo; 2018.

Introdução: A produção e o uso global de produtos químicos é alta e está em ascensão. Provocado pela globalização econômica, o movimento trans-fronteiriço de produtos químicos e seus resíduos tornam a exposição humana a produtos químicos um grande risco para a saúde pública. O Regulamento Sanitário Internacional (RSI-2005) revisado reconhece os riscos impostos pelos produtos químicos à saúde pública ao incorporá-los entre aqueles com potencial para se tornar uma Emergência de Saúde Pública de Importância Internacional (ESPII). A falta de implementação do RSI-2005 em um país pode ameaçar a segurança sanitária global.

Objetivos: O objetivo geral desta tese é apresentar uma proposta para superar o problema da baixa implementação das capacidades de saúde pública em produtos químicos no RSI-2005 e usar o regulamento como uma plataforma para fortalecer a governança para a saúde pública em produtos químicos em todos os níveis de complexidade dos sistemas de saúde. Os objetivos específicos são: desvendar os determinantes, forças motrizes, caminhos e processos que poderiam levar a eventos químicos com potencial ESPII; propor um construto teórico que possa orientar a governança para a saúde pública nesta questão; e identificar os mecanismos que poderiam facilitar a implementação das principais capacidades de saúde pública em produtos químicos para mitigar riscos.

Métodos: A secção de métodos inclui: uma revisão sobre riscos químicos locais e globais, apresentando seus determinantes; revisão do conceito de bens públicos, aplicando-o a aspectos relacionados à segurança química; revisão de eventos químicos passados que poderiam atender aos critérios de potencial ESPII; revisão dos princípios da atenção primária à saúde, explorando possibilidades e oportunidades de incorporar a capacidade em riscos ambientais no contexto dos sistemas locais de saúde para fortalecer a vigilância, o monitoramento e a análise da saúde ambiental em todos os níveis; e proposição de um kit de ferramentas de apoio à implementação das capacidades básicas do RSI-2005 em produtos químicos.

Resultados: Esta tese constrói seu argumento na seguinte sequência: "Segurança Química é um Bem Público Global para a Saúde"; "Lições Aprendidas de Surtos Químicos Mortais"; "O Estado da Vigilância em Saúde Pública para Incidentes Químicos: Dez Anos de RSI-2005 na América Latina e no Caribe"; "Capacidade de Vigilância em Saúde e Resposta: do Local ao Global"; e "Um Guia para a Implementação de Capacidades Básicas de Saúde Pública para Eventos Químicos".

Discussão: Existe relação entre as agendas globais e locais. O RSI-2005 pode ser interpretado como uma oportunidade para rever os princípios e as capacidades essenciais de saúde pública e para revitalizar a forma como os sistemas de saúde são

organizados, fortalecendo os mecanismos de governança para a saúde e a produção de bens públicos globais para a saúde. Isto requer o envolvimento do setor saúde com a sociedade em geral e um papel proeminente e proativo de liderança da OMS.

Conclusão: Atuação local não resolverá problemas globais, mas ela não pode ser desvinculada da atuação global. A necessidade de revisitar e atualizar os sistemas nacionais de saúde para responder a esse contexto de globalização é clara e urgente e o RSI-2005 fornece uma plataforma que pode ser inteligentemente usada na elaboração desta resposta. Não para proteger o comércio e a economia, mas a saúde do povo.

DESCRITORES: Organização Mundial da Saúde. Globalização. Direito internacional. Vigilância epidemiológica. Vigilância sanitária - Instrumentos. Intoxicação.

ABSTRACT

Silva AS da. Chemical Events in the International Health Regulations (2005): From Local to Global Health Statecraft (Thesis). São Paulo: Instituto de Medicina Tropical de São Paulo da Universidade de São Paulo; 2018.

Introduction: The global production and use of chemicals is high and on the rise. Triggered by economic globalization, the transboundary movement of chemicals and their waste makes human exposure to chemicals a widespread public health risk. The revised International Health Regulations (IHR-2005) recognized the risks posed by chemicals to public health by incorporating them among those with the potential to become a Public Health Emergency of International Concern (PHEIC). Lack of implementation of the IHR-2005 in one country can threaten global health security.

Objectives: The general objective of this thesis is to present a proposal to overcome the problem of low implementation of the public health capacities on chemicals in the IHR-2005 and to use the regulations as a framework to strengthen governance for public health on chemicals at all levels of complexity of the health systems. The specific objectives are: to unveil the determinants, main drivers, pathways and processes that could lead to chemical events with potential PHEIC; to propose a theoretical construct that could guide governance for public health on this matter; and to identify the mechanisms that could facilitate the implementation of the core public health capacities on chemicals to mitigate risks.

Methods: The methods section includes: a literature review of local and global chemical risks, presenting their drivers; review of the concept of public goods, applying it to aspects related to chemical safety; review of past chemical events that could meet the criteria of potential PHEIC; review of the principles of primary health care, exploring possibilities and opportunities of incorporating capacity environmental risks in the context of local health systems to strengthen environmental health surveillance, monitoring and analysis at all levels; and proposition of a toolkit for the implementation of the IHR-2005 core capacities on chemicals.

Results: This thesis builds its argument in the following sequence: “Chemical Safety is a Global Public Good for Health”; “Lessons Learned from Deadly Chemical Outbreaks”; “Status of Public Health Surveillance for Chemical Incidents: Ten Years of IHR-2005 in Latin America and the Caribbean”; “From Local to Global Capacity for Health Surveillance and Response”; and “A Guide for the Implementation of Core Public Health Capacities on Chemicals”.

Discussion: There are linkages between the global and local agendas. The IHR-2005 can be taken as an opportunity to revisit public health principles and core capacities, and revitalize the way health systems are organized, strengthening mechanisms of governance for health, and the delivery of global public goods for health. This requires the engagement of the health sector with the society in general, and a prominent and proactive leadership role of the WHO.

Conclusion: Acting local will not solve global problems, but it can no longer be disentangled from acting global. The need to revisit and update national health systems to respond to this context of globalization is clear and urgent, and the IHR-2005 provides a framework that can be smartly used in the elaboration of this response. Not to protect trade and the economy, but the health of the people.

DESCRIPTORS: World Health Organization. Globalization. International law. Epidemiological surveillance – Instruments. Intoxication.

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ACRONYMS AND ABBREVIATIONS

ACTO	Amazon Cooperation Treaty Organization
ATSDR	Agency for Toxic Substances and Disease Registry
CDC	Centers for Diseases Control
CWC	Chemical Weapons Convention
DALYs	Disability-Adjusted Life Years
EM-DAT	International Disaster Database
EMS	Event Management System
EU	Europe Union
GHS	Globally Harmonized System of Classification and Labeling of Chemicals
GKN	Globalization and Health Knowledge Network
GKN	Globalization and Health Knowledge Network
GNI	Gross National Income
GPGH	Global public goods for health
GPGs	Global Public Goods
GPHIN	Global Public Health Intelligence Network
HCB	hexachlorobenzene
HInt	Hazard Intelligence
HSEES	Hazardous Substances Emergency Events Surveillance
ICJ	United Nations' International Court of Justice
ICMSA	Industrie Chimiche Meda Società Azionaria
IDB	Inter American Development Bank
IHR	International Health Regulations
IOMC	Inter-Organization Programme for the Sound Management of Chemicals
IPCHS	Integrated People-centered Health Services
JEE	joint external evaluation
LAC	Latin America and Caribbean
LMIC	Low and middle-income countries
MIC	methyl isocyanate
NATECH	Natural Hazard Triggering Technological Disasters
NFP	National Focal Points
OECD	Organization for Economic Cooperation and Development
PAHO	Pan American Health Organization
PAHO/WHO	The WHO Regional office for the Americas, the Pan American Health Organization
PCT	porphyria cutanea tarda
PHC	Primary Health Care
PHEIC	Public Health Emergency of International Concern
ProMED	Program for Monitoring Emerging Diseases website
SAFCI	*Salud Familiar Comunitaria Intercultural*
SAICM	Strategic Approach to International Chemicals Management
SARS	Severe Acute Respiratory Syndrome

TCDD	2,3,7,8-tetrachlorodibenzo-p-dioxin
TCP	2,4,5-trichlorophenol
TSCA	Toxic Substances Control Act
UK	United Kingdom
UN	United Nations
UNEP	United Nations Environmental Program
UNICEF	United Nations Children's Fund
UNIDO	United Nations Industrial Development Organization
UNITAR	United Nations Institute for Training and Research
UNPD	United Nations Development Program
UNSDG	United Nations Sustainable Development Goals
WHA	World Health Assembly
WHO	World Health Organization
WSSD	World Summit on Sustainable Development

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1 INTRODUCTION

1.1 Of risks and hazards in times of globalization

The revised International Health Regulations[1] (IHR 2005) that were adopted by the 58th World Health Assembly (WHA) on 23 May 2005 [2], and entered into force in 2007, recognized the risks posed by chemicals to public health by incorporating these risks among those with the potential to become a Public Health Emergency of International Concern (PHEIC). The purpose and scope of the IHR (2005) are *"to prevent, protect against, control and provide a public health response to the international spread of disease in ways that are commensurate with and restricted to public health risks, and which avoid unnecessary interference with international traffic and trade."* The World Health Organization (WHO), through its Director General, and following specific procedures that include guidance and provisions to the emergency response, is the only organization that can declare a PHEIC, which refers to extraordinary events that "constitute a public health risk to other States through the international spread of disease", and "potentially require a coordinated international response"[3].

Since the approval of the IHR (2005) by the WHA in 2005 [1], the Director General of the WHO has already declared a PHEIC four times. The first, in 2009, during the third phase of the H1N1 pandemic; the second, in May 2014 because of the spread of the wild virus of poliomyelitis from Cameroon, Pakistan and Syria to other countries, putting at risk the Global eradication efforts in a period where it was expected that the disease would be dormant; the third, in August 2014 in response to the largest Ebola outbreak ever recorded, which started in Guinea in December 2013 and, seven months later, had involved three other countries. This outbreak counted, in the occasion of the declaration, with a total of 1776 cases and 961 deaths in West Africa, with high possibility of international spread due to its virulence, associated with the weak health systems in the currently affected and in the most at-risk neighboring countries, being "a coordinated international response deemed essential to stop and reverse the international spread of

Ebola"[4]. The fourth, on February 1, 2016, responded to the cluster of microcephaly cases and other neurological disorders reported in Brazil, following a similar cluster in French Polynesia in 2014. The emergency was related to the spread of the Zika virus and the increase in neurological disorders and neonatal malformations in Latin America and the Caribbean. The lack of vaccines and rapid reliable diagnostic tests, the broad geographical distribution, and the absence of population immunity in newly affected countries justified the declaration. The PHEIC was lifted on November 18th of the same year, recommending the transition for a longer-term response mechanism[5].

Historically, the IHR had been revised a few times before, always responding to the need of controlling specific sets of diseases. The IHR were preceded in the international health law by the International Sanitary Regulations, which were adopted in the Fourth World Health Assembly of 1951[6], and was revised in 1969 as the International Health Regulations to include six "quarantinable diseases". In 1973 the IHR were again revised to reduce the list of notifiable diseases to three (yellow fever, plague and cholera), and then again in 1981, to mark the global eradication of small pox [7].

The decision to substantially revise the last version of the IHR was taken during the 48th WHA in 1995, to respond to the growth in international travel and trade, and the emergence or re-emergence of international disease threats and other public health risks[8]. It should be noted that this period coincided with the rapidly evolving changes in the process of globalization of the world economy, when countries opened their borders in ways never experienced before. However, the political conditions for the adoption of the revised IHR (2005) were created and matured only ten years later, in the aftermath of the Severe Acute Respiratory Syndrome (SARS) pandemic, in 2003, as it demonstrated how interconnected the world had become and how rapidly a new disease could spread[9]. The SARS event represented also an opportunity to show the leadership of the WHO in dealing with the crisis, and the need to enforce collective defenses for global health.

The IHR (2005) is an international legal instrument that is binding for 196 countries, including all Member States of the WHO. The articles 21(a) and 22 of the Constitution of

the WHO confer upon the WHA the authority to adopt regulations "designed to prevent the international spread of disease" that enter into force for all WHO Member States that do not affirmatively opt out of them within a specified time period[10], hence the immediate adoption of the resolution by all its Member States. However, for its implementation, the WHO relies on global norms and transparency, rather than sanctions and incentives[11], which requires time and resources for advocacy and for technical support.

While built on the long history of control of the international spread of diseases, which is a central responsibility for the WHO, the revised IHR adopted in 2005 do not simply present a list of notifiable diseases, they include any "*illness or medical condition, irrespective of origin or source that presents or could present significant harm to humans*". Although innovating in the adoption of the broad understanding of risks to global health with the incorporation of the multi-hazard concept, the idea of health beyond infectious or contagious diseases is not completely new for the WHO. In the constitution of the WHO it is already stated that "*Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity*", and its Article 1 says that the objective of the WHO shall be the attainment by all peoples of the highest possible level of health [10].

Major incidents and disease outbreaks are reported, internationally, on a near daily basis. However, it is likely that the experience of facing and properly responding to a public health crisis is absent or fairly limited for most individuals and local health services. Therefore, a global health surveillance system for all types of hazards and disease outbreaks, which could become a PHEIC, is a major challenge. Yet it could also be an opportunity to improve health systems everywhere. Additionally, for chemicals, surveillance and response are only the visible parts of these capacities of the health sector. Others necessarily require, involve, or must be coordinated with other sectors, such as monitoring environmental risks or enforcing a legal framework for chemical safety. These capacities, though, are highly dependent on the enabling context provided by a series of other technical, political and institutional mechanisms, frequently bound to other sectors' responsibilities and activities.

Chemical incidents that are intentional or may occur under the assumption that they are intentional and malicious are managed under the warfare or terrorism framework. The context in which chemicals are treated for their use as weapons is singular, as they are regulated by the Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on their Destruction[12], in which the WHO is part of an operation organized at the United Nations (UN), but not the coordinator of the operations. All Latin America and the Caribbean (LAC) countries have signed and ratified the convention on chemical weapons, adopted in Geneva on 3 September 1992[12] and entered into force on 29 April 1997. Given the different nature of the problems, this thesis will focus on broad aspects of chemical safety, and not on chemical weapons, knowing that in many cases, being prepared for chemical safety in general will make a country prepared to efficiently assess, report and quickly respond to any potential chemical-related event.

1.2 Problem definition

Chemical safety is an essential component of health security, and lack of implementation of the IHR (2005) in one country can threaten global health security. This thesis presents the problem of the implementation of the International Health Regulations from the perspective of chemical events.

In general, chemical risks are sensed as local, having little or no association with the transboundary or the international impact with the potential to become a global threat, which are the essence of the IHR (2005). Therefore, it is not surprising that the core IHR (2005) public health capacities on chemicals are somehow left behind, as there are other capacities that are more appealing for the greater public, and more easily understood and implemented by the health sector. Difficulties with the implementation of these capacities on chemical safety may also be related to limited experience of the health sector in leading and contributing to inter-sectoral work. It is possible that in a given country the capacity on chemicals may be present, but has not yet been connected to any governance mechanisms to efficiently respond to chemical emergencies. In some cases, even when

complying with the IHR (2005), the tools that countries used to assess their compliance did not go beyond the minimum required[13].

The low public health capacities on chemicals in the IHR (2005) in LAC countries, and the difficulty to understand the processes that lead to this situation are the problems posed by this thesis. The construct that would guide the response to overcome these difficulties is also addressed in this thesis.

1.3 Objectives

The general objective of this thesis is to present a proposal to overcome the problem of low implementation of the capacity on chemicals in the IHR (2005) and to use the regulations as a framework to strengthen governance for public health on chemicals at all levels of complexity of the health systems.

1.3.1 Specific objectives

The specific objectives of this thesis are:

a) To unveil the determinants, main drivers, pathways and processes that could lead to chemical events with potential Public Health Emergencies of International Concern as defined in the International Health Regulations (2005).
b) To propose a theoretical construct that could guide governance for public health on this matter.
c) To identify the mechanisms that could facilitate the implementation of the core public health capacities on chemicals to mitigate those risks.

1.4 Methods

A seven-step process was conducted to properly meet the objectives of this thesis, as following:

a) A literature review related to chemicals and IHR (2005), including documents and websites of relevant intergovernmental organizations;

b) A summary of the drivers of chemical risks from local to global levels;

c) A review and summary of the concept of *public goods* in recent literature, and applying it to aspects related to environmental health and specifically associated with chemical safety;

d) A review and summary of past chemical events, analyzing them following the criteria of potential PHEIC of the IHR (2005);

e) Revising the principles of primary health care to explore the incorporation of environmental health monitoring, surveillance and analysis in the core activities at local level;

f) Exploring the possibility and opportunity of incorporating capacity on environmental risks in the context of local health systems to strengthen environmental health surveillance, monitoring and analysis at all levels of the health system; and

g) Proposing a toolkit for the implementation of the IHR (2005) core capacities on chemicals.

Taking into consideration the IHR and the UN World Summit on Sustainable Development (WSSD) commitments, and using the Sendai Framework and its proposed goals and targets, as well as the WHO road map to enhance health sector engagement in the Strategic Approach to International Chemicals Management (SAICM) towards the 2020 goal and beyond, it is understood in this thesis that a country will be prepared to efficiently assess, report, and quickly respond to any potential chemical-related PHEIC when it has all the means to attain and sustain: (a) a comprehensive legal framework for chemical safety and the means for its enforcement; (b) clear governance on chemical safety that includes provisions for health, and the sound management of the full cycle of chemicals; (c) a public health surveillance and monitoring system that include sensitive

environmental and occupational health indicators; (d) the means to diagnose, treat and report cases of intoxications; (e) the capacity to detect, and quickly assess and communicate public health risks of outbreaks of diseases suspected or confirmed to be caused by chemical exposure; (f) has the capacity to inspect and enforce ports of entry, and (g) has a priority chemical risks map embedded in the national system in place for early warning and disasters' risks reduction plans[14–16].

The rationale for the capacities listed above will be further developed in different topics. The response for each of the objectives and details of the methods used to do that are presented in the form of topics in this thesis, and the links that support the conclusions are elaborated in the final remarks and conclusions of the thesis. Thus, the topics presented subsequently in this thesis are as follows:

Topic two, ***Chemical Safety is a Global Public Good for Health*****,** sustains that the global production and use of chemicals is high and on the rise and that, triggered by economic globalization, the transboundary movement of chemicals and their waste makes human exposure to chemicals a widespread public health risk. It presents the revised International Health Regulations (2005) as a response to these recognized health risks, and discusses the major challenges to implementing the core IHR public health capacities on chemicals. It argues the need for more resources to strengthen these capacities at local, national and global levels. The argument used to strengthen governance on the matter is that chemical safety is a global public good for health, reasoning that this would justify larger voluntary contributions for the implementation of the core public health capacities on chemical safety in all countries, and to foster inter-sectoral action and cross-border collaboration to rapidly fill the gap in capacities, guaranteeing the necessary governance for global health on chemical safety at all levels.

Topic three***, Lessons Learned from Deadly Chemical Outbreaks*** presents and analyses a series of historical chemical events as examples that are either historic landmarks of disaster epidemiology, or offer crucial information on the dimension of the health consequences associated with technological disasters. It argues that human history

is full of chemical incidents and deadly outbreaks of chemical origin that had large impact on public health and could have been classified as a potential public health emergency of international concern (PHEIC). Some of them were also emblematic because they motivated the development of new legal frameworks to improve chemical safety and surveillance systems to prevent similar events from happening again. Whenever there is information available, the incidents are analyzed based on their possible external determinants or driving forces, and not only on their direct and recognizable cause.

Topic four, ***Status of Public Health Surveillance for Chemical Incidents: Ten Years of IHR (2005) in Latin America and the Caribbean,*** presents the results of a review of chemical events and outbreaks of diseases of unknown etiology where potential chemical etiology was identified in LAC. The search period covers ten years of implementation of the IHR (2005) after entering into force, on June 15th 2007. The findings are summarized in a table, and each event is compared to those events that were captured by the official channels of communications in the same period. The results underscore the importance of chemical incidents as potential PHEIC, and the existing information lag related to under-reporting chemical events in the IHR framework.

Topic 5, ***From Local to Global Capacity for Health Surveillance and Response***, discusses the opportunity to revisit and revitalize the revolutionary principles of equity, social justice and health for all of the Declaration of Alma-Ata, 40 years after the historic WHO / United Nations Children's Fund (UNICEF) Conference on Primary Health Care (PHC) in Alma Ata, former Soviet Union, currently Kazakhstan. This means clearly shifting from merely biomedical interventions to acting on the social and environmental determinants of health, and using the global health agenda to foster and sustain the delivery of public goods for health. In general, there is a tendency to organize health systems with the capacity to counterbalance the negative effects of the political and economic system, not to change them. This topic raises the question of whether empowering all levels of the health system with the capacity to generate and interpret information for health surveillance couldn’t be an alternative to guarantee the necessary information flow that will make the world safer, while providing instruments for political

inter-sectoral action at local and regional levels. Two different experiences of incorporating instruments to assess environmental health risks to primary care settings are presented as examples of the potential energy that could be liberated for the production of public goods for health with this strategy.

Topic 6, ***A Guide for the Implementation of Core Public Health Capacities on Chemicals***, proposes a series of questions and suggestions to guide the implementation of the core public health capacities on chemicals at national and subnational levels. It is intended to complement, not replace any of the existing instruments, such as the WHO checklist and the proposed indicators by capacity level[17], or the later developed tool to conduct joint external evaluation (JEE)[18]. The final product of the guide would be an actionable checklist for identified risks and for the identification of relevant stakeholders that could be engaged for the maintenance of adequate information flow in all phases of surveillance, preparedness, and response to chemical events under the IHR. The proposed guide considers eight interconnected layers of analysis that could assess different aspects of chemical safety. These could be translated into either or both aspects of environmental risk or increased population vulnerability, and could be classified as relevant to promotion, prevention, detection, or response.

Topic 7, ***Discussion***, presents the linkages between the global and local agendas by commenting on the content presented in topics two to six to argue that the challenge of implementing the IHR (2005) can be taken as an opportunity to revisit public health principles and core capacities, and revitalize the way health systems are organized. It also argues that although the globalization process is unstoppable and inevitable, there are other ways of organizing the health systems to embrace it and use it to produce public goods for health. The IHR (2005) incorporates intertwined concerns of public health, security, international trade, and human rights. It also institutes demanding obligations for state surveillance and response, and gives to the WHO the authority to declare a PHEIC independently of the approval of the involved Member States, and the sole authority to declare a PHEIC. While this is a positive development that could facilitate the delivery of global public goods for health, the “global” is a special type of public domain that depends

on policy choices of national governments, and hence on political and economic power, and how those are translated in the country's diplomacy. Therefore, if national governments of disempowered states want to use the IHR (2005) to foster public health gains and make the planet safer, it is necessary to invest internally, empowering health systems bottom-up with comprehensive information management systems, and revitalizing public health surveillance, monitoring and planning to include the all-hazards approach at all levels. It is also necessary to contextualize the global scenario, which differs significantly since the decision to revise the IHR, and since the adoption of the revised IHR (2005) by the World Health Assembly. The high mobility of goods, migrant workers and tourism, as well as the opening of countries' economies to the global market, with their numerous layers of challenges and complexities were already acknowledged as potentially new risks in the series of reports of the Globalization and Health Knowledge Network (GKN) to the WHO Commission on the Social Determinants of Health[19]. Globalization had also been described as the "quintessential upstream" of the "causes of the causes" of health inequities[20,21]. The deleterious effects of globalization were thus predicted and already showed significant warning signs, but the data available today provides much stronger evidence for this statement. The recently launched "World Inequality Report" shows how income inequality has increased in nearly all countries, with high concentration of income and decrease of the share of the bottom 50%[22]. This has clear consequences for public health in general, particularly related to financing universal coverage for a largely informal work force and their dependents, but also for the risks of chemical incidents discussed in this thesis, due to the expansion of production and distribution of goods under the effect of highly unregulated markets. Strengthening mechanisms of governance for health, including the delivery of global public goods for health, will require the engagement of the society in general, but it will likely only be accomplished with a more prominent and proactive leadership role of the WHO.

Topic 8, ***Conclusion***, presents a series of statements and recommendations to strengthen the role of the health sector, arguing that health is a universal language, a *lingua franca* that can facilitate the establishment of strong bonds. It can be used to strengthen

capacity on chemicals for the IHR (2005), but it will never work if this is done in isolation, as a sole initiative. It is necessary to provide the means for governance for health at the local level, which would deliver public goods for health, including on chemical safety. To build the necessary governance for health from the bottom up is a necessary but not sufficient condition for forging the production of global public goods for health and strengthening global health governance. That said, strengthening capacity at the local level helps to create a critical mass that in the end will trigger and sustain the necessary changes. A combination of both, local and bottom up, and high level politics is the only way to guarantee the full implementation of the aspirations of the IHR (2005), as this will only happen if "health for all" on its broader sense, as included in the WHO constitution is achieved. The polity of global health diplomacy cannot be neutrally played. It requires moving beyond the accommodation to the *status quo* and envisioning a future based on ethics, not on the economy. Regardless of the limitations imposed by underfunded health systems, health care facilities are spread throughout the Region of the Americas in a way that is unmatched by any other sector or organization. This privileged position makes the health sector a natural partner for the implementation of any policies at the community level, with the potential to bring about real changes. Acting local will not solve global problems, but it can no longer be disentangled from acting global. The need to revisit and update national health systems to respond to this context of globalization is clear and urgent, and the IHR (2005) provides a framework that can be smartly used in the elaboration of this response. Not to protect trade and the economy, but the health of the people.

2 CHEMICAL SAFETY IS A GLOBAL PUBLIC GOOD FOR HEALTH

2.1 Introduction

The global production and use of chemicals is high and on the rise in all fields of human activity: from extractive to industrial and agricultural production, through to electro-electronic services and devices, trade and commerce, health care delivery, among others. Triggered by economic globalization, the transboundary movement of chemicals and their waste is also on the rise, which makes human exposure to chemicals a widespread public health risk.

Based on evidence of the health effects of chemicals most frequently associated with human exposure in the literature, it has been estimated that 8.3% of the total deaths and 5.7% of the total burden of disease in Disability-Adjusted Life Years (DALYs) worldwide could be attributed to environmental exposure and management of selected chemicals, with the highest burden in developing countries[23]. Of the total DALYs attributed to chemicals, 11% are related to acute poisoning and 11% due to single chemicals in long-term exposures, while 54% of the total burden is borne by children under 15 years[23]. The World Health Organization (WHO) estimates that 71% of unintentional poisonings could be avoided by preventing easy access to chemicals, and that self-inflicted harm could be prevented by restricting access to pesticides, indicating a clear role for health promotion and primary prevention in chemical safety[23].

The revised International Health Regulations - IHR (2005)[1] that were adopted by the 58th World Health Assembly on 23 May 2005[2], and entered into force in 2007, recognize the risks posed by chemicals to public health by incorporating them among those with the potential to become a public health emergency of international concern (PHEIC). For that reason, in the context of the IHR, the sound management of chemicals is a core component of the public health capacities that are critical to protecting human health and guaranteeing global health security. The introduction of the IHR as a legal

framework presented an opportunity to respond to today's challenges of an increasingly interconnected world. However, a comprehensive list of core public health capacities on chemicals for the IHR has remained a subject of discussion and the theme is frequently misrepresented in all spheres of public health policy and decision-making.

Being a legally binding instrument for 196 countries, the IHR (2005) relies on global norms and transparency, rather than sanctions and incentives for implementation[24]. These loose features make it difficult to measure overall progress across the 13 core capacities required by the Regulations. Since the IHR entered into force, countries have reported on their progress of implementation of the IHR based solely on self-assessment. Notwithstanding these limitations, their results are available at the WHO Global Health Observatory[25]. The reports show that countries are making some progress towards acquiring the IHR (2005) core public health capacities but "the overall average scores suggest further efforts are urgently needed in the areas of human resources, capacities at points of entry, chemical events and radiation emergencies"[26]. The majority of countries in the region of the Americas lag behind in their capacities on chemicals and there are large differences between them[25].

Chemical safety is also an important component of the global agenda for sustainable development. There are global initiatives to strengthen cooperation and increase coordination in the field of chemical safety, with the Inter-Organization Programme for the Sound Management of Chemicals (IOMC) being the most relevant. The IOMC includes nine international organizations[1] that strengthen mechanisms for coordinated international action to achieve the WSSD commitment to the sound management of chemicals throughout their life cycle by 2020[14]. There was a renewed commitment to achieve this goal at the Rio+20 Summit in 2012 and the 2030 Agenda for

[1] IOMC participant organizations: Food and Agriculture Organization of the United Nations (FAO), International Labour Organization (ILO), United Nations Development Programme (UNDP), United Nations Environment Programme (UNEP), United Nations Industrial Development Organization; (UNIDO); United Nations Institute for Training and Research (UNITAR), World Health Organization (WHO), World Bank, and the Organisation for Economic Cooperation and Development (OECD)

Sustainable Development[14,27] extends the commitment, among others, by including a specific target on health: 3.9 "*By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals",* which requires actions well beyond the WSSD 2020 target.

Similarly to the IHR, the Sendai Framework for Disaster Risk Reduction 2015-2030 uses the multi-hazard concept, providing guidance for the management of disaster risk at all levels, within and across all sectors[15]. It aims to reduce hazard exposure and vulnerability to disaster, and increase preparedness for response and recovery. There are seven agreed global targets to assess its progress. Two of them are particularly relevant to the capacities for the IHR: (a) *"Substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to people by 2030" (b) "Substantially enhance international cooperation to developing countries through adequate and sustainable support to complement their national actions for implementation of the present Framework by 2030".*

There is an urgent need to respond to the issues identified above in order to strengthen the capacity of countries to mitigate the risks of potential public health emergencies due to mass chemical exposures. Thus, this topic provides an overview of the current chemical risks that pervade our daily lives and presents a framework to support countries in moving towards the implementation of these capacities to rapidly strengthen health security.

The aim is to provide self-interest arguments to justify larger voluntary contributions from developed countries for the implementation of the core public health capacities on chemicals in all countries, a need that has already been clearly identified in the Sendai Framework for disaster risk reduction[15]. Additionally, to foster inter-sectoral action and cross-border collaboration, and the changes in mechanisms of governance that are necessary to strengthen the countries' capacities on chemicals.

2.2 The status: chemical exposure is a widespread risk

Poisonous chemicals that threaten human health and the environment are seen as one of the three major global crises that, together with climate change and mass extinction of species, undermine development and poverty alleviation and lead to increasing global public costs[28]. It could be argued that human needs are the drive for technological advances that use chemicals, but the evidence suggests otherwise. Global economic drivers and market forces play a major role in the introduction, scaling up, and maintenance of the production and use of chemical products – independent of any measurable benefits to humans or the environment.

The increase in the production, distribution and use of chemicals, however, is not equally distributed among countries. Nowadays, the stronger year on year sector growth gains are concentrated in developing countries, where capacity to cope with risks are, in general, more limited[29]. The reasons for this can be controversial and include the economic development of individual countries and the export of hazards and transference of "dirty production" from developed to developing countries. The global market sales of chemicals increased by 2.3 times within the decade 2002-2012, and have quadrupled since 1992[30]. In Latin America, for example, Brazil alone is among the top 10 countries in the chemical sales market (ranked 7th), sharing 2.9% of the total global market, which is more than that of India and the United Kingdom (UK) combined[30].

The international chemical industry has grown significantly, from an output valued at US$ 171 billion in the 1970's to US$ 4.12 trillion in 2010. This enormous growth responds to increasing market demands and is responsible for a large proportion of the economy and of available jobs. The exact number of chemicals in the market is unknown but, based on the Europe Union (EU) market, there are estimates of more than 140,000 chemicals widely used, and the US Environmental Protection Agency adds 700 new chemicals per year to its Toxic Substances Control Act (TSCA) inventory[31]. Taken together, this places significant pressure on governments that have difficulties in

strengthening and enforcing regulations to guarantee security from production through to transport, import, export, use and final disposal of chemicals[32].

The state of the environment has also changed rapidly in the past half a century, more than in any other time in human history[33]. This could be firstly attributed to the great pressures from the coal and petroleum-based economy that required intensified extraction of reserves worldwide. Secondly, to the mass-production of goods, with an accelerated process of opening new markets and stimulating an increase in the consumption goods and services.

Associated with these changes in energy use and consumption patterns, there has been an intensification of agriculture and husbandry and an expansion of areas involved in these activities. These traditional human activities left subsistence status to become market commodities, increasing reliance on agrochemicals and new equipment. At the same time there has been an intensification of mining activities to support heavy industry and manufacturing needs, as well as to respond to the fast growing electrical-electronic industry. These activities have a high impact on the local environment and also increase the transboundary movement of chemicals.

Meanwhile, clashing economic interests and political disputes have generated multiple wars and other armed conflicts that have impacted the production, transportation, and distribution of chemicals. However, the extent of this impact is difficult to estimate, as it is necessary to consider their contribution to the changing environment as well.

The chemical production and the mining extraction processes required for all these activities have led to an escalation in the number of new highly contaminated sites and environmental legacies as deactivated industrial, oil drilling, mining or waste sites, which frequently occur in areas inhabited by populations with high social, economic and cultural vulnerabilities. Although limited by information availability, the Blacksmith Institute, using a rapid assessment method, identified 2,095 highly contaminated sites in 47 low and middle-income countries (LMIC), with an estimated at-risk population of 71.5 million. Of these, 1,400 sites were visited and the investigators concluded that lead, mercury,

chromium, arsenic, and pesticides are the most frequent risks; followed by radionuclides, cyanide, volatile organic compounds and, poly-aromatic hydrocarbons and other multiple chemicals[34]. In addition, this research group screened 406 mining-related hazardous waste sites from the above database (131 artisanal and small scale gold mining areas, and 275 industrial mining sites). Of these, 233 were in LAC and it was estimated that 7.5 million people were exposed to arsenic, lead, and mercury at these sites[35]. However, the impact on public health related to these exposures may go unnoticed by health systems if there are no environmental and occupational surveillance systems in place, and no capacity to confirm cases with clinical features suggestive of acute or chronic poisoning.

2.3 Toxic exposure to chemicals is a threat to sustainable development

Prevention of toxic exposure to chemicals has the potential to contribute to each of the four key dimensions of the UN framework for sustainable development presented in *'Realizing the future we want for all'* (UN System Task Team, 2012): inclusive social development (which includes health), inclusive economic development, environmental sustainability, and peace and security[36]. Further, *"managing disaster risk and improving disaster response"* is considered one of the enablers of sustainable development[37] and is also one of the core public health capacities for the implementation of the IHR (2005).

As such, there are various goals and targets within the United Nations Sustainable Development Goals (UNSDG) that consider toxic exposure to chemicals. These include:

a) Goal 3 – *Ensure healthy lives and promote well-being for all at all ages*

aa) Target 9 – "*By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination.* ab) Target d – "*Strengthen the capacity of all countries, in particular developing countries, for early warning, risk reduction and management of national and global health risks,*" for which one of the thirteen agreed core capacities is on chemicals. This target is a reference to the implementation of the IHR.

b) Goal 6 – *Ensure availability and sustainable management of water and sanitation for all*

ba) Target 3 *"By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally."*

c) Goal 12 – *Ensure sustainable consumption and production patterns*

ca) Target 4 "*By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment."*

Serious challenges threaten the achievement of the UNSDGs in developing countries, which have limited resources for competing government priorities. Finding ways to quickly implement and sustain the core IHR capacities on chemicals could reduce public health risks and help accelerate progress towards achieving the sustainable development goals.

2.4 Core public health capacity on chemicals is a *global public good for health*

Chemical releases can be a major public health problem, especially when they affect or displace large populations, contaminate sources of food or water, or limit mobility or access to goods and services. They may happen as a consequence of technological events, or as a consequence of natural disasters. The IHR (2005) reflects the fact that chemical emergencies are frequently complex and that their effects as well as their determinants may be beyond national boundaries. In the same way, the capacity to respond to chemical emergencies has many local, regional, national and global determinants. Although connected, international economic and social processes that are

part of international political negotiations are not a simple sum of the internal national processes. They involve economic as well as political power, and the countries' capacity for the management of external relations and diplomacy. The need to explain the drivers of the changes produced by the increasing and unstoppable process of globalization and to formulate policies to control its hazardous effects on health has led to a growing number of publications on issues that govern trade and commerce, as well as global health and global health security. The concepts presented in the following sub-sections are based on a review of this literature and are used to build the final arguments of this paper.

2.5 A brief introduction to the concepts of "public goods", "global public goods", and "global public goods for health"

The formulation of the theory of public goods was first introduced in 1999 to answer the question "*why do states cooperate and abide by, or defect from, international agreements*", focusing on a multi-actor world, rather than on intergovernmental cooperation[38].

The main properties of public goods are that they must have *non-excludable* and *non-rival* benefits, and should be available for all to consume. Further, the consumption of the good by one person should not prevent consumption of the good by others. Public goods may be tangible (e.g. clean air) or intangible (e.g. peace and security)[38].

In a very simple way, at one end of the spectrum are purely public goods and, at the other, purely private goods that are *excludable* and have *rival* benefits. These private goods, which are the majority of the goods, can only be provided upon payment and, once consumed, cannot be consumed again. However, within the extremes of this spectrum, is the type of policy that defines a public good, rather than a natural characteristic of the good itself. Some private goods may have positive or negative externalities, which means that they may have an effect on a third party that was not an active part and that had no control of the action. For this reason, from a policy perspective, they should be treated as

a public good as well[39]. If a good is under-supplied, such as clean energy for cooking for example, an individual may not be motivated to change wood burning cookstoves to gas or electric, if the individual cost-benefit is not sufficient to motivate the change, or if the individual cannot pay for the change. However, the transition to clean energy would benefit everyone because the reduction of air pollutants in a house would contribute to reducing ambient air pollution. This would be positive for reducing the direct risks to health as well as indirectly reducing climate forces of global warming. Therefore, a household cookstove that is a private good becomes a public good when policies to accelerate the transition to clean energy are in place.

According to the United Nations Development Program (UNDP), a public good is global when "*benefits are strongly universal in terms of countries (covering more than one group of countries), people (accruing to several, preferably all population groups) and generations (extending to both current and future generations, or at least meeting the needs of current generations without foreclosing development options for future generations)"* [38]. However, for Woodward and Smith[39], *global public goods* (GPGs) are those that exhibit a significant degree of publicness across national boundaries, with less importance placed on whether they include all ages, socioeconomic strata, genders, and population groups, or whether they have no generational boundaries. It is the Woodward and Smith definition of global public goods that is presented by WHO[40], because if global public goods needed to be universal and transgenerational in nature, the definition would exclude all health programs focused on gender or age groups, for instance, which benefit part of the population; or the eradication of diseases, which uses resources from the current generation for the benefit of future generations.

Distinctions are also made between international (more than one country) and global (cross-national) public goods. Cross-national means that there are implications for more than two countries, with at least one of them being in a different region; otherwise it could be a regional public good[39]. GPGs are generally a product of activities based on a multi-country, multilevel, and multi-sector process, and the main idea behind the concept of GPGs is that "…*the under-provision of public goods anywhere is felt around the world*"

[38,41]. Additionally, the production of GPGs requires negotiation spaces and multiple stakeholders that would be recognizable as accountable for the production and the delivery of the goods.

Health, per se, cannot be considered a GPG because an individual's health primarily benefits that individual. The same could be said of a country's population health. However, in many cases, individual health can influence the prevention and the containment of diseases, and in this situation one country's health can impact global health due to its greater vulnerability to the spread of deadly outbreaks and uncontrolled health risks. Therefore, the health of individuals and of countries could be considered clear GPGs. However, this property is not inherent to the good, and varies by disease, geography and historical events. A disease such as Ebola, for example, only became a PHEIC when the epidemic reached densely populated and highly vulnerable urban environments, putting at risk the safety of international travelers and exponentially increasing the risk of a pandemic of catastrophic proportions. Therefore, preventing and controlling the Ebola epidemic, wherever situated, became a clear GPG. Not because of the disease itself, but because of the widespread risk throughout various continents.

Even when considering that health *per se* is not a pure public good, the health of individuals and the public health attributes of one country, if compromised, can have large negative externalities that may limit mobility, trade, commerce and tourism, for example. Weakened health systems may have a delay in early detection and treatment of individuals, and in preventing the spread of infectious diseases that could endanger the mobility of people and goods. At the same time, the determination of good or ill health is complex, and is affected by the global economy, including those related to international trade and work and other sectors' agreements and laws[42]. For that reason, interventions with the potential to improve global health, even when it is done at local or national level can be viewed as GPGs and have been identified in recent literature as global public goods for health (GPGH)[39,43].

The environment, in principle, could clearly be considered a public good, as it is not excludable and all could use it without impeding others from having access to it. However, the scale of the exploitation of natural resources, and the appropriation and unequal distribution of the same resources creates rivalry, and access to the publicness of the "environmental good" cannot be taken for granted. Hence, environmental goods could also be local, national, regional or global public goods, or private goods depending on their availability and on the policies that govern their use and access.

2.6 Chemical safety as a global public good for health

The core public health capacities for the IHR (2005) are population-wide services[44] and, as such, they constitute a pure public good. Preparedness, surveillance, early warning, and response to deadly outbreaks of contagious diseases could be more easily perceived as global public goods because they can have a global impact. Therefore, both the public and private sectors could more easily justify financing these activities and interventions wherever needed, as this would protect themselves or their businesses or the people of their own country, a situation where self-interest can be coincident with the will to produce the good. On the other hand, there are some deadly outbreaks, such as cholera epidemics, that are highly related to local environmental conditions, such as poor coverage of water and sanitation. The benefits of investments in water and sanitation (a local, national or regional public good), which could control the epidemics and prevent their spread and re-occurrence, may be less clearly GPGs for countries at low risk and with little or no trade or exchange interests with high-risk countries. Further, as the problem could be restricted to the affected area and, at most, to neighboring countries, arguments linking the delivery of the goods to self-interest of countries not directly involved in the area may not mobilize their will to act in the production of those public goods.

Likewise, although chemical safety is the object of a number of international agreements, and chemical emergencies is in the core capacities of the IHR, chemical events are frequently considered to be a local or regional issue, and is only perceived as a

global threat in the case of an acute widespread use of chemical weapons. Slower moving risks or localized incidents may go unnoticed or receive only marginal attention, though their effects may be felt far from the initial spill or incident.

However, in most cases, the implementation of chemical safety policies that comply with the IHR could produce public goods with benefits that extend to all or most countries, people, and even generations, which would then characterize them as *global public goods*. The problem is that, when considering the nature of the immediate effect, most of the policies would primarily benefit the local level or the immediate neighboring area. In this case, only the nature of their publicness could help typify the good as a global public good. Nonetheless, "chemical safety" could also be typified as a global policy outcome as it is necessary for both human security and environmental sustainability. Global policy outcome efforts that are aimed at being a commitment and a benefit "for all" might then be considered a GPGH, such as the "2020 goal of sound management of chemicals".

Table 1 presents some examples of chemical safety "goods" according to their typology, whether they are excludable, whether they have a rival in consumption, the level of application of the "goods", an assessment of their publicness, and the relevance of the "goods" for the implementation of the IHR.

Table 1 – Examples of chemical safety "goods" according to their typology, their *publicness*, and their relevance for the International Health Regulation (2005)

Class of good	Type of good	Is it excludable?	Rival in consumption?	Level of application	Nature of publicness	Relevance for the IHR core capacities
Regulations on hazardous wastes/ enforcement of regulations	National or local policy implementation	No	No	Local/ National	Preventing the release of chemicals throughout their life cycle includes provisions for the sound management of the residuals of the production cycle, and of the leftovers and wastes at the end of use of the chemicals. With the public intervention, the competing private and corporate interests lose power, and the policy outcome envisaging the protection of public health and the environment becomes a public good, as nobody is excluded from the benefits, and the benefit of one does not prevent the benefit of others.	Prevention of NATECH disasters, i.e. technological hazards following natural events such as flooding, storms and earthquakes, which can increase the number of fatalities and other social and economic losses. Less relevance for the prevention and preparation for the risk of a chemical related PHEIC.
Notification and control of cross-border transfers of toxic chemicals	Global Conventions and Regional Agreements (The Rotterdam convention and the Basel convention)	No	No	National/ Regional/ Global	The Rotterdam convention[45] is a legally binding multilateral treaty to promote shared responsibilities related to importation of hazardous chemicals, and to provide instruments for informed consent, as well as a means to share information for decision making on imports and exports of chemicals. The Basel convention[46]* is also legally binding, and includes agreed norms to reduce the generation of "hazardous wastes" as well as to restrict and control transboundary movements of "hazardous wastes". Both conventions are "*global human made commons*", norms aiming to provide free access to knowledge that would otherwise remain private; and to increase awareness and control of chemical risks. Therefore, they are GPGH. Regional or bilateral norms will have similar *good* properties if the objectives are similar.	Norms that facilitate environmental health surveillance are part of the core capacities required to prevent, quickly assess the risks, and more effectively reduce the damages of chemical emergencies. Control of cross-border movements of toxic chemicals and hazardous wastes are highly relevant to preventing chemical related PHEIC.

(To be continued)

(Continuation)

Table 1 – Examples of chemical safety "goods" according to their typology, their *publicness*, and their relevance for the International Health Regulation (2005)

Class of good	Type of good	Is it excludable?	Rival in consumption?	Level of application	Nature of publicness	Relevance for the IHR core capacities
Ban on all uses of endosulfan in Costa Rica (2015, entry into force in 2017)	National policy	No	No	National / Global	Endosulfan is a substance that is persistent, bioaccumulative, toxic, and has a long-range environmental transport. It leads to significant adverse human health and environmental effects. Therefore, global action to ban its use was agreed in the framework of the Stockholm Convention[47]. The Stockholm convention is a human made norm that provides GPGH. Although a country may act in self-interest, the national public good produced by its ban is universal and, through the convention, aims to protect all. The *costs and benefits are shared and interdependent among all countries*, as a *free ride* is not possible (the country will only benefit from the global good if it takes action to ban the use of endosulfan).	Endosulfan has been implicated in a series of deadly events, mostly related to use within the legal and technical boundaries. Some of them are related to NATECH events (e.g. runoff from crop sites into water streams). Banning endosulfan also decreases deaths due to self-poisoning[48,49]. Banning the use of highly toxic pesticides is highly relevant to preventing chemical emergencies at national and regional levels (neighboring countries).
Minamata Convention (mercury)	Global policy outcome	No	No	National/ Global	The convention is an agreed *universalization* of local benefits; Banning the use of mercury in one product, activity or country *benefits all*: there are fewer releases to diverse environmental media; less risk of health effects locally and due to spill overs (to food, cosmetics, air, water); less bioaccumulation in the food chain; decrease in the market pressure for its production etc. The outcome is a GPGH.	The implementation of the Minamata Convention is primarily relevant for public health at local/ national and regional level. It also decreases the risk of potential PHEIC (major mass intoxication from mercury with high public health impact)

(To be continued)

(Continuation)

Table 1 – Examples of chemical safety "goods" according to their typology, their *publicness*, and their relevance for the International Health Regulation (2005).

Class of good	Type of good	Is it excludable?	Rival in consumption?	Level of application	Nature of publicness	Relevance for the IHR core capacities
Inventory of chemical sources in areas prone to spills, accidents and natural and technological disasters (production, transportation, storage, waste, residues, spills etc.)	National policy implementation	No	No	Local/ National/ Global	Environmental and public health risk assessment of chemicals requires a reliable inventory of sites where chemicals are produced, manipulated, transported, used, and stored. Based on the inventory, it is possible to design and implement specific preventive measures that will protect the geographical area where chemicals are located, but in the long run, the whole environment. Preventing human exposure to chemicals will decrease the burden of disease from air, water and soil pollution (UNSDG 3, target 9). Therefore, the activity provides the means for a *global policy outcome* (sustainable development), which is a GPGH. It delivers free access to knowledge that increases human security, and its benefits are inclusive. It is primarily a local and national public good.	Highly relevant for environmental health surveillance, preparedness and response to chemical emergencies and NATECH emergencies. It could prevent cross-border accidents and conflicts (a large chemical spill or escape of toxic sludge from mining activities in a bordering river, for instance). It should be part of the knowledge available to develop core public health capacities for the implementation of the IHR on chemical emergencies.
Public Network of toxicological centers / Poison Centers	National or Regional human-made commons	No (could be excludable if the Centers are not public or do not cover all areas)	No (there could be rivalry if the network is small and the response capacity is too limited)	National / Regional (could be Global)	A network of public CIATs increases the capacity of response, and therefore, promotes *inclusiveness*, while also providing free access to knowledge. Both could be identified as inherent properties of a public good. The extension and the quality of the network will determine the level of application. Furthermore, access to quality health care post-exposure to toxic chemicals may prevent unnecessary deaths, contributing to the achievement of UNSDG 3, target 9. Therefore, it contributes to a global policy outcome that is a GPGH.	Capacity to quickly diagnose and treat chemical intoxications is in the core public health capacities for the implementation of the IHR. CIATs are also crucial for strengthening the capacity for surveillance of health effects of chemicals for post-market assessment and re-registration of chemicals.

*It is important to note that the Basel convention was a UN response to uncontrolled "toxic trade" from developed to developing countries, where regulation was frequently absent, or legal enforcement was weak, leading to serious impact on public health and the environment). GPGH – Global Public Good for Health; NATECH – Natural Hazard Triggering Technological Disasters; PHEIC – Public Health Emergency of International Concern; UNSDG – United Nations Sustainable Development Goals.

The incorporation of chemical emergencies into the scope of the IHR (2005) adds substantially to the attribute of chemical safety as a global health policy, as it defines core public health capacities aimed "for all". The "for all" goal gives "*universalization properties of essentially private goods,"* being them produced at local, national or regional levels; it also adds the properties of "*indivisibility of benefits and costs,"* i.e. they become by nature, non-excludable goods, similar to what has been proposed by Kaul and Mendoza[41].

In the case of chemicals, it is necessary to consider, among other factors, their dispersion and distribution through the food chain and water, the runoff waters from contaminated soil to international ocean waters, and the transboundary movement of air pollution. Therefore, global health security obtained through policies to develop and strengthen the IHR core public health capacities on chemicals at a national level could be considered a global public good for health, as it potentially increases chemical safety and decreases the risk of harmful health effects for all.

2.7 Mechanisms of governance

2.7.1 Globalization and governance mechanisms

Health can be impacted by globalization through different pathways, and national and global governance reforms are needed to reduce the harms and increase the benefits from it[42,50]. Historically, the role of global health governance is an attribute of the WHO, particularly with the objective of protecting public health from major global threats. This mission is clear in articles 21(a) and 22 of the Constitution of the WHO that confer to the WHA the authority to adopt regulations "designed to prevent the international spread of disease", which enter into force for all the WHO Member States that do not affirmatively opt out of them within a specified time period[51].

The revised IHR adopted in 2005 build on the long history of control of the international spread of diseases that is a central responsibility of the WHO, but innovate

in many ways. Most importantly, they changed the scope to include any "*illness or medical condition, irrespective of origin or source that presents or could present significant harm to humans*"[2]. Secondly, under the IHR (2005), the responsibility for health security is necessarily multilateral and multidisciplinary in nature, with WHO as the coordinator of international organizations (e.g. UN organizations) in case of emergency responses related to a PHEIC. It should be noted, however, that this role does not apply to chemical weapons, as these are regulated by the Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on their Destruction[12], in which the WHO is part of an eventual operation organized by the United Nations, but not its coordinator.

It is clear though, that the innovation brought on by the revision of the IHR is a practical response to the risks represented by the unprecedented accelerated growth in international travel and trade, which increased the risks for the emergence or re-emergence of international infectious disease threats and other public health risks and hazards beyond infectious diseases. The negotiations for the IHR revision started with the 48th WHA in 1995. The process took ten years to reach maturity and obtain the status of an international agreement with the approval of the WHA – in a resolution in 2005[52]. This indicates the complexity of the processes involved in regulating a changing world and the potential conflicts of interest that could jeopardize their implementation. The difficulties are also shown by the fact that, after more than ten years since their approval, the multi-hazard concept has yet to gain sustainability by being incorporated and mainstreamed in all national policies in addition to those of the health sector.

2.7.2 Health and environmental diplomacy as a governance mechanisms

While WHO provides global health governance, the United Nations Environmental Program (UNEP) provides global environmental governance. For issues related to the environment in general, progressive ideas and principles have been adopted, such as the "polluter pays". This aims to make the owner of the production process

responsible for the whole lifecycle of production, including the final destination of wastes and leftovers. These progressive ideas have been internalized by the global environment diplomacy and have influenced international treaties, conventions and agreements, such as the Vienna convention and the Montreal protocol, the Stockholm, Basel, Rotterdam, and Minamata conventions, and the latest "Paris agreement" on climate change[32,45–47,53–55]. Although health has been used as a strong argument for the establishment of these conventions and for actions on the environment, health is not at the center of the global environment diplomacy.

In contrast, with few exceptions, diplomacy in global health does not include the environment, and remains based mainly on the principles of the WHO charter of 1948[56]. These principles, although defined broadly as "physical, mental and social well-being", are still used first and foremost to support the right to health care, and actions are sought mainly for the organization and provision of health services based on primary or family health care, and for the strengthening of health systems. Currently, WHO has incorporated the discourse of "universal health" which, in theory, should incorporate the social and environmental determinants of health. Therefore, the pursuit of healthy environments, which would help to produce healthy lives, should also be part of the core activities of the health sector, complementing and negotiating priorities with the environmental sector, and together, leveraging pro-health actions from the other sectors.

However, in general, even when included in the "health care" package, health promotion and prevention are most frequently translated into individual actions and interventions, rather than in the production of public goods for health. In the case of chemical safety, for example, individual interventions would be organizing services to treat intoxications, or keeping household chemicals out of reach of children, for example. Both would prevent deaths from intoxication, but the first would not prevent cases, it would only decrease the risk of death, and the second, would require individual commitment with the proposed action. Conversely, the implementation and enforcement of the Minamata and the Stockholm conventions would be population-wide-interventions for the elimination of the unnecessary uses of mercury and some of the most toxic organic

persistent pollutants, respectively[32,47]. This would include both primary prevention and health promotion, and the risks of exposure would decrease independently of individual commitments. Everyone would benefit from the population-wide interventions, which would produce public goods for health, whilst for improved health care and individual actions, only the individuals who received care or adopted the guidance would receive the benefit from it. This approach to the health sector in seeking mostly support for health care coverage and individual interventions for prevention in the negotiation with other sectors is problematic in terms of *governance for health.* Although the provision of health care systems is crucial for human health security, it has little appeal and convergence with other sectors, as they are clearly in the domain and control of the health sector.

To appeal to other sectors, a call for prioritizing actions that would mostly benefit health should be accompanied by clarification of the co-benefits that these actions would bring to all. Providing resources to supply health services is considered only costs if the benefits are only for the individuals receiving the services. There are some signs of change in this role at WHO, particularly with the appeal to reduce the burden of diseases from environmental health risks, which has put the organization in a privileged position to act on air pollution, on the delivery of water and sanitation services, and to put health in the center of the discussion on climate change. However, this approach has not yet been mainstreamed into the health sector in most of the countries.

The IHR, in this sense, provide a unique, legally binding platform to facilitate inter-sectoral action that benefits health, as all sectors can profit from its implementation. There is no possibility of acquiring and maintaining the core public health capacities on chemicals, for instance, if all areas related to chemical safety are not aligned to prepare and respond to public health threats related to chemicals. In addition, implementing the IHR is a safeguard that guarantees the continuity of economic production processes, including the distribution of goods and services, which are core principles of the regulations. Therefore, implementing the IHR in its full complexity would be a great contribution to strengthening health security, but also provide the national basis to deliver governance for global health and the provision of GPGH.

The fact that sovereign countries agreed on a number of conventions on chemicals[32,46,47,57], mainly based on their risks to health and environment, and agreed to include chemical risks in the array of issues covered by the IHR (2005), shows that there is a relative consensus that no nation can obtain chemical safety for health security alone. Likewise, it is not possible to build capacity on chemicals under the IHR with solo actions.

To deal with governance mechanisms there are programs financed by voluntary contributions, such as the SAICM, in which UNEP and WHO have a shared role in its secretariat[58]. The SAICM strategy has three components: the Dubai Declaration on International Chemicals Management, the Overarching Policy Strategy, and the Global Plan of Action[58]. SAICM was created as a mechanism to facilitate the financing and guidance of projects that could strengthen countries' capacity for the achievement of the WSSD 2020 target and beyond. Nevertheless, the role of the health sector in SAICM has initially been under estimated, and its participation in these mechanisms has been poorly financed.

2.8 Global governance mechanisms for chemical safety in the context of the IHR

Aiming at strengthening the role of the health sector on chemical safety, the World Health Assembly approved a resolution and a road map to enhance the role of the health sector in the SAICM towards the 2020 goal and beyond[16,57]. One of the four action areas of the roadmap is "*to strengthen national institutional capacities to address health threats from chemicals, including in response to chemical incidents and emergencies.*" The IHR is among the three key institutional capacities, together with national policy and regulatory frameworks and training and education. The roadmap recognizes that "*all sectors need to work together to achieve the goal of sound management of chemicals throughout their life cycle*", and "*identify concrete actions where the health sector either has the lead or important supporting role to play*"[16].

Although the discussion of a global governance framework in chemical safety for health is not explicitly mentioned in the roadmap, the main sectors and stakeholders involved in each aspect of the activities were identified in the document. The actions occur in different spaces of national and global governance and clearly involve not only the WHO Secretariat and the WHO Member States, but also other sectors and bodies of the UN system and non-State actors. In this sense, it already indicates the different spaces of governance at country and global level, which combined could produce the global public good of chemical safety with health as its center and objective. If this resolution and roadmap are fully implemented, the conditions to produce GPGH will be greatly augmented.

This WHO resolution and its roadmap to chemical safety are broad enough to incorporate the diversity of the problems and the different levels of capacity among the countries. However, in all existing documents, relatively little has been conceptualized about the connections between national and international policy development for chemical safety and the global health security agenda, and about the role that global health governance has on that. Similarly, the financing mechanisms are yet to be developed.

Despite the much-needed support of the non-State partners for the implementation of the plan of action that can lead to chemical safety, GPGH need to be provided by governments, as there will always be conflicting public versus private interests that need agreed mediation mechanisms, such as norms, regulations and conventions that cannot, and will not, be provided by the market or private interests if left alone. These governance mechanisms need to go beyond the guarantees of individual and human rights; they ought to be thought to increase the space of publicness for a common good. Kickbush and Szabo[43] argue that, “the transnational nature of global health will require a focus on providing GPGH and engaging different actors to support a rules-based and well financed global public health domain”. They also state that “the production of global health begins at national level, but depends on the engagement of other countries”, which in the case of the IHR would mean that there is no way a national government can guarantee health security for its own people, without addressing capacities of other countries to do the

same. Therefore, global health security delivered through the production of global public goods for health can only be guaranteed when all the political spaces for governance combine to serve this purpose.

At a national level, the Ministries of Health and the Environment would probably be the main stakeholders, but other partners such as the Ministries responsible for the Industry, Mining and Agriculture should also be considered when developing national chemical safety plans, including prevention, preparedness and response to chemical emergencies.

Other examples of governance instruments on chemical safety to deliver GPGH are the regional multilateral agreements such as those that regulate common trade or are organized by geographical zones. Through leadership, technical cooperation, or economic incentives, these agreements can promote the incorporation of mechanisms to strengthen the capacity of the participant countries on sound chemicals management during their full life cycle, from registration of the activity to safe end-of-life recycling or disposal of leftovers and wastes.

Additionally, regional governance can promote and facilitate bilateral or multilateral agreements for the maintenance of cross-border services for chemical emergency preparedness and response, including the maintenance of toxicology centers. These types of solutions that must include legally binding agreements could be cost-effective for small countries, accelerating the development of the core public health capacities on chemicals for the implementation of the IHR. It would ease the transboundary movement of experts and of supporting medicines and equipment in the case of emergencies, or for the investigation of outbreaks of diseases potentially caused by chemicals by putting in place standard procedures and mechanisms that could be actionable in any particular need.

2.9 Final remarks and conclusion

Considering chemical safety a global public good for health provides self-interest arguments that justify larger voluntary contributions not only from private and third sector donors, but also from developed countries to fulfill this need. Furthermore, this would scale-up support for the timely delivery of the core IHR public health capacities on chemicals in all countries.

Resourceful donors, frequently based in developed countries, have the financial and structural capacity to intervene in the global health agenda, and in plans and programs related to chemical safety in general. However, given conflicts of interest, no private sector or single country or group of countries could take the leadership in the production of GPGH related to chemical safety. Leadership must remain in the public domain.

The UN and all other intergovernmental and international organizations that regulate or provide technical cooperation for the extraction, production, distribution, use and elimination of chemicals would be the actors leading "global governance for health" on chemical safety. This must be differentiated from "global health governance", which is the role of the WHO, and that includes conducting and engaging with the other sectors and spaces to promote and strengthen global governance for health and the provision of GPGH[43].

Therefore, it should be the role of the Ministries of Health to engage and contribute with other areas and sectors to develop and sustain core public health capacities on chemicals to safeguard the implementation of the IHR at national and local levels and, also, to explore mechanisms for the cooperation with regional and neighboring countries to acquire and maintain these capacities. This could be an immediate solution for small, low and LMIC, as this strategy would avoid costly infrastructure and the maintenance of highly specialized laboratory and medical, toxicological and chemical safeguards in each small country. Internationally shared mechanisms to rapidly acquire capacity to avoid and respond to chemical emergencies in a well-planned and structured way would be guaranteed and delivered in a timely fashion. It could be organized in the same way as

for *orphan drugs*, which are those necessary for responding to medical conditions that are uncommon, but do not necessarily need to be stored in all medical centers; all medical centers need only to know when and how to quickly access them if needed.

The inter-sectoral work and the publicness of the decision-making process at all levels – from national to global – would be the main guarantee of the provision of public goods for health related to chemical safety, and the governance mechanism to sustain global governance for health on chemical safety.

3 LEARNING FROM DEADLY OUTBREAKS OF CHEMICAL ORIGIN

3.1 There are rumors of disease in the Global Village

Economies, crops, livelihoods and people are so intertwined and interconnected, especially since the 1980's, that the entire international community can be affected by a single health crisis in one country. Therefore, the capacity to detect, assess, report, and respond to public health threats, whether they are naturally occurring, accidental or deliberate in origin, is of high interest of all countries. Building and sustaining these capacities are at the core of the International Health Regulations (IHR) (2005)[1] and, in principle, should guarantee health security to all human beings.

The impact on human health related to environmental risks and to animal health is well known, and their impact on the disease burden is fully acknowledged in current scientific literature. This knowledge, though, is not reflected in the way information for decision-making in public health is collected and analyzed. Although the multi-hazard concept is at the core of the IHR (2005), health information and surveillance systems are hardly connected to other information sources, such as environmental health monitoring or indicators of wildlife and livestock health, for example. Currently, there are no systematic and well-established processes to analyze and share information relevant to health coming from different sectors.

A good example of the need to consider other sectors to strengthen capacity for prevention, early warning systems and, frequently, also the response to potential PHEIC was given by Schneider and colleagues[59]. The authors analyzed the events reported in the WHO administered IHR (2005) Event Management System (EMS), in the period between June 15th 2007 and December 31st 2008, and found that, of a total of 110 events recorded in the EMS for the Americas, 70% of them were either zoonosis or communicable diseases common to man and animals, indicating the relevance of theme for public health emergencies[59].

There are many examples in our time that corroborate with their conclusion. One of them is the outbreak of West Nile Virus in New York City, which started in 1999. It was only when parallel investigations of deadly outbreaks affecting birds and humans were connected that the identification of the cause of the human encephalitis outbreak, which by then had affected large part of the City, became clear. One of the major lessons learned from the event was that regular exchange of information between sectors is essential to protect public health. For an informative description of this outbreak and of the people involved in the investigation, see "Deadly Crows Falling from the Sky"[60].

Another example of other sector's crisis producing outbreaks of disease is well described in a book: "*Twelve Diseases that Changed our World*". In it, Sherman uses a historical perspective of disease, and very interestingly, one of the diseases he describes is not a human disease, but a plant disease – the Irish potato blight. This is the fungus that destroyed about 40% of the production of potatoes immediately, leading to the period known as "the great famine", around the mid-nineteenth century, when in Ireland "*more than a million people died of starvation or diseases such as typhus and cholera*", and more than two million migrated to the United States or Canada. The social and economic determinants of the single crop policy were not the cause of the potato blight, but they were certainly the cause of the famine and associated diseases, and hence of the health effects produced by the crop disease. The main goal of the British at the time was to please bankers and landowners, and they did that by extracting the greatest amount of resources and exports from their colonies, hence why no grains were sent to mitigate the losses of the already impoverished Irish people, and the potato blight became the cause one of the most deadly disease outbreaks in history[61].

From a different perspective, the importance of chemicals as potential PHEIC, the object of study of this thesis, was presented in a review article by Olowokure *et al.*[62] prior to the adoption of IHR (2005). The review identified the frequency, nature and geographical location of acute chemical incidents of potential international concern that occurred in the period between August 2002 and December 2003. The authors searched formal information sources, such as government reports, the WHO network, and others,

but also the Global Public Health Intelligence Network (GPHIN), ProMED-Mail, Hazard Intelligence (HInt), and other news media on the Internet. They found reports of 779 chemical events and evaluated that 35 (4.5%) of them, distributed in 26 countries, could have been a potential or actual international public health event of international concern. Two of these events had occurred in the Americas. One in Ecuador, in 2002, related to volcanic explosions that contaminated air and water, and the other in Mexico, 2003, an outbreak in a hospital, resulting in the death of 20 babies due to an unknown cause[62]. Although presenting some methodological limitations, the study provided support for the development of the multi-hazards surveillance system that is coordinated by the WHO.

According to the criteria used by the IHR (2005) on the decision-making algorithm presented in its Annex 2[63], an event must be notified when meeting two of the following four main decision criteria: *(i) is the public health impacts of the event serious? (ii) is the event unusual or unexpected? (iii) is there a significant risk of international spread?, and (iv) is there a significant risk of international travel or trade restriction?*

3.2 Deadly Outbreaks of Chemical Origin

Similar to what is normally done in clinical settings, where reviewing cases help the continuous learning process, it is useful to look at historical examples and analyze and unveil the series of events that lead to the incident, recognizing their direct cause and their local and global determinants, to learn from the experience as well. This is done in this section, with a selection of chemical incidents and deadly outbreaks of chemical origin that had large impact on public health and could have been classified as a potential public health emergency of international concern (PHEIC).

The number and variety of different chemicals that pose a health risk is daunting, and threat scenarios include not only the deliberate releases, but also accidents or attacks on chemical manufacturing plants, storage sites or transport vehicles[64]. Chemical incidents may also happen as a consequence of natural disasters, such as flooding,

hurricanes, landslides, etc., or be worsened by them. None of the examples presented here would fit in this last category, but rupture of petroleum ducts and fire or explosions following natural disasters are quite common.

The events presented in this section are either historic landmarks of disaster epidemiology, or offer crucial information on the dimension of the health consequences associated with technological disasters. Each of them was chosen at the discretion of the author to cover a broad set of contexts, places and types of chemicals involved. Some of them were also emblematic because they motivated the development of new legal frameworks to improve chemical safety and surveillance systems to prevent similar events from happening again.

The cases presented here are: the mass intoxication with hexachlorobenzene (HCB) in Turkey in the years 1955-59; the mass exposure to high levels of 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) in Seveso, Italy, in 1976; the high mass casualty event due to exposure to methyl-isocyanides released from an explosion in a chemical plant, in Bhopal, India, on December 2, 1984; the case of toxic waste poisoning in Abidjan, Côte d'Ivoire; and the lead poisoning in children in Zamfara State, Nigeria, first noticed in 2010.

3.2.1 The Turkish Epidemic of Porphyria Cutanea Tarda (PCT), Anatolia, Turkey, 1955-59

A deadly outbreak of porphyria cutanea tarda (PCT) and mixed porphyria occurred in Turkey, and affected between 3,000 and 4,000 people in the period from 1955 to 1959[65]. The cause of the outbreak was the ingestion of bread made of wheat contaminated with hexachlorobenzene (HCB), a fungicide used to treat seeds to avoid losses due to moisture during storage and in the soil[65].

The health effects were very severe in the affected population. Mortality of children under two years old was extremely high (95%) for those who had been breastfed

by mothers who had ingested the contaminated bread. These children presented a condition called “pembe yara” or “pink sore”, and their deaths were primarily associated with cardiorespiratory failure associated with this disease. They also presented weakness and convulsions. Children between six and fifteen years old, who had eaten the contaminated bread, and also some younger children and adults, presented a different disease called “kara yara” or “black sore, which included photosensitivity, skin fragility, hyperpigmentation, and hirsutism, with a mortality rate estimated at 10%. These skin lesions were diagnosed as porphyria cutanea tarda (PCT), a special type of porphyria caused by HCB[66]. HCB is a persistent organochloride chemical that bioaccumulates in fat tissue, which explains the high exposure of the children who were breastfed, as there is mobilization of fat from the mother’s body to the production of milk during breastfeeding.

PCT is a disease caused by an error of metabolism in heme biosynthesis, leading to the generation of porphyrins. The group heme is linked to the body’s production of the pigment hemoglobin, which gives color to the red blood cells and holds the oxygen when the blood circulates through the lungs. These porphyrins that are not used due to enzymatic defects may cause tissue damage, especially in the skin, and are excreted in the urine, that becomes dark. This excretion is particularly important after exposure to sunlight, which causes the skin lesions as well. Other symptoms include loss of appetite, weakness, arthritis, hepatomegaly, enlarged thyroid, and neurological symptoms that causes inability to perform daily activities, such as handling utensils or climbing stairs[67].

According to a doctor who attended the event, the affected children were generally undersized, and had apparently been undernourished before developing porphyria, and this preceding malnutrition-particular protein deficiency with a resulting poor liver function probably accounted for the severity of the symptoms[68]. Porphyric patients who survived have been shown to have persistent presence of residues of HCB in breastmilk for at least 25-30 years, but no signs of PCT were seen in the offspring of these mothers[65].

Although the cause of the disease was directly related to the ingestion of HCB, to understand the cause of the outbreak it is important to understand its context. The episode

occurred during a period post-Second World War, of relative famine in the country, and the wheat seeds, which contained two kilograms of the fungicide per 1,000kg of seeds, had been imported from Western Europe and arrived too late for planting, being diverted to direct consumption[69]. The ingestion of bread contaminated with HCB was the cause of the disease that killed thousands of people, but the post-war situation, with the consequent shortage of wheat to produce bread and lack of control of imported seed, was the distal cause of the outbreak.

This outbreak would meet the IHR criteria "i" and "ii", and could also meet criteria "iii", which would qualify it as a potential PHEIC.

3.2.2 Mass exposure to high levels of 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) in Seveso, Italy, on July 10th, 1976

On July 10, 1976, a chemical explosion in a reactor of 2,4,5-trichlorophenol (TCP) of the Industrie Chimiche Meda Società Azionaria (ICMESA), a chemical plant that was subsidiary of the Roche Group and that was located on the outskirts of Meda, a small town about 20 kilometers north of Milan, Seveso, Italy, released up to 30kg of 2,3,7,8-tetrachlorodibenzo-para-dioxin (TCDD) over an 18km^2 area, resulting in one of the highest residential TCDD exposures ever recorded[70,71]. The deadly cloud of TCDD affected directly more than 30,000 people[72].

The affected area was subdivided according to levels of TCDD in soil, with decreasing levels, from zone A, very high; zone B, high; zone R, low, and in a reference territory comprising surrounding, non-contaminated municipalities were used to estimate risks of the exposure and associated health effects. More than 3000 animals, mostly poultry and rabbits, were found dead in the area and more than 80,000 were slaughtered to prevent TCDD entering the food chain.

People living in the highly contaminated area were evacuated, and the area isolated. Other less contaminated sites were cleaned up. Fifteen children were hospitalized

with skin problems, and 447 people presented chloracne right after the accident. In the first years after the accident, in the most exposed areas, there was an increased general mortality from circulatory diseases, from chronic obstructive pulmonary disease, and from diabetes mellitus among females. In a follow-up study 25 years after the incident, excesses of lymphatic and hematopoietic tissue neoplasm were found in the contaminated zones, with an increased risk for the highest exposed zone[72]. The area is still under close surveillance, and the studies done in the population strengthened the evidence of the carcinogenicity of TCDD.

The dramatic consequences of the incident include high cultural, anthropological, sociological and economic impacts, besides the immediate increase of mortality and health impacts that persist up to today. The documentation of the event and of their associated social and economic costs were the basis to implement a series of very stringent industrial regulations in the European Union, known as the Seveso Directives. These directives increased prevention, preparedness and response during the industrial processes in Europe[73]. The first, Directive 82/501/EEC, in 1982, was later superseded by Directive 96/82/EC, in 1996, and later, by In 2012 Seveso-III (Directive 2012/18/EU)[74–77].

The Seveso accident is an illustrative example of how a chemical accident of terrifying proportions helped shape radical changes in legal frameworks to protect health in Europe. The quick and sustained response has also avoided long litigation processes, and helped the affected communities to cope with the losses, with the guarantee of health follow-up and assistance as needed.

The Seveso event would meet the IHR criteria “i”, “ii”, and “iv”, and could have been a potential PHEIC.

3.2.3 High mass casualty event due to exposure to methyl-isocyanides in Bhopal, India, on December 2, 1984

In the night of December 2 1984, more than 40 tons of methyl isocyanate (MIC) gas leaked from the Union Carbide pesticide plant in the state of Madhya Pradesh, Bhopal, India. The plant authorities had informed the Indian government that the cloud that had

taken the town would make people sick, but not kill, as it was carbon dioxide. Therefore, there was no immediate panic, and only when people started feeling constriction of the airways and difficulties to breathe did the severity of the accident become clear. The official immediate death toll reached more than 3,800 people, but there are estimates that go up to 6,000[78]. Additionally, the accident caused significant morbidity for at least 200,000 more; of these, 50,000 suffered long-term health effect. Bhopal is known as the worst industrial accident in history[78,79].

MIC has a pungent odor, but its hazardous effects can occur even below the threshold for odor. It is readily absorbed through the upper respiratory tract, and can also be absorbed through the digestive tract or skin. The health effects are diverse, and chronic inflammatory damage to the eyes and lungs were reported as the main cause of morbidity. Also psychological problems and the presence of multisystem effects, renal tubular necrosis, reduced liver function, and miscarriage were associated with the exposure[66]. Individuals who experienced greater health effects may have been exposed to higher doses because of the "*anxiety, disorientation, and panic"* caused by the acute irritant effect of MIC that made them run out of their homes, which increased exposure[78].

In March 1985, the Parliament enacted the Bhopal Gas Leak Disaster (Processing of Claims) Act, giving the Central government the exclusive right to *"represent, and act in place of every person who had made a claim, or was so entitled to make a claim, for all purposes connected with such claims in the same manner and to the same effect as such person".* The case was settled with the government at the value of $470 million, and only in June 2010 did the India court find Union Carbide India Ltd. and seven of its executives guilty of criminal negligence. The fine was set at 500,000 rupees ($10,870) and the individuals were each sentenced to two years in prison and fined 100,000 rupees ($2175)[80].

The litigation against Union Carbide has not been a straight forward case. Contrary to the Seveso accident, the tragedy did not make the place safer, and the compensation process was slow and controversial. The disaster indicated a need for enforceable

international standards for environmental safety to prevent similar accidents. It also shows how exporting risks and hazards to low and middle income countries can have catastrophic consequences, and that the capacity to respond to emergencies shows its effect not only in the immediate survival of the people affected, but also in the long term recovery.

The Bhopal event would meet the IHR criteria “i”, “ii”, and “iv”, and could have been a potential PHEIC.

3.2.4 The case of toxic waste poisoning in Abidjan, Côte d’Ivoire

In the night of August 19 2006, a ship unloaded around 400 tons of petrochemical waste into a number of trucks and dumped the waste in 10-14 places around the city of Abidjan, Côte d'Ivoire, a city of 5 million inhabitants. The dump sites included an area next to the main municipal waste site, alongside roads, a channel leading to a lake, and other areas of open ground[81]. The waste contained a highly toxic mixture of petroleum distillates, hydrogen sulphide, mercaptans, phenolic compounds and sodium hydroxide. People woke up with a foul smell that caused nausea, headaches, breathing difficulties, stinging eyes and burning skin[82,83]. The most severe cases presented respiratory distress, dehydration, and nose and intestinal bleeding[84]. In a study performed at the university hospital of Cocody, 10,598 patients were examined over a period of three months. In this hospital, 74.5% of the people intoxicated presented pulmonary symptoms, but other symptoms were also seen, such as neurological, ophthalmic, cardiovascular, and gynecological. The respiratory symptoms were significantly more frequent in patients over the age of 17, while diarrhea and vomiting were more often found in patients younger than 17 years old. Chest pain was significantly more common in men while abdominal pain and vomiting predominated in women (p=0.001)[85].

Health centers and hospitals were soon overwhelmed, and international agencies were recruited to help local medical staff. According to official records, between 15 and 17 people died, and more than 100,000 people were treated, but it is likely that the number

affected was higher as records are incomplete[86]. According to the WHO, one month after the dumping, there were almost 85,000 consultations, 69 people had been admitted to hospital, and eight deaths had been attributed to the event[84].

Cote D'Ivoire was already living in a climate of social unrest and political instability, and this event quickly overloaded the capacity of response from national authorities. Therefore, the incident had not only important public health consequences; it had also high social and economic consequences, as the instability was further intensified by the reactions of the people and the delay in solving the problem[84].

The international aspect of the problem was also clear, as neighboring countries were concerned that the rivers and the sea could carry contaminated waters over the borders. Additionally, as the ship had departed from Northern Europe and had stopped in a number of ports on its way in different countries, there were fears of discharges in other countries as well. This was further elucidated in an investigation done by Amnesty International, which uncovered the story behind the event. The ship had left the Netherlands with the toxic cargo because it refused to pay the price asked by the Amsterdam Port Service for the disposal of the waste. The toxicity of the cargo was well known by the Dutch authorities and by the company that had contracted the cargo ship, but this did not prevent the reload of the cargo onto the ship despite the fact that the destination of the ship was unknown. Although clean up actions have taken place, there are some criticisms on the effectivity of the measures taken. As for compensation and legal liability of the company, these are issues that to this date are not closed yet[86].

The toxic waste was the immediate and direct cause of the outbreak of diseases in Abidjan, but it was the lack of law enforcement to hold the ship in Europe the real cause of the event.

The Abidjan event would meet the IHR criteria "i", "ii", and "iv", and could have been a potential PHEIC.

3.2.5 Lead poisoning in Zamfara State, Nigeria, 2010

Field workers of the Médecins Sans Frontière were the first to report an increasing number of childhood deaths and an unknown illness in two Local Government Areas of Bukkuyum and Anka in the year of 2010. By the request of the Nigerian government, international investigation teams were sent to the area and concluded that the cause of the outbreak was massive lead intoxication. The cooperation team involved national authorities, the WHO and the Centers for Diseases Control (CDC) of the United States, which investigated the disease, and the Blacksmith Institute, which assessed the environment. In the first study, the villages of Dareta and Yargalma were found to have more than 100 children with a mean blood lead concentration of 119ug/dL, and lead soil concentrations were >100,000ppm around the dwellings in these villages. It was reported that the death of more than 400 children were attributed to intoxication, being this case the worst documented lead poisoning case in history. Investigators confirmed there were many other communities also affected[87–89]. Besides the high casualties, there is also a whole generation that has survived the lead poisoning and is doomed to live with all the harsh consequences and limits that their blood lead levels impose on their neurological development and quality of life.

The origin of the contamination was related to the processing of lead-rich ore for the extraction of gold. The solution for the problem is complex, and requires large investments for cleaning up the sites, moving families from highly contaminated areas and treating the affected population. Additionally, long-term commitment is necessary to increase investments to improve working conditions, regulate mining activities, and educate and empower local communities for sustainable solutions. The solutions are also hooked on global pressures, as the demand for gold is on an increase worldwide, and on the vulnerability of the mining communities, as their survival relies mainly on artisanal mining.

After the elucidation of the cause, it would not follow as a PHEIC, and should enter in a longer term action plan, and that is what poses the most difficulty to public

health. The harsh and immediate consequence of not acting on the determinants of the outbreak is that without cleaning the environment, children already diagnosed with lead poisoning cannot begin the chelating therapy that would prevent further damage. Although no technological constrains are involved in the solution, social and economic determinants play a key role in delaying policy actions toward elimination of the already clearly identified risk.

The massive lead poisoning event would qualify as potential PHEIC, meeting the IHR criteria "i" and "ii", with likelihood of criteria "iii", as artisanal mining in other areas could have similar conditions in the country or elsewhere in developing countries living in similar conditions[90].

3.3 Learning from the experience

The events presented in this topic have clear and well established links between the identified symptoms, diseases, and deaths and a specific chemical or a group of chemicals. The severity of the health effects is associated with the type and quantity of the chemical involved in the exposure. This is immediately noticeable from the acute effects and the death toll in the first hours or weeks of the event. However, long lasting and severe effects may bring as many losses or more in terms of premature mortality and of DALYs.

None of the chemicals involved in the events described in this Topic should exist close to populations. The fungicide HCB is no longer in use, but it does not mean the tainting of food is not a risk anymore. Later events not described here, such as the "Toxic Oil Syndrome" in Spain, in 1981, related to ingestion of illegally refined rapeseed oil that was sold as olive oil in the market[91], or the case of melanin added to baby food in China, in 2008[92] are good examples of the tragic dimensions chemical events that involve the food chain may have worldwide.

Chemical plants should not transfer risks and old technology to new markets, and should not have double standards for security and safety. The Seveso accident has driven

and accelerated a legal framework for Europe to prevent similar cases from happening again. However, there are no reports of any further development in India regarding strengthening chemical and technological safety after the much more dramatic and mortal accident in Bhopal. The responses were quite different as well, which poses the question of whether life has different "prices" depending on their geopolitical location.

Toxic waste, as in the case in Abidjan should have had clear and controlled final destination, and should not find its way far from where they were produced. No one should be allowed to produce anything prior to declaring what will be done with the waste. It is relevant that the incident could have been prevented if the ship did not receive authorization to leave the harbor in the Netherlands without demonstrating the destination of the toxic cargo. Countries need to enforce legal processes already established by international law to inhibit greedy and criminal behaviors on behalf of the common good, and not only to protect themselves directly.

Last, but not least, is the case of artisanal mining that has clear and direct links with poverty, ignorance, and high political and economic instability. The real cause of the lead intoxication of the children in Nigeria is a hungry market for the goods that are explored in unsafe ways, and high unwillingness to pay the real price for it. Therefore, the case cannot be disconnected from the effects of globalization. The solutions cannot be disentangled from global forces as well, and it is necessary to find governance mechanisms to protect these vulnerable groups in Nigeria and in multiple countries where artisanal mining is an important source of income (and disease).

The search for the cause of the causes of the events, though, is what needs to be taken as lessons learned, as those are the ones that could change the fate of future incidents. In a globalized world, more regulations are necessary, not less, and enforcement should be the responsibility of all countries. It is necessary to increase transparency and strengthen governance of chemical risks at all levels. Meanwhile, countries that have already have advanced internal norms and rules that prevent major incidents to happen, and have the power to enforce them, should share responsibility on providing chemical safety to other

countries as well. Making international enterprises from developed countries respond legally for their acts according to the law as prescribed in their country of origin, and not use double standards regarding chemical safety when working abroad could also help the enforcement of chemical safety at home and abroad.

Two other issues may be relevant, but are out of the scope of this Topic. The first are the economic losses that can be devastating, and delays in providing financial compensation and guaranteeing health care, which may bring additional layers of unnecessary suffering. The second is related to increased vulnerability of populations already living in chronic distress caused by poverty or other social and cultural conditions. These people may have little or no resilience or coping mechanisms and this should be acknowledged and taken care of in risk and health impact assessments done prior and post any event. Those are necessary to inform contingency and rapid response plans to the risks and impacts identified. Health impact assessment of large projects involving chemicals and capacity to perform public health risk assessment will be discussed in “A proposal to strengthen the implementation of core public health capacities on chemicals”.

4 THE STATUS OF SURVEILLANCE FOR CHEMICAL INCIDENTS OF INTERNATIONAL PUBLIC HEALTH CONCERN IN LATIN AMERICA AND THE CARIBBEAN: TEN YEARS OF IHR

Globalization has changed and challenged all concepts related to heath surveillance and monitoring. Diseases have the potential to rapidly transcend geopolitical barriers not only through contiguity, but also through travelling in different types of means of transportation at high speed to different continents. The revised International Health Regulations (2005) that were adopted in 2005 and entered into force on June 15th 2007, are the response of the World Health Organization (WHO) to this context of increased public health risks (see Introduction)[1].

The IHR (2005) was established to *"help the international community prevent and respond to acute public health risks that have the potential to cross borders and threaten people worldwide"*[1]. It includes all types of events that meet the criteria, including chemical incidents, the object of study of this Topic. Events identified as potential PHEIC are to be reported to one of the WHO's six Regional Contact Points, depending on where they occur. The decision instrument that is published in Annex 2 of the IHR defines an event as notifiable if it satisfies two or more of the following four criteria: (i) the event has a serious public health impact; (ii) the event is unusual or unexpected; (iii) there is a significant risk of international spread; (iv) there is a significant risk of international travel or trade restrictions[1].

There are many historical examples of chemical events that could have been a PHEIC (see "L*earning from deadly outbreaks of chemical origin"*). Large-scale chemical incidents are rare, and can occur from accidental or deliberate releases in any phase of the life cycle of chemicals, from extraction, processing, production, transport, distribution, use and discharge, or final disposal. However, even small releases can cause high numbers of injury and death, and even lead to risks of international spread. This is the case when toxic chemicals enter the food chain, for instance. Sometimes, the unusual occurrence of a disease or a syndrome of unknown etiology is the first sign of an important and

unnotified chemical release, or an unidentified source of contamination of food or water. Therefore, it is important to have a system that is sensitive enough to capture the occurrence of all types of events, and has the capacity to assess the risk and report them to all levels of decision-making at national level, and when appropriated, to the formal channels of the IHR (2005) [1].

In the Region of the Americas, all events that have been reported as potential PHEIC by the IHR National Focal Points or detected through epidemiological intelligence carried out by WHO are recorded into a database known as Event Management System (EMS). The EMS is the official repository for all information related to potential PHEICs, providing information that is organized chronologically, by country, WHO Region, and by type of event. Each event receives an identification number, and the clinical, epidemiological, laboratory and any other types of risk assessment data, as well as all information exchanged are stored in chronological order[93]. The EMS is a key element for a global early warning system as a web-based and secure platform to quickly share information among the three levels of WHO.

The region of the Americas is highly diverse geographically and economically, and one with the highest inequities in the world. Although highly urbanized, one in four people in LAC are still living below the poverty line[94]. This indicates the possibility of population groups presenting increased vulnerability, and the difficulty to achieve universal health, as large parts of the population are excluded from the formal market and often live in areas with low State presence and other institutional settings that could provide assistance and support. Low coverage of health services could be a barrier for public health surveillance mechanisms and delay notification and response to events of relevance for global health security.

Prior to the adoption of the IHR (2005), in the period between August 2002 and December 2003, Olowokure *et al.* [62] had identified 779 chemical events worldwide and found that 35 (4.5%) of them, distributed in 26 countries, could have been a potential PHEIC. Two of these events had occurred in the Americas. One in Ecuador, in 2002,

related to volcanic explosions that contaminated air and water, and the other in Mexico, 2003, an outbreak in a hospital, resulting in the death of 20 babies due to an unknown cause[61]. In addition to those examples, Table 2 presents different types of events that occurred in Latin America and the Caribbean before the IHR (2005) entered into force, which could have been reported as potential PHEIC. These events were also classified by the author of this thesis according to the IHR criteria for potential PHEIC, and to their association with international drivers or direct causality. These examples indicate the relevance of this type of risk in the region, but their impact has not been quantified.

Table 2 – Chemical incidents of potential PHEIC in Latin America according to their main determinants, and classified according to the algorithm of the Annex 2 of the IHR (2005), 1994-2006.

Year	Country	Number of people affected/ deaths	Description	IHR (2005) Annex 2 Criteria*	Global / International determinants	Reference
1994	Cuba	50,862 cases of neuropathy; Some cases presented an optic form, with sub-acute onset (3-30 days)	Cause not clear Possibly multi-causal: toxic (associated with tobacco use; others not identified); nutritional. Occurred during economic crisis following changes in the Eastern European countries and a tightening of the US economic embargo. Improved with supplementation of vitamins: Complex B, A, E, folic acid and high protein diet. (Authors refer to an early epidemic of amblyopia a hundred years earlier, during the US blockade in the Spanish war.)	Yes to (i), and (ii). No to (iii) and (iv)	YES Political (Crisis in the Soviet bloc) Economical (Embargo US)	Ordúñez-García, 1996[95]

(To be continued)

(Continuation)

Table 2 – Chemical incidents of potential PHEIC in Latin America according to their main determinants, and classified according to the algorithm of the Annex 2 of the IHR (2005), 1994-2006.

Year	Country	Number of people affected/ deaths	Description	IHR (2005) Annex 2 Criteria*	Global / International determinants	Reference
1996	Haiti	Epidemic of acute renal failure. 109 children affected, 11 evacuated to the US; 85 deaths in Haiti; 3/11 died in the US	Liquid acetaminophen manufactured by a local pharmaceutical company was contaminated with Diethylene glycol. Glycerin of Chinese origin with 24% DEG was used for the syrup.	Yes to (i), and (ii). No to (iii) and (iv)	Yes Unregulated market in China	Woolf, 1998[96]
2006	Nicaragua	801 affected 48 died, 15 blind	Methanol poisoning Alcohol beverage locally produced contaminated with methanol	Yes to (i), and (ii). Unknown of (iii) and no to (iv)	Unknown	PAHO, 2006[97]
2006	Panama	155 people affected, 119 official cases reported with Acute Renal Failure accompanied of neurological symptoms, 78 died;	Diethylene glycol contaminated liquid cough syrup Single lot number identified a product that was labeled as glycerin imported from China via a European broker	Yes to (i), (ii) and possibly (iii). No to (iv)	YES Unregulated market in China; failure to control distribution in Europe	Rentz *et al*., 2008[98]

* (i) the public health impacts of the event is serious; (ii) the event is unusual or unexpected; (iii) there is a significant risk of international spread; and (iv) there is a significant risk of international travel or trade restriction[1].

Since the IHR (2005) entered into force in 2007, the WHO measures progress of Member States in acquiring and maintaining core capacities. In general, countries in Latin America and the Caribbean have progressed in those capacities, but lag behind on the core

public health capacity on chemicals in the IHR[99] (for more details, see table 9 in Topic 6: *A proposal to strengthen the implementation of core public health capacities on chemicals*).

The objective of this Topic is to assess the types of chemical events occurred in LAC recorded in the EMS since the IHR entered into force in 2007. In addition, perform a systematic search in the formal and informal information sources to explore if there were other events that could have been a potential PHEIC. It will also help to estimate how many of these events published elsewhere were recorded in the EMS.

4.1 Methods

4.1.1 Data sources

This study is based on different types of data that are described below:

The first is based on data for the Americas region recorded in the WHO EMS from June 2007 to June 2017. The WHO *Event Management System is a password-protected web-based tool accessible to technical officers at WHO Country, Regional and Headquarter Office levels.* It includes all potential PHEICs notified by the IHR National Focal Points (NFP)[100] and signals detected by the WHO Regional office for the Americas, the Pan American Health Organization (PAHO/WHO) for which a verification was requested to the IHR NFP. The criteria for entering information into de EMS include: *an event notified by a Member State; an event for which a request for verification is sent to a Member State; and events for which WHO assistance is requested*[101]. The data was extracted directly from the EMS database, and comprises information provided by IHR NFP or other national authorities, and the PAHO/WHO surveillance system, which includes both specific staff dedicated to epidemiological intelligence and any other PAHO technical staff at Country or Regional offices. The author of this Topic had access to the EMS, and the analysis of the retrieved information was discussed with the Regional Focal Point for the EMS. No second reviewer has searched and analyzed the information

retrieved from the EMS. The information was used as it was entered in the system. Data and information was extracted from the EMS on October 16th 2014, and updated on October 14th 2017, and a descriptive analysis was conducted. Consequently, previous and future reports may show statistical differences as the information in EMS is continuously updated as new information becomes available

The second set of information is the result of a comprehensive search in the following information sources: a) PubMed and EMBASE, for articles or manuscripts published in peer review journals, and the database LILACS to search for articles and manuscripts from Latin America and the Caribbean that are not indexed in the two previous databases; b) The publicly available information of the International Disaster Database - EM-DAT; c) The ProMED - the Program for Monitoring Emerging Diseases website.

EM-DAT[102] is a global database on natural and technological disasters that is maintained by the Centre for Research on the Epidemiology of Disasters (CRED) at the School of Public Health of the Université Catholique de Louvain located in Brussels, Belgium. ProMED[103] is an Internet-based reporting system dedicated to rapid global dissemination of information on outbreaks of infectious diseases and acute exposures to toxins that affect human health. It is funded by diverse sources, including donations by users, who also contribute with the list by reporting and commenting on events.

Detailed search in the scientific literature are described below:

- PUBMED: ((((("chemical incident") OR "chemical accident") OR "chemical event") OR "chemical release") OR "chemical spill") OR outbreak of diseases of chemical origin) OR outbreak of diseases of unknown etiology
- EMBASE search strategy (822): 'chemical incident' OR 'chemical accident' OR 'chemical event' OR 'chemical release':af OR 'chemical spill' OR (('outbreak'/exp OR outbreak) AND ('diseases'/exp OR diseases) AND of AND chemical AND ('origin'/exp OR origin)) OR (('outbreak'/exp OR outbreak) AND ('diseases'/exp OR diseases) AND of AND unknown AND ('etiology'/exp OR etiology))

For EM-DAT, the events were selected by year (2007 - 2017), region (Americas), and disaster subgroup (Geophysical, Hydrological and Technological). For ProMED mail, the following terms were used for the search: “Chemical industry”, “Chemicals”, “Accidents”, and “Safety management”. Whenever necessary, information regarding the events identified in those databases were complemented with information retrieved from Google. The search on Google was performed using a combination of key terms related to the event, such as country, year, and number of affected people, disaster type and subtype. The languages used were English, Portuguese and Spanish. The first ten pages of the results were screened for additional information.

The search strategy, retrieval and organization of information were done in different databases in collaboration with two other independent reviewers. Each reviewer pre-selected a list of events in a database applying the IHR criteria for the decision on PHEIC. A second reviewer confirmed the selection, and then the information was extracted in a table. When there was disagreement between two reviewers, the event was sent to a third reviewer for decision, and this happened in two cases that were excluded.

4.1.2 Inclusion Criteria

The first criteria for the inclusion of events were that an event occurred in the region of the Americas, and that it had a positive response to at least two of the four main decision criteria for a potential PHEIC presented in the Annex 2 of the IHR (2005) described above according to the author of the Topic. From those, only the events occurred in Latin America and the Caribbean were selected to be analyzed in this topic. For more information about the algorithm, see Annex 2 of the IHR (2005)[63].

“Event”, in the context of the IHR (2005), is an outbreak of disease or any occurrence that creates the potential for an outbreak of disease. All events in the EMS are assigned according to a category related to a potential hazard (see Box 1 for hazards categories in the EMS). In the case of the EMS, all events in the category “chemical” from

the region of the Americas were retrieved and, additional manual search was done in the other categories.

BOX 1 - Hazards categories in the EMS

- *animal*, if there is potential harm to human health from zoonoses;
- *chemical*, if there is potential harm to public health from the toxic effects of chemical substances, which are chiefly non-medical, as to source;
- *food safety*, if there is potential harm to public health from the toxic effects of food (poisoning or injury);
- *infectious*, if there is the potential harm to public health from an infectious disease;
- *natural disaster*, if there is the potential harm to public health from a natural disaster;
- *nutritional deficiency*, if there is the potential harm to public health from nutritional deficiencies;
- *product*, if there is the potential harm to public health from contaminated or faulty therapeutic goods including medicines, blood products, tissues and organs, medical devices, diagnostic tests and devices, etc., including poisonings due to mislabeling of therapeutic goods;
- *radio-nuclear*, if there is the potential harm to public health from the toxic effects of ionizing radiation; and
- *undetermined*, if there is the potential harm to public health from an undetermined hazard.

Source: 2016 Report on acute public health events assessed by WHO Regional Offices for Africa, the Americas, and Europe under the IHR[101].

4.1.3 Analysis

The events retrieved from the EMS for the Americas were exported to Microsoft Excel, version 2010. Events from LAC countries registered in the period between June 15th 2007 and June 15th 2017 were selected for further analysis. In addition to the events in the category “chemicals”, a search for possible additional chemical events included in the categories “disaster”, “food safety”, “product”, and “undetermined” was done and

retrieved for further analysis. The final list includes events retrieved from any of those categories reported in the EMS.

Each event added to the list retrieved from the WHO EMS was also categorized as “substantiated”, i.e. presence of hazard confirmed or human cases occurring clearly in excess of normal expectancy; “no outbreak”, when a number of human cases or hazards reported is within the normal limits of occurrence; “unverifiable” when no information is forthcoming from the NFP or responsible national authority to substantiate or discard its occurrence, despite the best efforts to obtain such information[101].

4.2 Results

4.2.1 Literature search

The search in the scientific literature retrieved 1910 studies, leaving 635 studies after duplicate removal. Each of the studies was assessed using the algorithm of the annex 2 of the IHR (2005).

The search in EM-DAT retrieved 123 events for the Americas; from these, 97 were from LAC. After reviewing the events, five chemical events were retrieved: two oil spills, one in Chile in 2012, and one in Guatemala, 2013; one poisoning event in Colombia, and two chemical spills, being one in Mexico, in 2013, and the other in Panama, also in 2013. Other events could also have had chemical exposure, but this could not be confirmed with the data available: 13 fire events; 13 volcanic activities; and 12 explosions.

Table 3 shows the events selected from the information retrieved from all the searched databases. Each case is also assessed using the algorithm of decision as presented in the Annex 2 of the IHR (2005), on the relevance of global determinants for the event, and whether the event was reported on the WHO EMS database. The final assessment was done initially by the author and, confirmed by a second reviewer. There were no disagreements. When there was discordance, there was a discussion between the author and reviewers, and the assessment is the result of a consensual decision.

Table 3 – Chemical incidents as potential Public Health Emergencies of International Concern in Latin America and the Caribbean, 2007-2017

Year	Country	Number of people affected/ deaths	Description	IHR (2005) Annex 2 Criteria*	Global / International determinants	Recorded in the EMS Yes/ No	Ref
2008	Chile	8,000 affected	Eruption of the Chaitén vulcan caused the evacuation of all the residents from Chaitén city. Air traffic were also changed.	Yes to (i), (ii) and (iv). No to (iii).	No (Natural event)	No	Elissondo, 2016[97]. COMEVT, 2008[104] G1, 2008[105]
2008	Peru	50 children with clinical signs of mercury intoxications (Case reported in the media)	A spill of mercury in Ancash's mining region, in the central Andes of Peru affected pupils of the school "Jose Carlos Mariátegui" in Huamas's community, in Yungay's province, Ancash's department.	Yes to (i), and (ii), no to (iii) and no to (iv	Possibly: mining to supply global market with the lowest cost possible + poorly regulated/ enforced sector (safety and security measures) at national level	No	GPHIN, 2009[106]
2011	Ecuador	177 affected, 29 died	Methanol poisoning from contaminated alcohol beverage distributed throughout the country and possibly neighboring countries. Ecuador banned alcohol for some days after 23rd case of death	Yes to (i), and (ii). Possibility of (iii) and no to (iv)	Increasing market for alcohol beverages; low capacity for law enforcement.	Yes	PAHO, 2011[89]
2012	El Salvador	13 people affected, 2 children died	Probably pesticide poisoning after consuming contaminated or poisoned tamales in Canton Township, Coco Chalchuapa	Yes to (i), and (ii). No to (iii) and (iv)		No	ProMEDmail[103]

(To be continued)

(Continuation)

Table 3 – Chemical incidents as potential Public Health Emergencies of International Concern in Latin America and the Caribbean, 2007-2017

Year	Country	Number of people affected/ deaths	Description	IHR (2005) Annex 2 Criteria*	Global / International determinants	Recorded in the EMS Yes/ No	Ref
2012	Peru	140 people affected, 5 children	140 Peruvian farmers presented "irritative symptoms caused by the inhalation of toxins" after a large spill from a pipeline carrying copper concentrate containing arsenic and lead in the village of Santa Rosa de Cajacay, in the State of Ancash.	Yes to (i), and (ii), no to (iii) and no to (iv	YES pressure to supply global market with the lowest cost possible + poorly regulated/ enforced sector (safety and security measures) at national level	No	San Diego Union-Tribune, 2012[107]
2013	Mexico	27 people killed (10 children) and more than 30 injured	A tanker truck carrying liquefied petroleum gas lost control and ran into several cars and houses before it exploded on Federal Highway 85 in San Pedro Xalostoc community in Ecapetec de Morelos. No information on the expected increase in respiratory symptoms and other clinical signs and complains in the affected population.	Yes to (i) and possibly (ii), and No to (iii) and (iv),		No	EMDAT[102] BBC,2013[108]
2013	Cuba	88 people affected, 11 died	Methanol poisoning sold as rum and consumed.	Yes to (i), (ii), and possibility of (iii). No to (iv)	Increasing market for alcohol beverages	No	ProMEDmail,[103]

(To be continued)

(Continuation)

Table 3 – Chemical incidents as potential Public Health Emergencies of International Concern in Latin America and the Caribbean, 2007-2017

Year	Country	Number of people affected/ deaths	Description	IHR (2005) Annex 2 Criteria*	Global / International determinants	Recorded in the EMS Yes/ No	Ref
2014	Colombia	96 affected (90 children between 6 and 15 years old, and 6 adults)	Acute intoxication by Thiodan® fumigated in coffee crops close to Taparto community school in Andes municipality, southwest Antioquia Department.	Yes to (i), and (ii). No to (iii) and (iv)	Yes Agricultural policies with wide use of agrochemicals to an increasing market for Colombian coffee	No	ProMEDmail[109] Arango, 2016[110] El Colombiano, 2014[111] RAP-AL, 2014[112]
2015	Brazil	17 official deaths (other sources: 11-18)	Collapse of the Fundão/Samarco mining tailings dam, which took place in Minas Gerais in 2015. 34 million m³ of sludge with a mix of iron and other minerals was released and covered more than six hundred and sixty-three kilometers of rivers and streams that remained virtually dead after the sludge. The most widespread public health problem was the water supply for millions of people, as the Doce river, the main supply of water in the area was totally covered by the sludge 1,469 hectares of wild vegetation and crops were compromised; some towns were buried in the sludge. The mud reached other States and ended in the sea. No reports of health problems of the aftermath.	Yes to (i), (ii), and (iii), no to (iv)	Double standards for operations done by multinational companies. Increasing needs for metals from new industrialized countries, effects of globalization. l	No	Lacaz *et al*., 2017[113] Vormittag *et al*., 2017 [114]

(To be continued)

(Continuation)

Table 3 – Chemical incidents as potential Public Health Emergencies of International Concern in Latin America and the Caribbean, 2007-2017

Year	Country	Number of people affected/ deaths	Description	IHR (2005) Annex 2 Criteria*	Global / International determinants	Recorded in the EMS Yes/ No	Ref
2015	Paraguay	October 14, 2015	252 symptomatic people considered exposed to dioxins and furans through toxic fumes of a fire that took over 2 hectares of a large depot containing transformers, capacitors and other materials that containing polychlorinated biphenyls (PCBs), in Laurelty-San Lorenzo. 8732 people live in the one-kilometer area around the site, and livestock is present in some of the houses; it is not clear if their products are sold out of the area. The densely populated metropolitan area is located 11 km from the capital, Asunción.	Yes to (i), (ii), no to (iii), possibly no to (iv) *no assessment made regarding products that could be contaminated (eggs, milk and meat; but no large scale production was found in the study area)	No	No	Unidad Conjunta para el Medio Ambiente[115]

* (i) the public health impacts of the event is serious; (ii) the event is unusual or unexpected; (iii) there is a significant risk of international spread; (iv) there is a significant risk of international travel or trade restriction[1]

4.2.2 EMS

Considering only the events categorized as "chemical" hazard in the EMS, there are 26 records; from these, 20 were from Latin America and the Caribbean. Events in the categories hazards "food", "products", disasters, and "undetermined" were manually scrutinized for additional events related to chemicals. The total number of chemical events occurred in Latin America and the Caribbean reported in the EMS is 36 (2% of the total events in 10 years of the implementation of the IHR in the Americas). The results are summarized in the table 4.

Table 4 – Chemical events in the WHO EMS by hazard type and final assessment

Type of event/chemicals	Number of events	Number of substantiated events	No outbreak	Discarded	Unverifiable
Red tide	1		1		
Dichloroethane	1		1		
Pesticides	2	2			
Oil spill	10	2	5	2	1
Gas leak	2	1	1		
Mining	1		1		
Natural (meteor)	1		1		
Arsenic (water)	1		1		
Not applicable	2	1	1		
Methanol poisoning	6	4	2		
Mercury (beauty products)	2	1	1		
Drink tainted with cocaine	1	1			
Volcano eruptions (toxic gases)	5	2	3		
Acute Respiratory Syndrome (occurred in a touristic beach)	1		1		
TOTAL	**36**	**14**	**19**	**2**	**1**

4.3 Discussion

The assessment of the events using the algorithm of the IHR (2005) is dynamic, as it may change with new knowledge. Although the data collected contained information from the Region of Americas, in this Topic, only the events that occurred in LAC countries were presented. This is done because, in the region of the Americas, only LAC countries lag behind on the implementation of the capacity on chemicals in the IHR, the object of this thesis. The analysis of what is being reported here may better inform decision-making regarding policies that could be implemented to close this gap.

The list may not be exhaustive because there may be other sources at the country level that were not consulted, and might not have been captured by Google, or appeared in peer-review literature or in the database LILACS. No efforts have been made to complement information by consulting experts in the countries either. However, it is unlikely that a large chemical event that could have had a large impact on public health would not have been captured by any of the sources consulted.

The cases presented here provided enough evidence of the need to be prepared to detect and respond adequately to chemical-related public health events. The EMS, being an internal WHO site to quickly share information is useful to learn about the trends in IHR related events reported, but it cannot be used as a sole basis to assess the impact of the implementation of the IHR in the Region of the Americas. The criteria to enter the information in the EMS is clear and straight forward, and it is useful for reasons of accountability, but it does not replace any efforts needed or done by the countries to strengthen health surveillance in the context of the IHR. With all the limitations, most part of the events (61% of the events, in 2016) was received from NFP, and the rest, 39% was obtained to routine epidemic surveillance. From these, almost 40% of the events were collected by the regional office from unofficial documents and, most of them were *considered to be of potential international importance based on the additional gathering of information*. However, when NFPs were contacted to verify information and obtain further details, only 33% responded within 24h[101].

According to the last report on the matter, PAHO/WHO reports most of the events in the EMS, followed by WHO EURO[101]. Coverage could be higher than other WHO Regions because all forms of notifications, via email, message systems or telephone, or via epidemic intelligence are accepted and recorded in the EMS. However, as noted in a WHO report, not all WHO Regions systematically record events in the EMS. Furthermore, it should be noted that these events reflect those that are recorded in EMS and may not capture all events assessed by WHO.

However, of the 10 events that were considered to be of potential international importance in this review, which were found in additional information sources and presented in table 3, nine had not been recorded in the EMS. This may indicate potential difficulties in understanding the type of event that should be reported. For example, two of these events were large and plenty information was found in the media, one involving possible exposure of a large number of people to dioxins and furans, which are highly toxic chemicals, and the other a rupture of a dam and release of mining sludge, which affected a high number of people directly and indirectly. It is possible that these two events may have been interpreted as environmental disasters with no relevant international public health concern. The only event that was also recorded in the EMS was a massive intoxication by methanol, which had the potential to impact other countries.

Although the algorithm of the Annex 2 of the IHR (2005) is not very specific, the volume of notification is still low and manageable in the EMS. Chemicals events in Latin America and the Caribbean corresponded to approximately 2% from the total events recorded in the EMS in 10 years of the IHR implementation in the Americas. This probably also indicate that there is much room to improve the sensibility of the surveillance systems to capture potential events, and to improve the understanding of the definition of each of the criteria, particularly related to chemical events.

In an evaluation of the functioning of the Annex 2 across WHO-reporting State Parties, support for its use was high, and most countries had incorporated it within their national, regional and municipal surveillance systems. However, only 39% referred

having access to specific types of public health data on “chemical contamination of products or the environment”, and 32% of “other toxic releases” under the IHR. The authors also inform that respondents thought the Annex 2 was useful for assessing communicable diseases, and less helpful for discerning other types of potential PHEICs[116].

Communication may have improved since this evaluation, but as countries continue to report lower capacity on chemicals in the IHR, the problem may not have been solved yet. WHO has published a paper on the IHR (2005) and chemical events in 2015 that provides some guidance in that regard[117]. How to incorporate environmental health surveillance in the health surveillance systems at all levels remains a challenge, and this is probably the reason why capacity on chemicals in the IHR continues to be lower than average for the implementation of the IHR. This will be presented in greater details in Topics 5 and 6, and discussed in the last topic of the thesis, *Conclusion*.

4.4 Conclusion

The Region of the Americas has been increasingly reporting chemical events of potential international importance, but there is room for improvement. It may be necessary to detail the questions of Annex 2 of the IHR (2005) with more specific language related to chemicals. It should also be necessary to strengthen information systems for health by incorporating other sources that are relevant for detecting, reporting, investigating and responding to public health risks of chemical events in the context of the IHR, and maintaining ongoing training to improve health surveillance in general, and surveillance on chemicals in particular. Most of the reported events are related to major extractive industries, crude oil and mining. The second most important is related to methanol poisoning. Given the dimension those events have had in the past years, specific actions could be proposed to reduce risks and improve reporting, assessing risk and responding to these events.

5 FROM LOCAL TO GLOBAL CAPACITY FOR HEALTH SURVEILLANCE AND RESPONSE

The IHR (2005) requires countries to notify the WHO of any event that may constitute a public health emergency of international concern. At the national level, all member states are required to "detect events involving disease or death above expected levels for the particular time and place" and report essential information to the appropriate level of public health authority. This broadened scope of the IHR (2005) requires a shift from notifying based on a disease list to the paradigm of event-based notification[63]. However, independently of this broader scope of the IHR, surveillance infrastructures remain projected primarily to infectious diseases[118]. How to overcome this problem and increase awareness of all types of unusual events with potential PHEIC, including those related to chemicals, remains a major challenge.

Notification, though, is not the only means of communication with the WHO in the context of the IHR (2005). States Parties can also initiate a consultation with the WHO Focal Point, for example, even when there is not enough information to substantiate a decision about an event. Additionally, State Parties can also be required to respond to a WHO "Request for Verification", which needs to be done within 24 hours[119]. This "request" may happen, for example, when there are unofficial reports or communications received from different sources of an outbreak or of an event arising in the territory of a country that may constitute a PHEIC.

Annex 2 of the IHR (2005) is a supporting tool for the formally designated IHR NFP[120] to assess a given event and decide whether it should be reported to the WHO. This decision, though, is not necessarily done by the NFP; it may be done in collaboration with the WHO or in consultation with national experts. The algorithm presented in Annex 2 is sensitive, but not specific. It can support decision-making, but it is the capacity for informed judgment at all levels of the public health and health care systems that can strengthen surveillance for the IHR (2005).

As supporting tool, it needs to be applied according to the context in which each event occurs. To do that it is necessary to strengthen capacity for health surveillance in general, and not only to train the NFP to apply Annex 2, otherwise the information flow that is needed from frontline health care workers to public health authorities at all levels, and vice-versa, will not occur adequately. This could result in events that would not be notified, or could delay notifications or investigations when requested by the WHO and response to an event.

According to a systematic review on the matter, the most frequently identified reasons for not reporting events of concern for public health were: lack of knowledge among clinicians or frontline health care workers of the reporting process, confusion over the responsibility for reporting, and whether laboratory confirmation is required prior to reporting[121]. Although this information provided some insights into how to address the problem, the authors also reported that most of the studies considered only individual reasons, and that not many of them looked at obstacles and incentives of the systems for notification. The authors also mentioned that other reviews on the subject found that among the strategies to enhance reporting and completeness was strengthening relationships between clinicians and other key partners with strategies such as: a 24-hour toll free number for reporting; providing feedback to improve trust and understanding of how the information was used, and making clear how relevant a contribution of a single clinician can be to the whole system[121–125].

A report from a workshop on the same theme had already concluded that building sustainable disease surveillance systems would not only help with IHR compliance, but also improve pandemic preparedness and global health security[126]. This indicates that a country cannot comply with the IHR without strengthening capacity for preventing, detecting, and timely responding to any public health threats at the national level. The difficulties of doing so are much higher when the coverage of the public health system is low and access to universal care is not guaranteed, which is the case in many of the low and middle-income countries.

In principle, the availability of decentralized health care services, which are possibly the most outreaching public services available for the population, would provide the ideal condition for strengthening health surveillance. However, it should be noted that monitoring and surveillance are activities related to public health, and that in most health systems there is a separation between activities related to public health and those related to health care[127].

The objective of this topic is to challenge this type of structure, and propose the incorporation of activities and tools of public health into the primary care strategy, particularly those related to environmental health, exploring the interaction of public health and primary care. It builds on the discussion presented by others before, either to strengthen disease surveillance and improve reporting of events, or to bridge individual and public health in the community health strategy[121,127,128].

In the following sessions two incipient experiences of incorporating instruments to assess environmental health risks in different health care settings are presented as examples of the potential energy that could be liberated for the production of public goods for health with this strategy.

5.1 Public Health Security in the Fluid Borders of the Amazon region

Cross-border risks include infectious, vector-borne and non-communicable diseases, but also environmental degradation and conflicts. The WHO “Global Health Report” defined global public health security as those activities required to minimize vulnerability to acute public health events that endanger the collective health of populations living across geographical regions and international boundaries (WHO, 2007). Eight South American countries, Brazil, Bolivia, Colombia, Ecuador, Guyana, Peru, Suriname, and Venezuela share the ecosystem services of the Amazon, and there are 23 cities that share borders in the region, many times separated only by virtual barriers, a river or a cross-border police.

These twin cities at the international borders of the Amazon region have experienced rapid significant changes in their urbanization. In the last decades, the urban population in this region grew, in Brazil, from 59 to 79%[129]. Tabatinga, for example, had a population of 17,000 inhabitants in 1980, 38,000 in the year 2000, and 52,000 in 2010. Leticia, the neighboring city in Colombia, had 8,000 inhabitants in 1973, 25,000 in 1985, and an estimated population of 40,000 in 2010[130].

Large development projects involving new areas of agriculture or husbandry, building of large hydro-electrical power-plants, and an increase in the activities of the extractive industry (traditional forest-driven products, mineral mining, and petroleum), as well the construction of large highways connecting different cities are main drivers of this fast urbanization process. This pattern of urbanization and rapid migration is a trend observed in the Brazilian Amazon as a whole as well. In 1970 the population of the Amazon was composed of 63% of rural population, and in the year 2000, 69% lived in urban areas, which has caused problems not only related to disorganized urban growth, but also with regards to violence and lack of services and facilities to serve the population, particularly in mining areas and newly deforested areas[131].

In the framework of the collaboration project between the PAHO and the Amazon Cooperation Treaty Organization (ACTO) to strengthen environmental health surveillance in the Amazon Region, which was funded by the Inter-American Development Bank (IDB), the author of this thesis developed a proposal to identify the health risks related to chemicals in four bordering cities chosen by ACTO to pilot the project. The project included the development of an instrument to collect information from stakeholders working in different levels of the health system, from local to national level, with priority given to those working directly at the border areas. Following that, the project was to organize a basic training workshop on public health risk assessment of environmental risks, with focus on chemical risks in the IHR, in one of the cities, with the participation of representatives of other border cities.

The objective of the survey was to understand how risks of public health emergencies related to chemicals and to the environment in general were perceived by different stakeholders who work and live, or supervise the frontline, in one of the twin cities of the international borders of the Amazon region. The target population for the survey and for the workshop was defined as the public health managers and practitioners at the local level of four "pilot" twin cities from Brazil, Bolivia, Ecuador, and Peru that share international borders in the Amazon region, and their direct supervisors at State, Province, and National levels. See table 5, Cities sharing a border area in the Amazon Region that participated in the pilot ACTO – IDB project, for the names of the participant group of border cities. The author of this thesis executed the project on behalf of PAHO, in collaboration with the ACTO technical counterparts.

Table 5 – Border cities at the Amazon Region participating in the pilot project ACTO – IDB, 2014

Border	**Cities**
Bolivia-Brazil	Cobija – Epitaciolândia
Bolivia-Brazil	Guayera-Merin – Guajará-Mirin
Colombia-Brazil	Leticia – Tabatinga
Brazil-Peru	Assis – Iñapari

5.1.1 Risk perception and technical capacity

The first tool prepared was a survey to obtain a profile of the professionals involved in the monitoring and surveillance, and response to environmental risks in the border cities of the Amazon region (also called twin cities), and their perception about the environmental risks in the inhabited international border areas of the Amazon region. The survey questionnaire was submitted for the approval of the PAHO's ethics committee, and then sent to ACTO for the required administrative and diplomatic approval. During the month of August 2014, the survey was sent to the participant countries through the diplomatic channels of ACTO, with a correspondence indicating the target group of the project[130]. The target responders of the survey were public officers from the health or

environmental sector at all three levels of institutional organization, from local to national, working or supervising work done in the cities in the borders areas of the Amazon region.

5.1.2 Results of the stakeholders' survey

Seventeen responders from Brazil, Bolivia, Ecuador and Peru completed the survey and sent timely their questionnaires by email, as requested. Two reminder messages were sent using the formal communication systems of ACTO, but no additional responses were received.

Five of the responders lived and worked at a municipal level in one of the twin cities, four at Province or State level, and eight at national level. Fifteen of the respondents had some activity related to health surveillance, and eight with environmental surveillance, with seven doing both. The other two had a broader managerial role at national and State level. The level and type of education of the respondents had a very broad spectrum; six declared at least university level, five a master degree, two had specialization in public health, and one held a PhD.

The questionnaire had a mix of multiple choice and open questions, mostly asking about knowledge of environmental risks and procedures to prevent, detect, report and respond to them. Table 6 summarizes the responses regarding capacities that were classified by the author as relevant for the objective of this Topic of the thesis. The responses were individual, and comparison of responses between people with different background working in the same organization was not possible because of the limited number of participants from different countries. Table 7 summarizes the categories chosen by the respondents when they were presented with a list of possible environmental risks.

Table 6 – Number of responses according to knowledge level of the Institution and relevance of each of the subjects for the inhabited border areas of the Amazon Region

Subject	Knowledge level*				Relevance**				
	0	**1**	**2**	**3**	**0**	**1**	**2**	**3**	**4**
Epidemiological surveillance			10	7					17
Environmental surveillance		1	6	10				3	14
Assessment of risks to public health		1	8	7				2	14
International Health Regulations	3	1	4	9				4	13
Surveilance of intoxications	2	4	5	6				3	13
Chemical emergencies	3	1	7	6			1	3	12
Epidemiological profile	2		8	7	1			4	12
Diagnostic and treatment of intoxication	2	4	7	4			1	4	11
Environmental legislation		4	7	6			2	4	11
Toxicology	2	2	9	4	1			4	11
Surveillance of food quality and safety	5	2	6	4	1			5	11
Consumer's health	3	3	7	4	1		1	7	8
Rotterdam Convention	5	1	3	8	2		1	7	6
Estocolmo Convention	5	1	3	8	2			7	6
Minamata (Mercury) convention	5	2	1	9	2		1	5	8

Knowledge level: 3 = Advanced, 2 = Basic, 1 = Low or null, 0 = Do not know
Relevance: 4 = Very important, 3 = Reasonably important, 2 = Low importance, 1 = It is not important, 0 = Do not know.

Table 7 – Perception of public health risks from potential environmental exposures in the border cities of the Amazon region categorized by the respondents when presented with a pre-selected list, 2014

Type of Environmental Risk	Public Health Risk				
	High	**Medium**	**Low**	**No risk**	**Do not know**
1. Pesticides for agricultural use	13	1	2		1
2. Pesticides for the control of vectors of diseases such as malaria, leishmaniosis or dengue (fumigation, impregnated nets, etc.)	7	7	3		
3. Pesticides of direct application in people (used for scabies and pediculosis for example)	4	4	5	1	3
4. Mercury	13	2	1		1
5. Lead	14	1			2
6. Diesel - Oil fuel for motor (ACPM)	5	4	1		6
7. Oil (extraction)	3	5	2	2	1
8. Oil (pipelines transport by pipes)	7	3	2	1	3
9. Oil (transport by road or river)	8	5	1		2
10. Air pollution	4	7	4		2
11. Use of firewood (or coal or solid fuels) for cooking	5	8	3		1
12. Food contamination	7	7	2		1
13. Water pollution (to drink)	13	3	1		
14. Water pollution (for swimming / recreation)	6	8	2		1
15. Water pollution (fish and other foods)	10	5	1		1
16. Garbage / household solid waste	5	9	3		
17. Garbage / industrial / hospital waste	11	5	1		

(To be continued)

(Continuation)

Table 7 – Perception of public health risks from potential environmental exposures in the border cities of the Amazon region categorized by the respondents when presented with a pre-selected list, 2014

Type of Environmental Risk	Public Health				
	High	**Medium**	**Low**	**No risk**	**Do not know**
18. Fires (in the forest)	7	6	1		2
19. Fires (agricultural production,)	7	5			3
20. Mining activities	12	1	1		3
21. Extraction / production of rubber	3	5	2	1	4
22. Illicit drugs (plantations)	7	6	1	1	1
23. Illicit drugs (manufacture)	9	3	3		2
24. Illicit drugs (transport)	7	7	2		1
25. Transportation of chemical products or other dangerous cargoes by river	9	5	2	1	
26. Transport of chemical products or other dangerous cargoes by land	9	3	2		3
27. Climate change	5	7	3		2
28. Floods	11	5			1
29. Droughts	5	8	2	1	1
30. Other: explain					

When asked about the three major types of activities or chemical substances that represent the highest risks to public health in the border areas of the Amazon, the three most important activity areas mentioned were “energy”, which was related to the extraction and transportation of petroleum, and storage and transportation of its refined components; “mining” (gold and bauxite), and “agriculture”; and the three most important chemicals were agrochemicals (organophosphates and carbamates), heavy metals

(mercury and lead), and substance abuse (alcohol and cocaine). Clandestine and illegal enterprises, and the chemicals related to them were also mentioned.

Table 8 – Responses to questions related to potential chemical emergencies in the bordering cities of the Amazon Region, 2014

Questions	**Responses**
Are there guidelines for the prevention and response to accidents and chemical emergencies?	Yes =11; No = 5; Don't know = 1
In the event of an outbreak of a disease of unknown etiology in a border city, who (which institution or professional) should confirm the occurrence?	13 people answered, but the responses varied on types of people and structures.
In the event that a spill of crude oil occurs in the river that supplies water to the city on one side of the border, indicate what action should be taken, and who should take the action?	Don't know = 5 The responses on whom to notify and on actions to be taken were very dissimilar.
In case of a chemical accident near the border with another country, indicate which actions should be taken, and who should take the action	Don't know = 6 The responses on whom to notify and on actions to be taken were very dissimilar.
Are there poison centers, or toxicological information centers in your country?	YES = 15 12 responded it would be easy to contact them, but only nine knew how to find the information if necessary.

The survey confirmed that there was need for specific training and that information should be harmonized within countries and between countries, particularly in cities sharing international borders. The workshop was then organized to present the basic concepts related to public health risk assessment that could strengthen capacity for health surveillance. Training in public health risk assessment with focus on environmental risks,

and particularly on strengthening environmental surveillance and monitoring chemical risks was then implemented in Cobija, Bolivia, in September 2014.

Based on the results of the survey, the content of the workshop was adjusted to include more hours to present the IHR (2005) and discuss the concepts of "event-based surveillance".

All 29 participants of the workshop were invited to answer a pre-test questionnaire, which some of them sent the results in advance. The content of the pre-test included questions related to the IHR (2005), on chemical emergencies and chemical safety in general. The same test was applied in the last day of the 4 day workshop, and the summary of the differences shows that 25% of the responses were correct or correct and incomplete in the pre-test, and this increased to 60% in the post-test. In the same way, the themes with more wrong answers were those about the IHR (2005), and those that were not answered or were those about event-based surveillance. Although some change occurred after the workshop, it remained the most difficult topic for the participants.

Interestingly, the perception that those were themes the group should know about was quite clear, as they appeared in the priority list proposed by different stakeholders who responded the first survey, and in the suggestion to increase the time used for these issues in the evaluation of the training confirmed that perception also amongst the workers in the field. One of the most frequent comments made at the end of the workshop was how the exercises proposed during the workshop had strengthened their capacity to perceive problems in their environment, and to identify the knowledge gaps and information gaps regarding health surveillance in the border areas of the Amazon region. A proposal for continuous training and preparedness involving the discussion of better protocols for formal and informal exchange of information on public health risks between the cities of the two sides of the international borders, and agreed protocols for shared "health situation rooms" in case of an event of concern for both sides of the border[130].

5.2 Renewing the Commitment to Alma Ata through the Incorporation of Environmental Health in the Primary Health Care Strategy

Forty years after the historic WHO/UNICEF Conference on PHC in Alma Ata, former Soviet Union, this Topic looks back to the political principles of social justice and human rights that constituted the PHC strategy[132]. Far from the neutral position that distances itself from causes, interests and power struggles in the production of diseases, the Conference represented a political project that had evolved after decades of progress towards a freer and more equitable world. The strategy served to respond to the needs and dreams of large parts of the world that looked positively to the future after the decolonization and redistribution of power in the global diplomacy arena.

In this sense, the “health for all” goal was a sound unifying proposal that concentrated in one strategy all the advances of the time that had occurred in the formulation of global and national health policies. The PHC was actually seen as an empowering strategy to act on the drivers of ill health, rather than accommodating or creating resilience to them, giving choices to people, and tools to take control over their own health and well-being. It was a proposal to “conquer” health, breaking the alienation caused by the social and economic position of the individuals in society. There is much written about the conceptual framework for the strategy and its historical significance, and this Topic uses the perspective expressed in the text of the “Declaration of Alma Ata”, rather than on the later developed focus on priority programs[132–134].

There is much discussion about the reasons for the failure of the "health for all 2000" model, and about the adaptation of this model to the current context in which the globalization process is consolidated. More recently, the WHO document on the social determinants of health has recovered the discourse that was implicit in the PHC strategy, but has had a limited impact on the way health systems are organized. In general, there is a stronger tendency to organize health systems with the capacity to counterbalance the exaggerators of the political and economic system, in order to accommodate them, and not to change them for the promotion of peace and the common good, values that are at

the heart of the creation of the United Nations system and of the World Health Organization in particular, and the initial motivation for the promotion of PHC.

Revisiting the original principles of PHC as a political project to transform the reality of life and health of the population, it is proposed the incorporation of environmental health in primary care in the Americas. The effects of exposure to physical, chemical and biological risks can lead to premature death and modify the potential for healthy life throughout the course of life. Public health services produce "public goods"[135], reducing exposures that could reduce diseases[43], nevertheless it could also be a tool to improve local and sub-national capacity for surveillance, contributing to global health security.

These same principles are embedded, though less visible or explicit, in the core strategy of the WHO Framework on Integrated People-centered Health Services (IPCHS) adopted by the Member States in 2016 in the form of "commitment and empowerment" of people and of the communities. This document reiterates that person-centered care "transcends clinical consultation to also encompass the health of people in their own community and the crucial role that the population plays in shaping health policy and health services". In this framework, five interdependent strategies have been proposed: *(1) empowering and engaging people and communities; (2) strengthening governance and accountability; (3) reorienting the model of care; (4) coordinating services within and across sectors; and (5) creating an enabling environment* and their joint execution "*will help to erect more effective health services, and conversely, the lack of progress in one of these fronts could slow down the progression in the others"*[136].

In the years that followed Alma Ata, the "Declaration" was being considered more a type of an inspirational document than a guide for action[133,134]. The focus of donors in fact lead the way to a selected group of interventions and a selected set of indicators that could be measured, practically abandoning the idea of the "right to health", and focusing on reduction of those indicators. As developing countries struggled to strengthen health services and guarantee universal coverage, most of the attention has been on child and

maternal health, a window of high vulnerability represented by pregnancy and the first years of life.

The example reported here use this weakness or window of vulnerability as an opportunity to act in this period of accelerated growth, when environmental risks respond directly or indirectly to the greater burden of diseases, and often have an impact on health in the short, medium and long term. This is also a period covered by free services in all the countries of the region of the Americas, which represents the opportunity of action for health services.

In this sense, we present the historical context, the conceptual framework, and the method used in an ongoing pilot project in Bolivia. This project has incorporated work tools that facilitate the diagnosis of the situation, while it has the potential to empower health workers for the necessary inter-sectoral work, and all social actors to search for solutions.

5.3 Shouldn't we be asking why people become ill?

(Reporting a pilot experience in Bolivia of incorporating environmental health into the PHC strategy)

Bolivia is a landlocked low-income country with over 60% of its population belonging to one of the indigenous ethnic groups. The geographical and cultural diversity is at least as challenging as the organization of public services with limited resources. The country has implemented the primary care strategy with a model based on intercultural family health (SAFCI, following the acronym in Spanish, for *Salud Familiar Comunitaria Intercultural*), which serves as the cornerstone of health care nationwide based upon the principles of community participation, inter-sectorality, interculturality and integrality[137,138].

The experience summarized here is part of the lessons learned from the project "Childhood, health and the environment in primary care" (La niñez, la salud y el ambiente

en la atención primária”), funded by Canada and the PAHO/WHO. The areas “El Alto”, “Oruro” and “Desaguadero” were chosen for implementing the project in collaboration with the different areas of the Ministry of Health to represent a variety of environmental problems in the country. The project was carried out during the period of May to December 2017.

The main objective of the project was to incorporate activities and instruments for environmental risk assessment into the daily work carried out by health services in the areas selected. It was thought that the information could contribute with the necessary evidence to subsidize future interventions to reduce or eliminate identified risks. Based on the type of services made available in the whole country, it was decided that the main target population was children under five years of age. Observing the reduction of environmental risks, however, requires a time much longer than the period available for the execution of this project. Therefore, no attempt to assess the impact of the project on health or on the environment has been or will be made.

The part of the project that is related to the general objective of this thesis is on “strengthening health systems”, with specific links to the following immediate results of “increasing the capacity of health workers to respond to health challenges”, which includes the multi-hazard concept for health monitoring and surveillance. The author of this thesis designed and was the leader of the project in collaboration with other areas of PAHO/WHO, and in consultation with the Ministry of Health of Bolivia. The full report and evaluation of the project will be published later. In this Topic only the initial lessons learned that are directly related to the theme of the thesis will be presented, i.e. ideas about how to strengthen capacity to perceive and report risks in the context of PHC, and use the information for decision-making in public health at all levels.

During the preparatory visits to the areas of the project, it was noticed that the idea of exploring the environment where people live was something already incorporated into the SAFCI method. However, information was mainly used for reporting purposes, and was not incorporated as part of the arsenal available for decision making during the

clinical consultation occurred at the health center, or used by the local, regional or national managerial levels for any type of action. Home visits told more stories about diseases or cases of pregnancy, diabetes or hypertension, and much less on environmental risks that could be reduced.

Interestingly, people working in each of the areas had pre-conceived ideas of the environmental risks, being “mining-related” in Oruro, “solid waste” and “waste waters” in El Alto, and “solid waste” in Desaguadero. In theory, all areas have full coverage for water distribution, and this was not considered a priority initially. The involved professionals were very interested in the method and committed to the idea of improving health of the population in their areas.

The project design and the instruments were developed in collaboration with experts in different fields, and in consultation with all stakeholders involved, including SAFCI, child health, environmental health, local and regional managers, and representatives and leaders of the communities where the project was implemented. It was agreed that four types of instruments would be elaborated and tested in the project. Two of them under the responsibility of the health unit: one to be used in the clinical setting, the environmental history of the child, or the “green page”; and another to be incorporated in the family file during the visit of the field worker. The other two instruments would be used by health workers of the environmental health unit of the Ministry of Health and their counterparts at local and regional administrative levels, the first to assess risks at the institutions attended by the children in the geographical area covered by the health unit, and the other was an instrument to identify environmental risk factors that affect health in municipalities and other territorial units.

The project also included meetings with local authorities, the organized community members and with other government areas and other sectors to engage their leaders in the identification of major environmental risks in the community and discuss the ways to deal with those risks identified. This should be done in a participatory process and following the decision-making structures already in place in the country.

There was a very intense debate on where the final risk assessment would take place, and it was decided that the doctor should have access to the information during the consultation, as this would help with the diagnostic and suggested intervention and treatment, but that the territorial risks should be summarized and discussed in the diverse inter-sectoral and community forums already in place. It was also agreed that a sustainable information flow, with protection of patient's identity, would be further established to allow for better use of information for planning and decision-making at all levels.

The final meeting of the project occurred with the participation and support of the current Minister of Health and stakeholders from the three areas of the project, including professionals from the different units that tested the instruments and representatives of the communities and their political leaders. A particularly interesting session was presented by the mayor of Desaguadero, who in the course of the project got really involved, and confessed that he was unaware of the problems he had related to the environment. He said he had never thought before that besides nuisance odors, insects and mice, there would be a problem in not treating solid waste and solving the problem of wastewater. His municipality shares borders with Peru, and he has been keen to make an agreement to clean up the place and safeguard the environment and the health of the people. He mentioned the extremely intense traffic of people and goods in these cross-border cities.

It was also a surprise to all health workers that beyond the risks they had already thought existed, there were many others they had never realized they would be present in their areas, such as 30% or more people still involved in agricultural practices using uncontrolled pesticides that were many times stored in their own homes. The visit to schools and day care centers were also a source of great empowerment for the local authorities. A high level representative of the Ministry of Education participated in the workshop and commented on the findings presenting very concrete suggestions to solve the problems.

The data presented, the pictures and the live debate confirmed not only the need to incorporate instruments that empower frontline health care workers and the

communities with structured and useful information, but also the possibilities of real change given the enormous political pressure that this type of activity generates. In Desaguadero, there was a meeting with the indigenous community, who complained of cleaning up the mess left by visitors of their daily open market, but also suggested changes to the municipal law, which was taken by the Mayor and by the president of the city council, who also attended the final workshop of the project. A suggestion for a collaboration project in the international border area was also discussed.

During the meeting, the experience in the filling of each one of the instruments in each one of the areas of the project was presented. This was a very rich systematization process, as many of the comments and suggestions given for the incorporation of the instruments showed a clear appropriation of the project and of the evaluation process by all participants. Doctors and nurses responsible for children's health have increased their knowledge about environmental risks and their effects on health.

One of the common arguments used during their presentations was that they were "seeing" things that were previously invisible to them. One of the examples given was that they were overlooking risks such as exposure to lead, as there are people living on top of old mining sites or their dross; also to unsafe water, for instance. One of the participant family doctors mentioned that she was surprised to see how much information she had been missing that explained things such as persistent and frequent diarrheas in a child that lived in a house not served with treated water. Others mentioned the bleeding noses that was attributed solely to the dry Andean environment, and the emissions of a chemical plant close to the school and the complains people had about odor and irritation of the nose, throat and eyes, which were ignored. Additionally, a representative of the organized community asked for the investigation of excess of cancer in children in the area, which was confirmed by the representatives of the Ministry of Health.

The questions of the four instruments need to be revised to incorporate the suggestions offered by the participants, and some problems were already identified, such as questions that were not clear for the user, and the method to estimate risks that did not

differentiate types and severity of risks and needs to be harmonized among the four instruments. The territorial instruments had fewer problems in terms of clarity, but still the consistency of responses needs to be verified.

In the course of the project, a series of studies done in the intervention areas and published in the peer-review international journals were identified, which shows that some routes of exposure were already well-established for heavy metals, for example, and that it is necessary to recover the findings to produce a risk map and inform the health care unities in the affected areas. There are many studies confirming levels of contaminants in the environment[139–145]. Other studies present evidence of health effects related to environmental exposures, mainly from mining activities[146–150]. Although there may be other studies in the area, they have never been analyzed systematically, and this is the type of information that could help build the case to strengthen environmental monitoring and surveillance in the country.

The main lessons learned from the project were: there is willingness to decrease the distance between public health and individual health, and the return to the principles guiding the "Alma Ata Declaration", renewing the commitment with the idea of health for all and actions centered on the determinants of health, and not on diseases. The need to strengthen the information systems and establish sustainable information flow, combining different information sources for analysis, was already clear. Nevertheless, the project shows that the solution is possible and that, at least in the pilot areas participating in the project, there is political support for the change.

5.4 The way forward

It is not possible to eradicate poverty and its effects on health from local action alone. Yet there is a clear role for the health sector in the transformation of society by empowering people with knowledge and promoting the direct participation of citizens. This, hopefully, will also mitigate the alienation that occurs by separating individual

health from public health for both: health care workers and the people in the community where the services are located.

The activities related to public health include, among others, the capacity for "surveillance of population health", "health protection and control of diseases", and "drafting regulations, legislation and public policies that have an impact on health". These are all functions that complement the activities related to PHC of "preventive clinical practices", "early diagnosis and interventions", "case finding and notification", "raising awareness and advocating" for health[128].

In this globalized world, there is no place that is isolated enough to not influence or be influenced by others. As well presented by Laurie Garret: "*Public health needs to be - must be – global prevention. Now that would be genuine progress*."[151].

6 A PROPOSAL TO STRENGTHEN THE IMPLEMENTATION OF CORE PUBLIC HEALTH CAPACITIES ON CHEMICALS

6.1 The gap: countries' self-assessment of IHR core capacities on chemicals

The International Health Regulations (IHR (2005)) are an international instrument that is legally binding for 196 countries, including all Member States of the World Health Organization (WHO). It was adopted by the WHA *"to prevent, protect against, control and provide a public health response to international spread of disease in ways that are commensurate with and restricted to public health risks, and which avoid unnecessary interference with international traffic and trade"*[2], Though binding on national governments, the IHR (2005) relies on global norms and transparency, rather than sanctions and incentives for implementation[152]. These loose features make it difficult to measure overall progress across the 13 core capacities required by the Regulations.

Since entering into force, the adoption of the IHR (2005) has been monitored by the WHO through mandatory reporting by all Member States, and the strengthening of adoption has been measured based solely on a self-assessment tool until 2016. The tool included a checklist and a proposed indicator by capacity level according to development of core capacities for chemical event detection and response (World Health Organization, 2013). Although there are instruments to guide the process of self-assessment, there are no legal instruments that force the country to report, or to respond to inquiries regarding any existing inconsistencies in the information provided, or to enforce compliance with the regulations.

Notwithstanding these limitations, their results are available at the WHO Global Health Observatory[99]. The reports show that countries are making some progress towards acquiring the IHR (2005) core public health capacities but "the overall average scores suggest further efforts are urgently needed in the areas of human resources, capacities at points of entry, chemical events and radiation emergencies"[16]. The much lower than average capacity on chemicals, in particular, is seen throughout the yearly self-assessment

reports submitted to the WHO since 2010. The reports show that the development of the capacities on chemicals lags behind in the majority of the countries in the region of the Americas, and that there are large differences between countries[99].

It is difficult to compare the year-to-year improvements in the capacities because the countries might have used the instruments for self-assessment differently. However, the components analyzed each year are the same and include: legislation, coordination, surveillance, response, preparedness, risk communication, human resources, laboratory, points of entry, zoonosis, food safety, chemical, and radio-nuclear.

In relation to the LAC countries, Table 9 presents a chronological series of results from the self-assessment reports regarding the IHR capacity on chemicals. Numbers are a percentage of the total expected capacity for each assessed year. Table 9 also shows the classification of the countries according to their current Gross National Income (GNI) and their Human Development Index (HDI), a measure of social development. Based on the yearly reports, the differences found in the IHR capacity on chemicals in LAC countries are not solely associated with their GNI or with their HDI. Not surprisingly, many countries rank differently on these two indicators, showing that social development is related not only to income, but also to policy choices. Further, interactions between these two measures – GNI and HDI – do not predict capacity on chemicals (results not shown in Table 9). It is remarkable that some countries show great variability on the percentage of capacity, and that only one country classified as LMIC (Guatemala) reported good capacity (>70% to <80%) on chemicals in the 2015 report, and two LMIC (El Salvador and Nicaragua) reported high capacity (more than 80%) in 2016.

Table 9 – Countries' self-assessment of core IHR public health capacities on chemicals, 2012-2016, classified by income category and by their Human Development Index (HDI)

Country	2010 %	2011 %	2012 %	2013 %	2014 %	2015 %	2016 %	Classification by income (WB)	HDI (2014)
Antigua and Barbuda	50	33	62	85	85	85	69	High Income	0.783
Argentina		50	69	69	69	69	69	Upper Middle Income	0.836
Bahamas	21	8	-	-	38	54	69	High Income	*0.79*
Barbados	64	75	54	54	46	77	77	High Income	0.785
Belize	0	8	8	15	-	38	-	Upper Middle Income	0.715
Bolivia (Plurinational State of)	.	8	31	15	15	23	23	Lower Middle Income	0.662
Brazil	42	100	-.	62	85	92	100	Upper Middle Income	0.755
Canada	100	100	100	100	100	100	100	High Income	0.913
Chile		67	23	31	23	54	46	High Income	0.832
Colombia	85	42	62	77	69	77	85	Upper Middle Income	0.72
Costa Rica	71	25	38	77	77	46	38	Upper Middle Income	0.766
Cuba	-	100	100	92	85	100	92	Upper Middle Income	0.769
Dominica	14	8	31	46	31	15	15	Upper Middle Income	0.724
Dominican Republic	14	-	23	31	23	38	38	Upper Middle Income	0.715
Ecuador	28	50	38	15	54	62	31	Upper Middle Income	0.732
El Salvador	-	17	46	54	62	54	92	Lower Middle Income	0.666
Grenada	-	25	23	46	-	46	46	Upper Middle Income	0.75
Guatemala	-	67	62	100	67	77	54	Lower Middle Income	0.627
Guyana	0	75	62	62	62	62	-	Upper Middle Income	0.636
Haiti	-	17	-	0	0	38	69	Low Income	0.483
Honduras	7	0	0	31	8	38	46	Lower Middle Income	0.606
Jamaica	7	92	54	62	38	77	71	Upper Middle Income	0.719
Mexico	14	33	69	69	85	100	100	Upper Middle Income	0.756
Nicaragua	-	92	92	92	92	0	92	Lower Middle Income	0.631
Panama	-	8	54	15	15	15	15	Upper Middle Income	0.78
Paraguay	-	58	46	69	-	69	38	Upper Middle Income	0.679

(To be continued)

(Continuation)

Table 9 – Countries' self-assessment of core IHR public health capacities on chemicals, 2012-2016, classified by income category and by their Human Development Index (HDI).

Country	2010 %	2011 %	2012 %	2013 %	2014 %	2015 %	2016 %	Classification by income (WB)*	HDI (2014)
Peru	-	-	8	31	46	69	31	Upper Middle Income	0.734
Saint Kitts and Nevis	-	-	31	8	-	0		High Income	0.752
Saint Lucia	14	0	15	8.	23	23	23	Upper Middle Income	*0.729*
Saint Vincent and the Grenadines	-	-	0	8	8	0	8	Upper Middle Income	0.72
Suriname	-	33	54	62	62	62	62	Upper Middle Income	0.714
Trinidad and Tobago	35	-	46	54	62	62	62	High Income	0.772
United States of America	92	92	100	100	100	100	100	High Income	0.915
Uruguay	-	-	-	69	-	69	69	High Income	0.793
Venezuela (Bolivarian Republic of)	-	42	85	92	92	100	100	Upper Middle Income	0.762

*Notes: (a) the criteria proposed by WHO for self-assessment differs per year, following advances in the plan of implementation of the IHR; (b) the numbers presented may not be final; (c) *n.a.*=not available. Income classification: low-income economies are defined as those with a GNI per capita of $1,025 or less in 2015; lower middle-income economies are those with a GNI per capita between $1,026 and $4,035; upper middle-income economies are those with a GNI per capita between $4,036 and $12,475; high-income economies are those with a GNI per capita of $12,476 or more.
Sources: (a) Global Health Observatory of the World Health Organization; (b) Classification by income according to the World Bank Atlas, as of 1 July 2016.

In 2016, the World Health Assembly approved an IHR global implementation plan and a new IHR monitoring and evaluation framework for core capacities, which included the annual reporting, after-action review, simulation exercises, and an independent external evaluation, all based on voluntary reporting[153]. The IHR Review Committee on Second Extensions for Establishing National Public Health Capacities and on IHR Implementation (WHA 68/22 Add.1) has revised this process and suggested moving from exclusive self-evaluation to approaches that combine self-evaluation, peer-review, and voluntary external evaluations.

A technical consultation meeting held in Lyon in October 2015 suggested the development of processes and a tool to conduct JEE. This tool was developed based on the original IHR core capacities and has incorporated other multilateral and multisectorial initiatives. It maintains a matrix of indicators, with a classification (<1, 1, 2, or 3 for "foundational", outputs and outcomes, and additional achievements respectively) according to the evaluation of the core capacities. One of the sections of the tool is on chemical events and it includes more references to the work with different sectors[153]. Up to December 2017, none of the Latin America and Caribbean countries had been submitted to the JEE.

6.2 A practical guide

To guide the countries on issues related to chemical events in the IHR, a technical document published by the WHO, "International Health Regulations (2005) and chemical events", provides additional information about building capacity on chemical events, including how to identify national institutions having a role in the management of chemicals and the possible stakeholders with a role on chemical events[117]

The rationale behind all the existing tools is that all countries should have mechanisms in place to prevent, detect, and respond to chemical events. The surveillance and response capacity for chemical events are only the visible part of these capacities that

necessarily require, involve or are coordinated by the health sector. However, these capacities are highly dependent on the enabling context provided by a series of other mechanisms, frequently bound to other sectors' responsibilities and activities. This indicates the need to assess how effective multi-sector and inter-sector communication and collaboration on chemical risks occur in the country. Also, how well do national plans include clear roles of public sectors responsible for the different chemical safety aspects and of other sectors of the society dealing with chemicals? For instance in agriculture, mining and extraction activities, industries, transportation and storage, and those responsible for their final disposal.

6.3 Legislation and regulatory control for toxic chemicals

Different from previous binding WHO instruments to control the global spread of diseases, the IHR has a focus on protecting public health, and not only the security for business and for the global trade of goods. Law is a powerful and necessary tool, not only to protect against health threats that cross borders requiring international solutions, but also to guarantee national compliance with international norms and evidence-based guidelines, and to international treaties that can protect public health.

The regulation of chemicals at the national level incorporates all the legislative intent of a variety of national and international laws. Some of them are specific and define the use, fate, distribution, exposure or emission limits of chemicals, and some elaborate on their elimination or environmental liability. It is important to have at hand the main issues included in national laws and regulations, and how they are being used to prevent chemical events from occurring and, when occurring, to provide adequate response and quick recovery. Also, it is important to identify eventual gaps and propose corrections to them.

In respect to international law, article 38 of the UN's International Court of Justice (ICJ) lists three primary sources: treaties, custom, and general principles[152]. Treaties are

agreements between states and are similar to contracts, as the parts consent to be bound, and only the ones who consent are legally bound. Customary international laws are widely accepted legal obligation norms that are imposed by repeated practice by a significant number of states. They are also legally binding to the ones who accept them, and could be compelling international law in some specific cases, such as slavery trade or genocide. General principles of law are rules that are recognized in most of the world's legal systems. However, they have less significance nowadays, as the most important laws are explicit in the form of international treaties, agreements, or conventions[154].

For practical reasons, in this instrument, customary international law and general principles are not assessed because their interpretation could be controversial. The implementation of some voluntary strategies and frameworks are included in the assessment because of their broad acceptance and their emphasis on risk management that is essential for chemical events preparedness.

The international "law" or frameworks of interest for chemical safety, for which focal points, their activities and information sources that should be identified in each country are:

a) Stockholm convention
b) Rotterdam convention
c) Basel convention
d) Minamata convention on Mercury
e) Chemical Weapons Convention (CWC)
f) Globally Harmonized System of Classification and Labeling of Chemicals (GHS)
g) Strategic Approach to International Chemicals Management (SAICM)
h) Montreal protocol
i) Sendai Framework for Disaster Risk Reduction 2015-2030

For a short and practical description of the content of the conventions, see topic 2, *Chemical safety is a global public good for health* and the WHO publication "International Health Regulations (2005) and chemical events" (2015)[117].

6.4 A proposed toolkit to support the implementation of the capacity on chemicals for the IHR (2005)

This proposed toolkit complements the content of both the IHR checklists and the JEE process, and uses the elements for capacity-building suggested by the guidance WHO publication "The International Health Regulations (2005) and chemical events". Its contribution would be towards a better understanding of the practical issues behind each of the indicators of the IHR (2005) core capacities or the WHO checklists, as a guide for action at national and sub-national levels.

It is thought to be a simple matrix to help identify and respond to the needs, providing guidance on where to build and strengthen capacity. It is a tool to facilitate the constant improvement of the capacities at national and subnational level with the intention of providing a sustainable platform for health surveillance and environmental monitoring, and to promote global health security related to chemicals at all levels. The knowledge gaps would become visible, and a plan of action could be then further developed.

6.4.1 Target audiences

The target audiences include the IHR National Focal Point, public health managers and technical people working in the health surveillance processes, and focal points in all sectors responsible for any aspects of chemicals' life cycle, or involved with the prevention and detection of, and response to chemical events, including but not restricted to the national focal points for the international agreements of interest.

6.4.2 Goals of the toolkit

To assist the IHR NFPs and public health managers at all levels to identify relevant national and international institutions and stakeholders that have a role in the management of chemicals, and to provide a practical checklist of relevant information and

infrastructures that should be available for the implementation of the regulations, including possible information sources from different policies and programs that should be connected for public health surveillance and environmental health monitoring on chemicals. It might be possible that just by connecting the information available, the countries would improve the capacity on chemical events for the implementation of the IHR (2005).

The proposed tool does not replace in any way the necessary political and participatory decision-making processes in chemical safety as well. It is a tool to facilitate the conversation with the different sectors through the assessment of needs and measurement of advances, based on the public health perspective, as part of a necessarily permanent activity to achieve and attain the core capacities on chemicals under the IHR.

It is proposed that the following steps should be taken:

a) The initial checklist provides guidance on how to identify the composition of the interdisciplinary country team that should respond the questionnaire and be involved in the solutions or actions proposed at the end of the exercise. This might be different in each country. Additionally, at smaller areas other relevant stakeholders may have a role in the situation analysis. The consolidation of the information to provide an overview of risks will probably be at national or State / province levels, but the impact of small events in local areas may require the same type of planning as well.
b) This guided tool is not comprehensive. It will only provide some references to allow the responder to better identify the aspects related to their own mandates and responsibilities on chemicals events that could be relevant for public health.
c) Each of the identified parties should be contacted to complete their self-assessment exercise in the aspects that are related to their own mandates and responsibilities. It is possible that different sectors respond differently to the same questions, and if there are any contradictions, they could be addressed at the end of the exercise by the coordinator person or inter-sectoral team.

d) Following completion, the analysis of the self-assessment tool should be reviewed to deliberate and prioritize the identified needs to reach minimum capacity on chemicals at national, subnational and local levels under the IHR, and to plan for continuous development.
e) The final product would be: (a) an actionable checklist that would provide specific guidance on how to overcome the identified gaps or to strengthen aspects that were considered weak in the process. (b) the composition of the interdisciplinary country team that should provide the necessary governance on chemicals for the IHR (2005) public health capacities; they should be involved in the prevention, preparedness and response to chemical related disease outbreaks, events, and emergencies, and to measure progress on that; (c) a booklet containing all the information needed for the maintenance of adequate information flow in all phases of surveillance, preparedness, and response to chemical events under the IHR.

Based on the WHO IHR (2005) instruments, on the proposed JEE and the WHO guidance document on chemicals in the IHR, this tool was built to check and complement information on eight interconnected layers of analysis that will assess different aspects of chemical safety that can be translated into either or both aspects of risk and vulnerability to risks, and could be classified as highly relevant to the following aspects of the core capacities: “primary prevention” (P), “detection, verification and risk assessment” (D), or “preparedness and response” (R). All of them are relevant for “coordination and communication”:

a) Legislation and regulatory control for toxic chemicals. (P, R)
b) Governance on chemical safety. (P, D, R)
c) Management and control of chemicals throughout the life-cycle. (P)
d) Health surveillance systems and risk communication on chemicals. (D,R)
e) Management and control of chemical intoxications and medical countermeasures. (R)
f) Technical capacity of the health services and workforce on chemical emergencies and disease outbreaks related to chemical events. (D, R)

g) Management and control of ports of entry, import and export of chemicals. (P, D)
h) National and sub-national and local surveillance systems for early warning and disasters' risks reduction plans that include chemicals. (D, R)

Table 10 summarizes the type of information needed and the response to the checklist with the information collected for each of the components. This could be organized in a document following the same structure that would be permanently updated. If done online and if access is given to all relevant stakeholders, everyone would have access to the relevant information, either directly, or through contacting the person or institution directly responsible for the theme. As information is organized as problem-oriented and it is proposed to be easily accessible, it may encourage ongoing assessment and revision by all members of the interdisciplinary team at different levels of complexity, from national to local, connecting the available information for further analysis of the health surveillance system. It is also designed to identify the partners for support and inter-sectoral collaborative and permanent processes to identify strengths, weaknesses and knowledge gaps that could help tailor work plans and technical cooperation to those identified weaknesses and gaps.

Table 10 – Stakeholders checklist and level of implementation of chemicals in the IHR (2005).

Technical component	Suggested sectors	Levels of implementation	Checklist
Legislation and regulatory control for toxic chemicals.	Environment Health Agriculture Foreign affairs, trade and commerce Energy Mining and extractive industry Chemical and petrochemical	National State level Municipal level	Verify each component of the chemical cycle, from production and import, to waste management, to identify at which level regulations take place. Example: transport routes for dangerous chemicals may be regulated at all levels. The definition of quantity imported, produced, stored and transported that needs to be notified to the authorities may be national, etc.
Governance on chemical safety.	Environment Health Agriculture	National	Check all national and international institutions and stakeholders. A focal point to each of them should be identified.
Management and control of chemicals throughout the life cycle.	Environment Health Agriculture Energy Mining and extractive industry Chemical and petrochemical Transport, trade and commerce	National Sub-national Local	Identify institutions with legal mandates for each aspect of the chemical cycle and the contact person for each of them, from extraction and production to final disposal of waste and leftovers.
Health surveillance on chemicals and risk communication.	Health Environment	National Subnational Local	Check which institutions collect, analyses and publish information on chemicals (quantity and quality of import, export, production, use spills and accidents etc.) Identify the institution that act as first responder, and who is in charge of communicating accidents that are relevant to public health. List of people, their role, and direct contact phone numbers.

(To be continued)

(Continuation)

Table 10 – Stakeholders checklist and level of implementation of chemicals in the IHR (2005)

Technical component	Suggested sectors	Levels of implementation	Checklist
Management and control of chemical intoxications and medical countermeasures.	Health	National Sub-national Local International: bi-lateral and multi-lateral agreements for coordinated response	Identify all toxicological centers, their scope and area of influence, their accessibility (public/private, hours of operation, public phone numbers). Check information flow to report intoxications; who collects, analyses and publish information. Check if there are stocks of medical countermeasures/ orphan medicines and who is the contact point for that. In case there are no toxicology centers in the country, check if there are centers in neighboring countries that could respond to emergencies, and the legal steps to facilitate cross-border movements in case needed. Check if there is an assessment of laboratory capacity to respond to chemical emergencies (public/ private; types of analysis; quality control etc.)
Technical capacity of the health system and of the workforce on chemical emergencies and disease outbreaks.	Health	National Local	Check for official clinical guidelines for the most common types of intoxication, training, number of specialists and their location, and list of essential medicines and laboratory for first responders and care. Check for *sentinel* emergency centers or reference centers in case of chemical emergencies or possible intoxication of unidentified etiology. Check for guidelines and forms for notification of chemical intoxications and their information flow. Check for a free phone number to contact a toxicology center in case needed (Is it public? Is it available for health care workers in the frontline?)
Management and control of ports of entry, import and export of chemicals.	Foreign affairs, trade and commerce Health Agriculture Environment	National Points of Entry (POE)	Identify who checks cross-border transport of chemicals, and collects, analyses and publishes quantity and quality of chemicals in the country. Check National Focal Point for the international conventions related to chemicals and their role in the country.

(To be continued)

(Continuation)

Table 10 – Stakeholders checklist and level of implementation of chemicals in the IHR (2005)

Technical component	Suggested sectors	Levels of implementation	Checklist
National systems for early warning and disasters' risks reduction plans on chemicals	Environment Health Agriculture Mining and extractive industry Chemical and petrochemical Transport, trade and commerce	National Sub-national Local	Check if the national disaster's plan includes chemical emergencies, and who are the institutions and stakeholders participating in it. Who coordinates the action in case of emergency? A focal point should be indicated. Check if there are the same provisions done at all levels. Check if a chemical risk map is available

7 DISCUSSION

Taking into consideration that acquiring and sustaining core capacities on chemicals for the implementation of the IHR (2005) are an ongoing process, and not a fixed point in a timeline, this thesis presented a proposal to overcome the problem of low implementation of the capacity on chemicals in the IHR (2005), and to strengthen governance for public health on chemicals at global, national, subnational and local levels. The rationale for the proposal is that chemicals are a widespread risk to public health, which is widely sustained in Topics 2, 3 and 4, and that chemical safety is a global public good for health, which is reasoned in Topic 2. Topics 3 and 4 provided historical evidence of the impact that chemical events may have on public health, and how the capacity of countries to deal with crisis is crucial to defining the severity and magnitude of the effect on public health. The information also provided contextual evidence of the macro-determinants of the events, and how globalization has increased the possibility of chemical related PHEIC. Then, it is demonstrated that to acquire and sustain core capacities on chemicals for the IHR, it is necessary to involve all institutions and stakeholders with a mandate related to chemical safety at national and subnational level, and to strengthen public health surveillance at country level, which is done in Topic 4.

Next, Topic 5 discusses the need to strengthen the interaction and the capacity for both public health related activities and PHC, and that public health surveillance can only flourish in its purpose and be sustained if it is part of the national health system, and embedded in its different levels of complexity, from local to national levels. Additionally, Topic 5 shows that there is an added value of using the global IHR (2005) framework to strengthen the PHC strategy, as it offers a way to improve the capacity to identify, investigate and respond to chemical related events. It further offers a way to also mobilize the social forces needed for the changes that could become necessary to mitigate public health risks. Finally, a simple tool to facilitate the identification of information gaps and to guide intervention plans is presented in Topic 6, applying all the concepts developed in the previous topics.

There are limits to this approach, as it requires leadership at all levels of the health system, and political will to use the IHR (2005) as a framework to strengthen the countries' own systems. It also requires strong global health governance that is willing to lead the process and facilitate the links with other sectors. The biggest limitations are related to political and economic drivers and constrains, rather than on conceptual or technical shortcomings. The thesis is based on the construct of safeguarding spaces of *publicness*, as a way to guarantee access to health and resources to all, and not to a selected group of people. This could be contested if the interest is to increase the space of private goods to satisfy market pressures, for instance. It is also based on human rights and solidarity, following the principles of the Declaration of Alma Ata, which could also be an object of controversy. The constructs of *publicness*, human rights, and solidarity are not necessary, however, to demonstrate that chemical safety is a global public good for health, and to justify solidarity on the shared costs that would be involved in providing this good. For higher income nations, no less interdependent on their poorer counterparts, could be based on self-interest, rather than on any idea of reciprocity or *publicness* of the good itself. The *publicness* of the provision of the good would be guaranteed by means of the governance of the public good, as explained in Topic 2.

Surveillance is the foundation of all public health practice and its application is quite broad, from detection of epidemics, estimates of the magnitude of a problem, or detection of changes in health practice or planning public health actions, among many others[155]. It requires a "continuous, systematic collection, analysis, interpretation, and sharing of health-related data for advocacy and for planning, implementing and evaluating public health practices"[156]. There are some difficulties for health surveillance related to chemicals, but not exclusively, and that is related to the difficulties to confirm agent and exposure, what the effects may be long term, and the fact that there is hardly unique markers of exposure and identifiable specific diseases outcomes[157]. That is the reason why "event-based" surveillance may help increase the sensitivity of public health surveillance. Although not discussed in detail in this thesis, there is a growing body of literature assessing the benefits and cost-effectivity of implementing "syndromic surveillance", and

this should also be explored as possibilities to strengthen capacity for chemicals in the IHR (2005)[158–162].

In the context of the IHR (2005), the main idea of pursuing the implementation of any health surveillance system is to manage information that will help reduce avoidable risks and provide timely reliable information that will help to avoid or reduce the impact on health of any type of public health risks. Surveillance systems should necessarily be linked to action, and that is the reason why building reliable health surveillance systems that are not embodied in national universal health coverage systems presents a challenge, as such systems "*not only rely on but may also improve clinical practice"*[156].

The first guideline of the WHO on ethical issues in public health surveillance is that *"Countries have an obligation to develop appropriate, feasible, sustainable public health surveillance systems. Surveillance systems should have a clear purpose and a plan for data collection, analysis, use and dissemination based on relevant public health priorities."* Therefore, health surveillance for the implementation of the IHR (2005) cannot be disentangled from the surveillance system that is needed for the protection of public health of the country where it is implemented. It cannot serve the purpose of global health security if it is not embedded in the system that protects the population of the country and serves its public health priorities. This means that there are no general solutions, and that an intelligent system is necessary in each country, with capacity developed in each local health care facility.

As seen in previous topics of this thesis, the IHR (2005) is the latest development on surveillance system at global level to respond to the old and new risks alike that have been incremented because of the rapidly increase in connectivity between places, and the consequences of the globalization of the economy. The increase in the transboundary movement of people, live animals and goods, and the accelerated expansion of the geographic range of disease vectors, as well the transport of bulk quantities of hazardous chemicals challenged the capacity of the regulations that existed previously to protect public health and safeguard the global economy.

Environmental factors are in the scope of environmental health surveillance, hence the need to connect the relevant information sources on chemicals to provide the means of protection for public health. The importance of strengthening capacity of the health sector on chemicals was stressed in this thesis, and concrete examples were given in Topic 5. However, it is unlikely that the potential risk of a major chemical emergency will end up in the priority list for public health actions when compared to other competing priorities. Competing priorities include those on the front pages of the news media, or those that are directly related to health care shortages or even to donor-driven types of programs.

Therefore, advocacy is still needed to put the issue in perspective, and give the exact dimension of the problem, which is been frequently underestimated. Countries that developed sensitive systems to collect and analyze information related to chemical events provide a clear picture of the dimension of the problem, and help justify that preparedness for chemical events is a capacity that should be built everywhere. For example, the United States Agency for Toxic Substances and Disease Registry (ATSDR) operated a system called Hazardous Substances Emergency Events Surveillance (HSEES) during January 1991-September 2009 to collect data on hazardous chemical releases, and had 57,975 acute incidents notified in nine different States, being the majority in places that use or store more hazardous chemicals and in urbanized areas with potential for drastic public health consequences (Young, 2015). In another study on the effects of globalization, there is a very detailed analysis of 105 major industrial incidents between 1971 and 2010, and the paper concludes that the data show a consistent pattern of significantly greater fatality rates per industrial incident in developing countries. Following the analysis, the average number of fatalities per major incident in developing countries in the period 2001-2010 was 107.1 as compared to 24.0 in developed countries in the same period[163]. These numbers may reflect the double-standards in the safety strategy of large chemical corporations that was mentioned in Topic 3 of this thesis, which are well demonstrated in previous literature[163–165].

7.1 How much risk is an acceptable risk?

The concepts of "risk" and "hazard", as well as "health" vary greatly along history and amongst different social, cultural and economic contexts. Discussing the ontology of "disease" and "health", Canguilhem, in his thesis about the normal and the pathological, talks about the norm and average and I quote something that I believe applies to the discussion of risk in the present thesis: *"In short, the techniques of collective hygiene which tend to prolong human life, or the habits of negligence which result in shortening it, [depend] on the value attached to life in a given society…"* Furthermore, Canguilhem's defines health as the *"margin of the inconstancies of the environment".* Therefore, health is the capacity to react to and absorb oscillations and new events in the environment; it is not the presence of risks and hazards that characterize ill-health, as "disease" would only occur when either the capacity to deal with changes in the environment were restricted, or when the changes in the environment were beyond the capacity of response of the individuals[166].

Public health surveillance systems exist to protect public health and not necessarily to eliminate, but at least to manage risks. How much risk one accepts is a judgment of value and values are and will always be ideologically and politically defined and based "*on the value attached to life in a given society*." This could be the case for the IHR (2005), as the main purpose of the regulations are to protect public health without unjustified disturbance of trade, commerce, tourism and the global economy. The way each country wants to use the IHR (2005) will reflect the position regarding risks and regarding the value that society gives to health and to life itself. While there will always be some positive outcomes, even with minimum control of diseases, this thesis argues that tangible gains can be made by using the IHR (2005) legal framework to strengthen health system that is centered on people, and where health is a human right, as proposed by the Alma Ata Declaration[132].

Safety regulators, public health managers, technical advisors, communicators and the public they serve often have contrasting views on risk perception and the veracity of

institutional estimates of risk and harm. Conflict and distrust between these groups is often a result of a lack of public involvement in decision making on safety-related matters. It is impossible to eliminate chemical risks; it is necessary to manage the risks adequately to avoid public health emergencies and disasters. Working on good governance on chemicals for public health will deliver public goods for health, and having the support of a network of institutions and stakeholders for the governance of chemicals for public health can help guarantee trust and quick and sound response to any chemical emergencies. It can also help building governance for health, and facilitate delivering and sustaining public goods for health.

7.2 About rumor, resistance and health security issues

Following the IHR (2005), the WHO can collect information from events from different and unofficial sources. This means that there must be a structure to verify rumors in the countries, and that the public health authorities should be prepared to collect information, analyze, interpret and communicate it, not only to WHO, but also with the general public, as rumors can be a great source of distress, and conflict may even worsen the situation[167]. Unfortunately, rumors, disasters and conflict occur quite frequently together, and provisions should be made to build this capacity as well.

The number and variety of different chemicals that pose a health risk is daunting and threat scenarios include not only the deliberate releases, but also accidents or attacks on chemical manufacturing plants, storage sites or transport vehicles[168]. Incidents may also happen as a consequence of natural disasters, such as flooding, hurricanes, landslides etc. Chemical events have the potential to cause large number of casualties and to lead to health effects beyond the emergency crisis. Furthermore, in case of a mass casualty event, the number of potentially affected persons can quickly overwhelm the country's available resources. Considering that disaster prone areas are frequently places where under-served populations live and accumulate higher socioeconomic vulnerabilities for other health risks, resources to respond to emergencies are frequently inexistent or very limited.

Additionally, the capacity to quickly identify the chemical involved in the event or to assess the extent of the damage and the means to deliver proper care may be also absent. Another problem is that low coverage or poorly funded health systems cannot fulfill the core public health capacities of health surveillance, which could delay the identification of disease outbreaks with potential for international spread, or with the potential to destabilize health systems.

7.3 From Global to Local-Global

As discussed previously in the different topics of this thesis, the IHR (2005) incorporate intertwined concerns of public health, security, international trade, and could be used to promote health as a human right. It also institutes demanding obligations for state surveillance and response, and gives the WHO the authority to declare PHEIC independently of the approval of the involved Member States, being the sole authority that could declare a PHEIC.

While a positive development that could facilitate the delivery of global public goods for health, global is a special type of public domain that depend on policy choices of national governments, hence on political and economic power, and how those are translated in the country's diplomacy. Therefore, if national governments of disempowered States want to use the IHR (2005) to foster public health gains and make the planet safer, it is necessary to invest internally, empowering health systems bottom-up with comprehensive information management systems, and revitalizing public health surveillance, monitoring and planning to include the all-hazards approach at all levels.

It is also necessary to contextualize the global scenario that differs significantly since the decision to revise the IHR and since the adoption of the revised IHR (2005) by the World Health Assembly. The high mobility of goods, migrant workers and tourism, as well as the opening of countries' economies to the global market with their numerous layers of challenges and complexities were already acknowledged as potentially new risks

in the series of reports of the Globalization and Health Knowledge Network (GKN) to the WHO Commission on the Social Determinants of Health[19]. Globalization had also been described as the "quintessential upstream" of the "causes of the causes" of health inequities[21].

The deleterious effects of globalization were thus predicted and already showed significant warning signs, but the data available today provides much stronger evidence for this statement. The recently launched "World Inequality Report" shows how income inequality has increased in nearly all countries, with high concentration of income and decrease of the share of the bottom 50%[22] work force and their dependents, and for the risks of chemical incidents discussed in this thesis because of the expansion of production and distribution of goods under the effect of highly unregulated markets.

To strengthen mechanisms of governance for health, including delivery of global public goods for health, will require the engagement of the society in general and the bottom-up empowerment of the health sector to work inter-sectorally ensuring governance for health and delivering of public goods. It is evident, however, that WHO, as an entity that embodies global health governance, has a prominent and proactive leadership role to play. In this sense, the crisis of the WHO, as well described by Ventura & Perez, which has decreased public funds to respond to the global agenda and increased "ear-marked", "donor-driven" contributions, does not help the current situation very much[169]. It is of best interest of developing countries to ensure this public negotiation space at global level. It is important for developed countries to guarantee the public space and to support development for health in all countries in order to guarantee sustainable peace and security in general, and health security in particular, as argued in this thesis.

There are many ways to respond to challenges, and history has presented many to public health. Globalization will not come to a halt, and neither will the clear trend of increasing public health risks related to chemical exposure. This thesis argues that it is possible to use existing mechanisms and profit from the increased global connectivity to strengthen health systems and improve public health. Increasing *publicness* of activities

to deliver health is a way of guaranteeing the delivery of health for all, and is a way to guarantee health security for all as well. The thesis is about chemicals in the IHR (2005), but it is clear that capacity for the IHR (2005) more generally and for chemicals, in particular, must be built as a strong public health surveillance system that is part of the public health system, and links public health activities to individual health care activities. The different aspects presented in the previous topics show that this is a viable solution that could be explored.

8. CONCLUSION

Health is a universal language, a *lingua franca* that can facilitate the establishing of strong bonds that can be used to forge partnerships and collaboration with different sectors and stakeholders with the objective of strengthening capacity on chemicals for the IHR (2005). Partnerships and collaboration are necessary to deliver the core public health capacities for the IHR (2005) in general, and for chemical safety in particular, and sufficient resources need to be made available to all countries to strengthen those capacities.

Considering chemical safety as global public good for health (GPGH) provides self-interest arguments that justify larger voluntary contributions not only from private and third sector donors, but also from developed countries to fulfill this need. Furthermore, this would scale-up support for the timely delivery of the core IHR public health capacities on chemicals in all countries.

Leadership in the production of GPGH related to chemical safety must remain in the public domain. The UN Environment and all other intergovernmental and international organizations that regulate or provide technical cooperation for the extraction, production, distribution, use and elimination of chemicals should be the actors leading "global governance for health" on chemical safety. The WHO is the UN organization leading "global health governance" and needs to stay engaged with other sectors and spaces in order to promote and strengthen global governance for health and the provision of GPGH.

Similarly, it is the role of the Ministries of Health to lead the inter-sectoral work and international cooperation, the bilateral and multilateral agreements needed to acquire, strengthen and sustain the core public health capacities on chemicals for the IHR (2005) at national, sub-national and local levels. To build the necessary governance for health from the bottom-up is a necessary but not sufficient condition to forge the production of global public goods for health and strengthen global health governance. But, it is the

publicness of the decision-making process at all levels – from national to global – that would be the main guarantee of the provision of public goods for health related to chemical safety and the governance mechanism to sustain global governance for health on chemical safety.

In a globalized world, more regulations are necessary, not less, and enforcement should be the responsibility of all countries. Making international enterprises from developed countries to respond legally for their actions according to the law as prescribed in their country of origin, and not use double standards regarding chemical safety when working abroad, could also help the enforcement of chemical safety at home and abroad.

It is also necessary to acknowledge the increased vulnerability of populations already living in chronic distress caused by poverty or other social and cultural conditions by acquiring capacity to do health impact assessments of large projects involving chemicals, and capacity to perform public health risk assessment in case of chemical events.

All countries need to enforce legal processes already established in international law to inhibit greedy and criminal behaviors on behalf of the common good, and not only to protect themselves directly. This could eventually compensate the deleterious effects of globalization in areas of increased vulnerability to chemical events that are linked to poverty, ignorance, and high political and economic instability.

The Region of the Americas has been increasingly reporting chemical events of potential international importance, but the core public health capacities on chemicals in the IHR remain low. It is necessary to strengthen information systems for health by incorporating other sources that are relevant for detecting, reporting, investigating, and responding to public health risks of chemical events, and strengthen public health surveillance in general, and surveillance on chemicals in particular. Specific actions to prevent and quickly respond to the most common cause of chemical-related emergencies, such as those related to oil spills and mining activities or methanol poisoning could have high positive impact on public health.

It is not possible to eradicate poverty and its effects on health through local action alone. Though there is a clear role for the health sector in the transformation of society by empowering people with knowledge and promoting the direct participation of citizens. To unlock this powerful drive for change, it is necessary to intensify and scale-up training opportunities on all relevant issues related to chemical safety and the core IHR (2005) public health capacities on chemicals for health care workers and technical people involved in public health surveillance. This should be a permanent activity that could contribute to strengthening governance on chemical safety, and would create the conditions for the delivery of public goods for health.

The public health surveillance for the implementation of the IHR (2005) cannot be disentangled from the surveillance system that is needed for the protection of public health of the country where it is implemented. In this globalized world, there is no place that is isolated enough to not influence or be influenced by others. Strengthening information systems for environmental health monitoring and public health surveillance would improve the capacity of the health sector to accommodate to these increasingly complex needs.

It is also necessary to contextualize the global scenario that differs significantly since the decision to revise the IHR and since the adoption of the revised IHR (2005) by the World Health Assembly. Globalization will not be reversed and neither will the clear trend of increasing public health risks related to chemical exposure. Increasing *publicness* of activities to deliver health is the guarantee of delivering health for all and is the way to guarantee health security for all as well. The thesis is about chemicals in the IHR (2005), but it is clear that capacity for the IHR (2005) in general, and for chemicals in particular, must be built as a strong public health surveillance system that is part of the public health system, and links public health activities to individual health care activities.

A combination of both, local and high level polity is the only way to guarantee the full implementation of the aspirations of the IHR (2005). The privileged position of the health sector, which provides a network of far-reaching decentralized health care services,

embodies the potential to bring about real change from the community to the global level. However, to put this force in movement, polity of global health diplomacy cannot be neutrally played. It requires moving beyond the accommodation to the *status quo* and envisioning a future based on ethics, not on the economy.

Acting local will not solve global problems, but it can no longer be disentangled from acting global. The need to revisit and update national health systems to respond to this context of globalization is clear and urgent, and the IHR (2005) provides a framework that can be smartly used in the elaboration of this response. Not to protect trade and the economy, but the health of the people.

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ANNEX A – Encuesta sobre la percepción de riesgos para la salud en las áreas de fronteras entre Países de la Región Amazónica (Topic 5).

COOPERACION TECNICA INTERINSTITUCIONAL

ORGANIZACIÓN PANAMERICANA DE LA SALUD
SECRETARIA PERMANENTE DE LA ORGANIZACIÓN DEL TRATADO DE COOPERACION AMAZONICA
(OPS/OMS - SP/OTCA)

Encuesta sobre la percepción de riesgos para la salud en las áreas de fronteras entre Países de la Región Amazónica

Estimado respondiente:

La presente encuesta hace parte de las actividades de cooperación técnica entre la Organización Panamericana de la Salud (OPS/OMS) y la Secretaria Permanente de la Organización del Tratado de Cooperación Amazónica (SP/OTCA) en el proceso de implementación de las actividades del Programa de Vigilancia en Salud Ambiental para la Región Amazónica[2]. El objetivo de la encuesta es conocer la opinión de personas en los Países Miembros de la OTCA que comparten áreas de fronteras en la Región Amazónica acerca de su percepción de riesgos a la salud pública en estas mismas áreas. Esta encuesta no es una consulta formal a los países. Este es un instrumento que busca recoger información que permita facilitar la implementación de las políticas ya acordadas entre los países participantes de la OTCA.

Los profesionales invitados a responder la encuesta pueden o no estar ubicados en la zona de fronteras de la Amazonia, pero deben tener responsabilidad en cualquier aspecto en la Región (coordinación de actividades, vigilancia, acciones técnicas, toma de decisiones, etc.), o deben vivir o tener sus actividades profesionales en cualquier de los niveles de decisión o de trabajo ubicados a las áreas de frontera habitadas de la Amazonia.

Los resultados de esta encuesta contribuirán a la implementación de políticas públicas de protección a la salud en esta región, mediante propuestas que puedan hacerlas sustentables. Las encuestas son individuales y la información de contacto

[2] El Programa Sistema de Vigilancia en Salud Ambiental para la Región Amazónica es una cooperación técnica entre el Banco Interamericano de Desarrollo (BID) y los ocho Países Miembros de la OTCA (Bolivia, Brasil, Colombia, Ecuador, Guyana, Perú, Surinam y Venezuela), para establecer un sistema de vigilancia en salud ambiental armonizado a través de indicadores y estrategias consensuadas entre los países.

suministrada es para establecer contacto con usted, y no será tornada pública. Solamente será publicado el resultado de los análisis de las respuestas en su conjunto, sin que los autores de las mismas puedan ser identificados.
Agradecemos muy respetosamente su colaboración y el tiempo que usted disponga para contestar las preguntas. Le pedimos que las responda con el máximo rigor y de la forma más completa posible. Su identificación completa es la garantía de la veracidad de la procedencia, y servirá de apoyo al proceso de recolección de información.
El cuestionario está diseñado para ser contestado por una persona identificada. La información de contacto debe ser proporcionada para el control de calidad, y para facilitar el contacto con el entrevistado en caso de que cualquier información debe ser confirmada. Los datos de identificación no serán distribuidos o publicados en Internet o en cualquier documento. Sólo los resultados del análisis serán publicados, y no se identificará ninguna contribución personal. Cualquier publicación derivada de la encuesta no identificará a los participantes de forma individual. Si alguna información es sensible, la persona y la institución y el país involucrado, se consultarán formalmente antes de divulgar la información.
Le contactaremos solamente en caso hayan dudas en relación a su respuestas, y para compartir la publicación de los resultados de la encuesta, en caso que usted desee recibirlos.
Después de completar el cuestionario, por favor retornelo en la forma de un archivo en formato PDF o Word a Luis Francisco Sánchez Otero, Coordinador del programa OTCA BID Sistema de Vigilancia en Salud Ambiental para la Región Amazónica (e-mail: francisco.sanchez@otca.org.br) con copia a Agnes Soares da Silva, Asesora Regional de Epidemiologia Ambiental, OPS/OMS (e-mail: soaresag@paho.org), indicando en el asunto: encuesta sobre riesgo. Recibiremos encuestas hasta el día 10 de agosto de 2014

¡Muchas gracias por su colaboración!

IDENTIFICACIÓN

(Esta parte deberá ser respondida con su información de contacto)

31. País: _____ Fecha:____/____/_____
    (día/mes/año)
32. Nombre y apellidos:
    _____
33. Institución:_____
    _____
34. Profesión:
    _____
35. Función:
    _____
36. Ubicación:
    _____
37. Teléfono:
    _____
38. Correo electrónico:
    _____
39. Usted vive y/o trabaja en la zona de frontera de la Amazonia?

    No ___ En caso negativo, pase al cuadro de "Opción de privacidad";

    Si __, En caso positivo, complete:

    a. Por favor informe el nombre de la ciudad:
       _____
    b. ¿Su ciudad es cercana o vecina de otra ciudad en otro país?
    c. No ___; En caso negativo, pase al cuadro de "Opción de privacidad";;
    d. Si___, En caso positivo, informe el nombre de la ciudad vecina_____;
    e. Marque las opciones correctas sobre las vías de comunicación entre las dos ciudades:
       i. terrestre (seca)_____ ;
       ii. rio (fluvial)___ : por embarcación___; por puente___;

Opción de privacidad:

¿Usted acepta tener su nombre en la lista de como contribuyente en el reporte final de la encuesta? No __; Si __; ¿Usted acepta que se publique el nombre y ubicación de su institución en la lista de participantes de la encuesta? Si__; No__;

PARTE I – SOBRE SU FUNCIÓN Y/O ACTIVIDAD PROFESIONAL

40. Por favor marque cuál de estas opciones mejor describen su/s función/es:
    a. Gerente de servicios:
       Nivel nacional__; provincial_; municipal_; comunitario_;
    b. Técnico/científico:
       Nivel nacional__; provincial_; municipal_; comunitario_;
    c. Tomador de decisión:
       Nivel nacional__; provincial_; municipal_; comunitario_;
    d. Legislador:
       Nivel nacional_ ; provincial_ ; municipal_;
    e. Fiscalizador o vigilancia y control:
       Nivel nacional_ ; provincial_ ; municipal_;
    f. Gestor: Comunitario__ De proyectos:__ De ONG´s: ___
       Nivel nacional_ ; provincial_ ; municipal_;
    g. Otros: (describa)
       _____
       _____

41. Por favor marque las opciones que describen su área de actuación actual. Puede marcar más de una opción si es necesario)

Area de actuación/ trabajo	SI	NO
a. Salud:		
i. asistencia;		
ii. vigilancia;		
b. Ambiente:		
c. Economía:		
d. Transporte:		
e. Seguridad:		
f. Otros: (describa) _____		

42. Por favor marque con una **X** el nivel de formación más elevado que usted ha alcanzado.
    a. Técnico/profesional ____
    b. Universitario ____
    c. Universitario con especialización en salud pública ____
    d. Universitario con especialización en otra área de salud ____
    e. Universitario con otra especialización: (describa) _____
    f. Postgrado Maestría ____
    g. Postgrado Doctorado ____
    h. Otro: (describa) _____
    i. Sin formación técnica o profesional ____

PARTE II – SOBRE ÁREAS DE CONOCIMIENTO Y PRÁCTICA DE SU INSTITUCIÓN O SERVICIO

(La respuesta debe ser dada de acuerdo con su nivel de actuación: local, Departamental/estadual, nacional, está basada en su conocimiento personal y en su trabajo respecto a la Amazonia)

43. Por favor indique cuál es el nivel de conocimiento que usted considera corresponde a su institución en las siguientes áreas; y evalúe la importancia que cada uno de los temas tienen o podrían tener en la práctica cotidiana de trabajo en las áreas de fronteras habitadas de la Amazonia:

Temas	Nivel de conocimiento	Nivel de importancia
	3 = avanzado; 2 = básico; 1 = bajo o nulo; 0 = No sabe;	4 = Muy importante; 3 = Medianamente importante; 2= Poco importante; 1 = No es importante; 0 = No sabe;
Vigilancia epidemiológica		
Vigilancia ambiental		
Evaluación de riesgos para la salud pública		
Calidad del aire ambiente		
Calidad del aire en las viviendas		
Calidad del agua		
Residuos sólidos domésticos		

Residuos sólidos industriales		
Aguas residuales domésticas		
Aguas residuales industriales		
Emergencias químicas		
Diagnóstico y tratamiento de intoxicaciones		
Vigilancia de intoxicaciones		
Bioestadística		
Vigilancia de calidad e inocuidad de los alimentos		
Salud de los consumidores		
Legislación ambiental		
Reglamento Sanitario Internacional		
Convención de Rotterdam		
Convención de Estocolmo		
Convención de Minamata (Mercurio)		
Toxicología		
Demografía		
Perfil epidemiológico		
Diseño de estudios epidemiológicos		

PARTE III - SOBRE LA PERCEPCIÓN DE PROBLEMAS DE SALUD DE LAS CIUDADES DE FRONTERA EN LA AMAZONIA

(Nota: Si está en el nivel local, responda sobre el nivel del municipio donde vive y/o trabaja)

44. En su opinión, ¿cuáles son los principales problemas de salud pública de las áreas de fronteras de la Amazonia? Clasifíquelos en orden de importancia, y marque **SI** o **NO** si usted piensa que el problema tiene relación con el medio ambiente. Enumere un mínimo de tres (3) y máximo de diez (10).

Problema de salud en las ciudades de Frontera	¿El problema tiene relación con el ambiente?	
	SI	**NO**
1		
2		
3		

4		
5		
6		
7		
8		
9		
10		

45. Muchas veces los productos químicos ingresan a un país en forma ilegal o sin control adecuado. En su opinión, ¿cómo clasificaría el riesgo de que eso ocurra en las áreas de fronteras habitadas en la Amazonia?

    Alto ___; Medio___; Bajo___; No sabe___

46. En su opinión, ¿hay producción y/o distribución de bebidas alcohólicas cuya producción no tiene el control sanitario adecuado en las áreas de fronteras habitadas en la Amazonia (Bebidas alcohólicas adulteradas y/o de producción artesanal, en general ilegal)?

    Si___; No___; No sabe _____

47. Con base en su conocimiento y experiencia en el área de fronteras de la Amazonia, indique el tipo de riesgo (alto, medio, bajo, inexistente, no sabe) para la salud pública de cada uno de los siguientes posibles riesgos ambientales:

Tipos de riesgos ambientales	**Riesgos a la salud pública**				
	Alto	**Medio**	**Bajo**	**No hay riesgo**	**No sabe**
Plaguicidas de uso agrícola					
Plaguicidas para el control de vectores de enfermedades como malaria, leishmaniasis o dengue (fumigación; redes impregnadas, etc.)					
Plaguicidas de aplicación directa en personas (usado para escabiosis y pediculosis por ejemplo)					
Mercurio					
Plomo					

Diésel –Aceite combustible para motor (ACPM)					
Petróleo (extracción)					
Petróleo (ductos transporte por tuberías)					
Petróleo (transporte por carretera o rio)					
Contaminación del aire					
Uso de leña (o carbón o combustibles sólidos) para cocinar					
Contaminación de alimentos					
Contaminación del agua (para beber)					
Contaminación del agua (para nadar/recrearse)					
Contaminación del agua (pescado y otros alimentos)					
Basura/residuos sólidos domésticos					
Basura/ residuos industriales/ hospitalarios					
Incendios (en bosques y florestas)					
Incendios (para producción agrícola, roceo)					
Actividades de minería					
Extracción / producción de caucho					
Drogas ilícitas (plantaciones)					
Drogas ilícitas (fabricación)					
Drogas ilícitas (transporte)					
Transporte de productos químicos u otras cargas peligrosas por vía fluvial					
Transporte de productos químicos u otras cargas peligrosas por vía terrestre					
Cambio climático					
Inundaciones					
Sequías					
Otros: explique					

48. En su opinión, ¿cuáles son las actividades económicas/ productivas más importantes del área de fronteras en la Amazonía? Haga un listado en orden de prioridades y clasifique las mismas de acuerdo con el riesgo que usted cree que cada una de ellas pueden traer para la salud pública, de acuerdo con el encabezado de la tabla:

Actividad productiva/económica 0=no hay riesgo; 1=bajo riesgo; 2=medio riesgo; 3=alto riesgo; 4=no sabe;	**Riesgo para la salud pública**

1	0	1	2	3	4
2	0	1	2	3	4
3	0	1	2	3	4
4	0	1	2	3	4
5	0	1	2	3	4
6	0	1	2	3	4
7	0	1	2	3	4
8	0	1	2	3	4
9	0	1	2	3	4
10	0	1	2	3	4

49. En su opinión, ¿cuáles son las sustancias químicas o los tipos de actividades que representan riesgos más elevados para la salud pública en las áreas de fronteras de la Amazonia?
    a. _____
    b. _____
    c. _____

50. En su opinión, ¿cuáles son las personas/ grupos poblacionales más expuestos a riesgos ambientales para la salud en las áreas de fronteras de la Amazonia?
    a. _____
    b. _____
    c. _____

Parte IV - Sobre su conocimiento de capacidades existentes en su país, institución o servicio

51. En su país/ institución o servicio donde usted trabaja, hay guías para la prevención y respuesta a los accidentes y emergencia químicas?
    a. Si; __
    b. No; __
    c. No sabe.__

52. En caso que ocurra un brote de una enfermedad de causa desconocida en una ciudad de frontera, ¿quién (que institución o profesional) debe confirmar la ocurrencia? _____
    a. ¿Hay que comunicar a alguien?
    i) No____ (en caso negativo, pase a la pregunta 23);
    ii) Si ____: describa el proceso:_____

    _____
    iii) No sabe la respuesta a esta pregunta ___
53. En caso que ocurra un derrame de petróleo crudo en el río que abastece la ciudad de un lado de la frontera, indique cuál acción hay que tomar, y quien debe tomar la acción?
    a. Describa:_____
    _____
    _____
    b. No sabe ___

54. En caso haya un accidente químico próximo a la frontera con otro país, ¿indique cual las acciones hay que tomar, y quién debe tomar la acción:
    a. Describa:_____
    _____
    _____
    b. No sabe ___

55. ¿Hay centros de intoxicación, o centros de información toxicológica en su país?

    a. Si ____; No____; ¿es fácil contactarlos en caso de necesidad? Si____; No____;

    En caso positivo, por favor informe la ubicación del centro, el número de teléfono, y los horarios en que se puede contactarlos _____
    _____
    _____
    b. No ___
    c. No sabe ___

56. Con base en su experiencia personal, ¿conoce, ha registrado o ha manejado algún evento relacionado con riesgos químicos y/ o ambientales en general? (puede marcar una o más opciones)
    a. Si conoce ____; ha registrado____; ha manejado____;

b. Sustancias químicas___; Residuos sólidos___; Aguas residuales___ Agua potable___;
   Rios y/o lagunas___; Plaguicidas___; Incendios___; Inundaciones___; deslizamientos __;
   Brote de enfermedad de origen desconocida___;

Describa el (los) evento (s):
_____
_____
_____

c. No ___

57. ¿Qué recomendaciones usted tendría para mejorar la salud ambiental de las ciudades de frontera en la Amazonia?

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

Por favor, informe si desea recibir por correo electrónico copia de la(s) publicación(es) con los resultados finales de la encuesta: Si ___; No ___;

¡Muchas gracias por su colaboración!