TRW

TOXIC REMNANTS OF WAR

DISCUSSION PAPER

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# TOXIC HARM: humanitarian and environmental concerns from military-origin contamination

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# CONTENTS



ABOUT

There is growing acceptance that certain military materials and practices can cause environmental damage with the potential to affect civilian health and interfere with post-conflict recovery. While the impact of explosive remnants of war is comparatively well documented, and increasingly well managed, less attention has been focused on toxic materials released during military activities.

The Toxic Remnants of War Project was launched to consider, and quantify, the detrimental impact of these materials and activities on the environment and human health. As part of this process, the project is also reviewing gaps in existing state obligations for reducing the humanitarian and environmental harm from military-origin toxics, and examining parallel systems of protection based on environmental and human rights law and peacetime regulatory frameworks. Our website and reports are intended as a resource for policy makers, civil society and members of the public concerned with reducing the impact of conflict on communities and the environment. The project was launched in 2012 by the International Coalition to Ban Uranium Weapons (ICBUW) and IKV Pax Christi and is financed by the Royal Norwegian Ministry of Foreign Affairs.

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# EXECUTIVE SUMMARY

## INTRODUCTION

This paper introduces concerns over civilian and environmental harm stemming from the release of toxic substances during military activities, and discusses the need for action based on an assessment of the current legal and practical measures in place for environmental protection during and after conflict. In doing so it presents an argument in favour of a humanitarian-centred approach to reducing harm from Toxic Remnants of War (TRW) based on peacetime norms, and presents a framework methodology for the scientific study of military-origin contamination.

## BACKGROUND AND RATIONALE

The TRW Project focuses on weapons and military practices that release materials with incidental or unintentional toxicity. A framework to identify TRW has been developed as part of the project (outlined in Appendix 5). TRW are defined as: '*Any toxic or radiological substance resulting from military activities that forms a hazard to humans and ecosystems*'.

Dioxin contamination from Agent Orange (AO) spraying in Viet Nam is a key example of the need for a formalised mechanism to deal with conflict-related pollution. US authorities were aware that the AO was contaminated with dioxin at the time but continued to use it on the basis of the military advantage they felt that defoliation offered. Exposure to dioxin has subsequently been implicated as a cause of the birth defects documented in Vietnamese civilians, yet the problem is only now being acknowledged and is still far from resolved, more than 40 years after the initial contamination.

In light of the inherent uncertainty in studying the environmental origins of disease, a key question throughout this work is the need for an approach based on the Precautionary Principle, which necessitates preventative action in the face of uncertainty and forms the basis of many peacetime health protection norms.

## HUMANITARIAN AND PUBLIC HEALTH CONCERNS

Contemporary examples of conflict-related public health concerns with environmental associations highlight the difficulty in mapping harm and attributing causality. Reported increases in cancers and birth defects in both Iraq, and the town of Quirra (near the Polygone Interforze Salto di Quirra military facility) in southern Sardinia, were difficult to conclusively corroborate through epidemiological studies.

Speculation over similar cases of conflict-related public health problems exists elsewhere, for example in Palau, but data constraints are likely to parallel those in Iraq and Quirra. However, it remains necessary to determine the sources of such problems in order to guide both health assistance and appropriate actions to avoid future harm.

## HARM, UNCERTAINTIES AND THE ROLE OF PRECAUTION

Epidemiological studies, environmental assessment and evidence of exposure can all assist in resolving controversies regarding the environmental origins of disease. Unsurprisingly, any association with vested interests such as industrial or military activities can trigger controversy.

However, epidemiology can struggle to establish harm if the population studied is a small one; this necessitates different approaches. Limitations in determining the risks associated with exposure to chemical substances of military origin stem from a variety of factors, including, but not limited to: the complexity of assessing the toxicity of mixed exposures; the lack of complete toxicological information for many substances; and the lack of reliable exposure models for civilian populations; in addition to complications arising from chemical and physical transformations occurring to substances after their release into the environment.

In the face of uncertainty and incomplete evidence, there is scope for applying the Precautionary Principle, and using it to inform primary, secondary or tertiary harm prevention measures. However this does not negate the need to adequately study the health and environmental effects of contaminants.

## A HUMANITARIAN CENTRED APPROACH TO MILITARY-ORIGIN CONTAMINATION?

There are significant disparities between the protection from toxic chemicals afforded to residents and consumers in belligerent states, and the protection of civilians from chemical exposures during or after conflict.

A humanitarian-centred approach, underpinned by the Precautionary Principle could ensure that civilian and environmental health during conflict is better protected through four measures: improved testing of weapon components for toxicity; clearer state responsibility for measures to reduce the generation of TRW; constraints on the use of certain weapons in particular settings and more clearly defined obligations for post-conflict assistance. The adoption of such measures could help ensure that the basic human right to health is safeguarded, in a parallel to peacetime health and environmental protection standards, such as the European Union's REACH legislation and domestic regulations for the management of contaminated land.

## EXISTING ENVIRONMENTAL PROTECTION LEGAL ASPECTS

There is consensus amongst experts, including the ICRC, that legal protection for the environment during war is inadequate and needs further development. A major limitation of treaty-based International Humanitarian Law (IHL) is the high threshold of damage required for it to take effect and the fact that obligations for remediation are not covered. Customary international law is thought to have good potential to address these deficiencies.

Work remains to be done to increase our knowledge of the risks and negative environmental effects of substances in order to better inform any legal process, but many dual use substances are already defined as hazardous and controlled under peacetime regulatory frameworks.

## PRACTICAL EFFORTS AND MEASURES

As with legal protection, there are deficiencies in the practical responses following conflicts, for example in the fields of environmental protection, assessment and remediation. Where practical measures exist, they are often limited by state capacity and donor interest or the logistical difficulties posed by post-conflict environments; as such they are often conducted on an *ad hoc* basis. Research into the environmental and toxic effects of weapons rarely includes an analysis of potential civilian harm; while state obligations for remediation after conflict are unclear or wholly absent.

## CONCLUSION

The TRW Project was launched over concerns about risks to civilian and environmental health from substances used in weapons and military practices that may generate significant environmental contamination. History has demonstrated that particular materials or compounds may be deployed on the basis of perceived military need, with little knowledge of their potential impact.

Even for relatively well known substances, our understanding of the risks they pose is limited. These uncertainties should be of concern to military planners, policy makers and civil society alike. Scrutiny over the acquisition, assessment and use of particular substances is also limited, and militaries often remain outside regulatory frameworks. State practice demonstrates that legal restrictions on the targeting of industrial facilities are insufficiently robust, similarly, military environmental compliance overseas is poorly regulated, which allows the prevalence of harmful practices.

Identifying harm following the use of particular substances is fraught with difficulties and this has delayed victim assistance and remediation; even in benign settings, establishing causality is a complex task. Factors common to many post-conflict environments pose challenges to assessment and research methodologies, there is therefore a key role for precautionary thinking and values.

There is consensus that the legal standards for the protection of the environment during conflict need strengthening, this could be informed by principles found in customary IHL, environmental and human rights law. Given the broad scope of the problems, no single solution is likely, instead thought should be given to pragmatic and effective preventative and restorative measures. In a 2011 review, the ICRC proposed possible solutions for dealing with toxic materials and for clarifying state obligations for assistance.

To help resolve some of these problems, the TRW Project proposes a humanitarian-centred framing, which safeguards environmental quality and by extension civilian health. We believe that peacetime norms and values could make an important contribution to environmental justice and civilian protection in post-conflict settings.

While it may pose political and technical challenges, we believe that the developing TRW framing could offer the opportunity to resolve some of the current inadequacies in civilian protection from conflict toxics, help provide the political impetus for action and create a welcome opportunity to unite environmental protection with the emergent field of humanitarian disarmament.

# RECOMMENDATIONS


## 1. BUILD AN EVIDENCE BASE OF PROBLEMATIC SUBSTANCES AND PRACTICES:

A framework for the further study of TRW is presented in Section 5: Appendix of this paper. The framework considers practices and activities that may result in the release of substances of concern, it then proceeds to classify these substances based on their environmental and toxicological properties. Such an evidence base would help inform further study or, where necessary, stricter regulation.

## 2. BUILD CAPACITY FOR THE ASSESSMENT OF TRW:

Civilian epidemiological research could be improved through the increased characterisation of environmental contamination in conflict zones, which in turn requires increased support for affected states, international organisations and civil society to undertake monitoring and assessment.

## 3. DEVELOP NOVEL AND RIGOROUS CONFLICT EPIDEMIOLOGY:

There is a need for more novel and rigorous environmental epidemiological studies of conflict-related public health problems, in order to establish the extent of their link to military-origin contamination.

## 4. APPLY A HUMANITARIAN-CENTRED APPROACH TO TRW:

Precautionary measures form the basis of the proposed humanitarian-centred approach to TRW, which is in turn rooted in peacetime health and environmental protection standards. Primary preventative measures to reduce harm from TRW could seek to standardise assessment and encourage replacement of the most problematic substances; secondary measures could ensure the early detection and monitoring of health and environmental problems; and tertiary measures would support environmental remediation and assistance to affected communities.

## 5. USE TRW TO IMPROVE LEGAL PROTECTION FOR THE ENVIRONMENT:

Efforts to enhance legal protection for the environment through IHL are inextricably linked to protecting its civilian inhabitants. Thus a humanitarian-centred TRW framing, which synthesises elements of IHL, environmental law and human rights law, could help catalyse efforts to improve protection for the environment during and after conflict. Any such efforts should take place alongside the consideration of practical measures, such as mechanisms to fund post-conflict assessment and remediation, and a clarification of state obligations for assistance.

# 1. INTRODUCTION

The Toxic Remnants of War (TRW) Project was established to study and better understand the humanitarian and environmental impact of pollution caused by military activities, specific substances or weapons. The ultimate aim of the project is to explore state responsibility for military-origin pollution, and consider mechanisms through which civilian and environmental harm stemming from it might be reduced or prevented.

> Toxic Remnant of War: *'any toxic or radiological substance used in or resulting from military activities that forms a hazard to humans and ecosystems'.*

This discussion paper reports on the initial research conducted by the TRW Project on some of the environmental problems and associated health issues resulting from military-origin contamination. The paper is presented in three main sections. Firstly, the **background and rationale** for the TRW Project are introduced, including an analysis of **humanitarian concerns** - public health problems arising from military activities, an analysis of the **established means of studying environmental public health problems** and a suggested **humanitarian-centred approach** to military-origin pollution. Secondly, there is an outline of the **existing legal protection** for the environment in conflict, and the **work being undertaken to assess, minimise and remediate the toxic footprint of war**.

Finally a proposed **framework for an evidence-based study of toxic substances of concern** generated from military activities can be found in the Appendix. This begins with a working definition encompassing materials and substances that could be classified as TRW. The definition is followed by a discussion of military activities that are likely to result in the production of toxic remnants. The framework includes an introduction to the methodology applied by the TRW Project for the assessment and ranking of substances of environmental and health concern.

# 2. BACKGROUND AND RATIONALE

The TRW Project seeks to address with facts and evidence the environmental concerns and associated public health problems resulting from modern warfare. The work stems from the chronic public health problems often linked to environmental damage from military-origin contamination and, importantly, the lack of a proper regulatory mechanism for dealing with this environmental legacy. The TRW approach specifically excludes the use and legacy of prohibited chemical weapons of intentional toxicity. Instead it focuses on pollution from the use of conventional weapons, the targeting of industrial sites and infrastructure and general conflict pollution, as these incidental pollution and health problems are not currently regulated, as will be demonstrated below.

The use of the chemical defoliant 'Agent Orange' (AO) during the Viet Nam War is a well documented example of the negative health and environmental impacts of modern warfare. AO was known at the time to be heavily contaminated with 2,3,7,8-tetrachlorodibenzodioxin (TCDD)[1], an extremely toxic and environmentally persistent form of dioxin, which resulted in the contamination of 5 million acres of farmland and forest in South Viet Nam alone and which persists to the present day. Residents of southern and central areas of Viet Nam, where AO was sprayed, have been found to have dioxin levels as much as six times higher than their northern Vietnamese counterparts. TCDD is the most potent dioxin in terms of health effects and it is a known teratogen (i.e cause of birth defects). Exposure to TCDD is suspected to be the cause of health problems in residents of affected areas of Viet Nam, birth defects in their offspring and in the offspring of US military personnel[2].

In spite of the compelling data on TCDD's toxicity, certain factors have confounded epidemiological studies into the legacy of AO on civilians. These have included under-reporting of previous birth defects due to social stigma, population displacement, and a lack of proper health records[3]. So, it has never been possible to confirm definitively whether dioxin from AO contributed to birth

1 See Table 1 in the appendix for an overview of the toxicity of TCCD and other contaminants.

2 Allukian, M., Jr., & Atwood, P.L. (2008). The Vietnam War. In B.S. Levy & V.W. Sidel (Eds.), *War and Public Health*. Oxford, Oxford University Press.

3 Hay, A., (1982). The Chemical Scythe: Lessons of 2,4,5-T and Dioxin. New York, Plenum Press.

defects in Viet Nam[4,5].

The situation with regard to illnesses amongst US veterans of the Viet Nam War and their progeny is somewhat different. The Veterans' Association (VA), the US government body responsible for veteran welfare, recognises: *"…certain cancers and other health problems as presumptive diseases associated with exposure to Agent Orange or other herbicides during military service."* The VA also acknowledges the link to birth defects such as *spina bifida* in the children of US veterans[6]. However, the US government has not similarly acknowledged the health problems of Vietnamese civilians, so efforts to afford them the same protection as US veterans continue[7].

The US government recently agreed to fund the clean-up of the area surrounding the Da Nang air base in Viet Nam, which was heavily contaminated as a result of the storage of large quantities of AO. That remediation has been undertaken on an *ad hoc* basis only demonstrates the current lack of international mechanisms available to states affected by TRW.

There are other historical examples of chronic civilian health legacies resulting from war that prompt questions about the link between military activities and harm to the environment and human health. The examples in the next section highlight cases of suspected public health problems in conflict or military settings. Proving harm from environmental exposure to toxic substances is never a simple matter and, as such, cases often attract a great deal of speculation and controversy. The inherent scientific uncertainties associated with these complex cases raise the question of whether the Precautionary Principle should have a greater role in guiding society's response to the environmental impacts of conflict[8].

4 Ngo, A.D., Taylor, R., Roberts, C.L, & Nguyen, T.V. (2006). Association between Agent Orange and birth defects: systematic review and meta-analysis. *International Journal of Epidemiology*, 35(5), 1220-1230. DOI: 10.1093/ije/dyl038

5 Schecter, A., & Constable, J.D., (2006). Commentary: Agent Orange and birth defects in Vietnam. *International Journal of Epidemiology*, 35(5), 1230-1232. DOI: 10.1093/ije/dyl135

6 United States Department of Veterans Affairs. (2012). Benefits for Veterans' Children with Birth Defects. Retrieved November 12, 2012, from www.publichealth.va.gov/exposures/agentorange/benefits_children.asp

7 Vietnam Agent Orange Relief & Responsibility Campaign. (2012). Front Page. Retrieved November 12, 2012 from www.vn-agentorange.org/

8 The Precautionary Principle is a means of preventing harm in the face of scientific uncertainty over the impacts of certain activities. The two most cited sources of the Precautionary Principle are the 1992 Rio Earth Summit declaration and the 1998 Wingspread Statement; broadly speaking, both aim to improve environmental and health protection by urging precaution in the face of scientific uncertainty over the impacts of potentially harmful activities.

## 2.1 HUMANITARIAN AND PUBLIC HEALTH CONCERNS

As the legacy of pollution from AO demonstrates, not only does the introduction of manufactured toxic chemicals into the environment have the potential to cause serious health problems, it can also result in environmental damage persisting for decades after conflict. In light of historical experiences, it is natural to investigate the toxic legacy of military activities as a factor in the health problems associated with more recent conflicts and around military installations. Observed increases in health problems in Iraq and the Polygone Interforzo di Salto di Quirra (PISQ) testing ground in Sardinia are presented as case studies. Both cases have similarities in that the problems were highlighted by local doctors but the epidemiological evidence is currently either insufficient or inconclusive.

An important theme to note in relation to military contamination is the incompleteness of available information on munitions, substances and practices; gaps also exist in the documentation of the nature, cause and extent of environmental effects. This has led to an interesting interplay in the debate regarding the chronic public health effects of conflict. Reports on health problems in Iraq and Quirra (below), and previously in the Viet Nam War, have at times led to speculation over the facts, typically in the face of denial of a problem on the part of military authorities. It is important to note that this is not a debate about differing opinions, but rather a disagreement on the interpretation of facts regarding cause, effect and the extent of problems.

The denial of problems on the part of states may be a useful short-term strategy for a state to avoid liability, as was the case in Viet Nam. Yet morally, a humanitarian-centred approach, which seeks to determine the cause-effect relationships and thus identify and remedy or avoid problems, seems better balanced with recognised health and environmental protection norms. Pragmatically speaking, it could also be argued that an approach that seeks to identify and resolve problems at an early stage could serve to reduce long-term state liabilities.

### 2.1.1 Iraqi cancers and birth defects

Since the 1991 Gulf War, media reports and some health professionals have insisted that the prevalence of cancer and congenital birth defects and disabilities in Iraq has been increasing. As an example of this trend, a small selection of studies into these health outcomes is

overviewed.

Beyond media reports and the concerns voiced by health practitioners, epidemiological studies conducted point to the existence of a public health problem, with military-origin contamination being a suspected cause or factor. Hagopian and co-workers[9] found that between 1993 and 2007 childhood leukaemia in Basrah (southern Iraq) *'more than doubled'* suggesting that there was a problem to be addressed. However, Greiser and Hoffman[10] suggest flaws in the work of Hagopian and co-workers, criticising their population figures and the use of a hospital-based cancer registry as incomplete. Nonetheless, Hagopian and co-workers[11] maintained that more accurate population figures could have shown an even higher increase in cancer, and emphasise that based on the current evidence there is a need for further work to establish the extent of the problem and its origins.

Evidence of increased cancers and birth defects is also reported in other parts of Iraq, most notably in Fallujah, which was subject to intense bombardment and urban warfare in 2004. A study by Alaani and co-workers[12] on congenital abnormalities suggests a connection between '*war contaminants*' and the observed congenital abnormalities. Another study by Alaani and co-workers[13] which measured heavy metals in hair samples from Fallujah, asserts that the problem could be connected to the presence of low enriched uranium, suggesting that the source was weapons used in US attacks. It should be noted that this finding of enriched uranium is controversial and is challenged by unpublished work from researchers in the field who carried out similar testing of hair samples and found only evidence of natural uranium[14].

As stated earlier, the few studies cited from Iraq are far from an exhaustive list, but merely examples highlighting the uncertainties regarding the extent and causes of public health problems in Iraq in the post-war period. It is clear that while there are suspicions, the data so far are incomplete and that more work is necessary in order to fully understand the nature, cause and extent of any problems and also, to find solutions. Indeed, in 2012 the World Health Organisation (WHO) undertook a widespread study of congenital birth defects in nine Iraqi governorates[15]; the results of which are anticipated in early 2013.

Years of sanctions under the Oil for Food Programme and multiple wars have led to nutritional deficiencies and infrastructure problems which have been suggested as confounding factors in Iraq. For example folic acid deficiency during pregnancy is known to be linked to *spina bifida* and *anencephaly*. Additionally, lax environmental regulation of Iraq's oil industry could also have contributed. It is emphasised by physicians in the field of public health that observed birth defects and cancers are usually the result of multiple factors (both environmental and nutritional) and there is seldom a single cause[16].

### 2.1.2 Quirra: military toxics outside conflict

Quirra is a village of 150 residents in the south east of Sardinia. In 2001, a general practitioner in the Villaputza locality reported an increase in Non-Hodgkin's lymphoma (a type of cancer) in the locale; additionally farmers noted an increased number of animals born with birth defects. Concerned residents, the media and activist groups focused their attention on the nearby rocket and military training and testing ground Polygone Interforzo Salto di Quirra (PISQ) as the source of the problem[17].

As with the studies conducted in Basrah, the epidemiology conducted to determine the source of Quirra's observed public health problem was inconclusive and became a

9 Hagopian, A., Latfa, R., Hassan, J., Davis, S., Mirick, D., & Takaro, T., (2010). Trends in Childhood Leukemia in Basrah, Iraq, 1993-2007. *American Journal of Public Health*, 100(6), 1081-1087 DOI: 10.2105/AJPH.2009.164236

10 Greiser, E., & Hoffmann, W., (2010). Questionable Increase of Childhood Leukemia in Basrah, Iraq. *American Journal of Public Health*, 100(9), 1556-1557. DOI: 10.2105/AJPH.2010.195321

11 Hagopian, A., Latfa, R., Hassan, J., Davis, S., Mirick, D., & Takaro, T., (2010). Questionable Increase of Childhood Leukemia in Basrah, Iraq response. *American Journal of Public Health*, 100(9), 1557-1557 DOI: 10.2105/AJPH.2010.195446

12 Alaani, S., Savabieasfahani, M., Tafash, M., & Manduca, P., (2010). Four Polygamous Families with Congenital Birth Defects from Fallujah, Iraq. *International Journal of Environmental Research and Public Health*, 8(1), 89-96. DOI:10.3390/ijerph8010089

13 Alaani, S., Tafash, M., Busby, C., Hamdan, M., & Blaurock-Busch, E., (2011). Uranium and other contaminants in hair from the parents of children with congenital anomalies in Fallujah, Iraq. *Conflict and Health*, 5(15). doi:10.1186/1752-1505-5-15

14 Manduca,P. (2012). Personal communication.

15 WHO Regional Office for the Eastern Mediterranean. (2012). *Congenital birth defect study in Iraq: frequently asked questions*. Retrieved November 13, 2012 from: www.emro.who.int/irq/iraq-infocus/faq-congenital-birth-defect-study.html

16 Al-Hadithi, T.S., Al-Diwan, J.K., Saleh, A.M., & Shabila, N.P. (2012). Birth defects in Iraq and the plausibility of environmental exposure: A review. Conflict and Health, 6(3). DOI:10.1186/1752-1505-6-3

17 PISQ was established a military experimental range in 1956 and is Italy's largest such facility. It is a joint facility for the Italian army, airforce and navy and also provides services to foreign armed forces and institutions (e.g. the European Space Agency). PISQ has been used for the testing and development of aircraft, missiles and rockets (for more information see http://www.needatestrange.net/range_awti_decimomannu.html).

matter of debate. Cocco[18] states that most of the three independently commissioned studies of Quirra and other regions of Sardinia do not indicate an increase in health problems above the regional average. While one of the studies shows a 20% increase in lymphomas and leukaemia, it also states that this increase is not statistically significant. However, in a scenario mirroring the situation in Iraq, other experts in the field consider it too early to reach that conclusion: in a comment on the analysis of Cocco, Bianchi[19] notes that the results of the epidemiology are indeed not conclusive, in part because the studies were short in duration and had small sample sizes[20].

Economic sensitivities also surround the issue in Sardinia. There were fears that negative publicity would be detrimental to the export of produce and also to the thriving tourism industry in Sardinia, additionally PISQ is considered an important contributor to the local economy[21]. In 2012, the matter was subject to a judicial investigation; the state prosecutor Domenico Fiordalisi called for the exhumation of the bodies of shepherds who had died of cancers. The remains were studied and found to contain high levels of anthropogenic isotopes of thorium, which were used in the guidance system of MILAN missiles tested at PISQ. Tissue samples from local residents were also found to be contaminated with small particles of metal alloys, which could only be formed as a result of the combustion processes found during the testing activities at PISQ[22]. Based on multiple strands of evidence, in December 2012, Fiordalisi called for the trial of more than 20 military and other officials, technicians and academics on the basis that their negligence caused the public health problem.

The humanitarian situation in Iraq and the ongoing concerns over the cancer clusters in Sardinia are but two examples of where pollution related to modern warfare may be causing public health problems. There is speculation in many other areas such as Palau in the south Pacific[23] and the occupied Palestinian Territories, of links between contamination from war and public health problems. With the existence of limited evidence, the main question is how to determine the source of the problem and, if this is not conclusively possible, how to decide on the correct course of action to reduce the risk of future contamination.

## 2.2 ESTABLISHING HARM AND THE ROLE OF PRECAUTION

The limited, and at times controversial evidence available on the health problems in Iraq and Quirra means that the cause of these illnesses remains unresolved, the public health problems continue and, in the absence of a satisfactory solution or investigation, so does the controversy.

Establishing causal links between contaminants and environmental health problems is not a simple matter. Epidemiological investigation of the problem, environmental assessment and ideally, proof of exposure to suspected toxic substances can all assist in resolving the cause of environmental health problems. Often these investigations will include retrospective assessments of the concentration of suspected toxic substances in the environment, in order to establish the resulting dose to residents or workers, and whether a harmful dose is likely to have occurred[24].

Epidemiologists rely on a well established set of criteria[25] laid out by the British statistician Bradford-Hill, which should be satisfied in order to establish a causal association between an environmental contaminant and a given health outcome. The criteria are logical and some are as simple as determining whether the contamination came before the disease, the strength of association between cause and effect and whether there is a dose response relationship.

However the conditions set out in the paragraphs above cannot always account for complexities relating to conflict, some of which will be discussed below and in the subsequent section on scientific uncertainty.

18 Cocco, P., (2010). Lessons learned from the "Quirra syndrome" Epidemiology? No, thanks. *Epidemiologia & Prevenzione*, 36(1), 41-44.

19 Bianchi, F., (2010). Lessons learned from the 'Quirra syndrome': more epidemiology and prevention. *Epidemiologia & Prevenzione*, 36(1), 45-48.

20 Sample size is an important determinant of the reliability of statistical analysis. When studying an illness manifesting itself in a population, the size subset of the population of an epidemiological study allows increasing confidence to be attributed to whether the phenomenon studied is attributable to chance or related to an environmental factor. For a more detailed discussion of sample size and other factors in statistical analysis the reader is referred to http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2493004/pdf/11999_2008_Article_346.pdf

21http://www.alde.eu/event-seminar/events-details/article/military-pollution-in-non-war-zones-37914/

22 Gatti, A.M., & Montanari, S., (2009). *Nanopathology: The Health Impacts of Nanoparticles*. (Gatti, 2009). Singapore, Pan Stanford Publishing.

23 Francis, S., Alama, I., & Kershaw, L., (2011). WWII Unexploded Ordnance: A Study of UXO in Four Pacific Island Countries. Pacific Islands Forum Secretariat.

24 Ryan, P.B., (2005). Exposure Assessment, Industrial Hygiene and Environmental Management. In H. Frumkin (Ed.), *Environmental Health: From Global to Local*. San Francisco: John-Wiley and Sons.

25 Bradford-Hill, A., (1965). The Environment and Disease: Association or Causation. *Proceedings of the Royal Society of Medicine*, 58, 295-300.

Additionally, establishing causality in conflict settings is further complicated by the difficulties of performing epidemiology in unstable environments and on transient populations. Furthermore, volatile political situations mean that the study of environmental contaminants can be logistically challenging. Other confounders include limited access to information, the politicisation of contamination and difficulties in establishing pre-conflict environmental and health conditions.

Even studies undertaken in stable conditions in the US have struggled to establish causation, as is illustrated by the case of Fallon, Nevada below. Institutional deficiencies are also a concern. Box 1 discusses the US Agency for Toxic Substances and Disease Registry and problems in its work. There is potential for such institutional failings and conflicts of interest to be of even greater significance in post-conflict environments.

**BOX 1: ATSDR**

The US Agency for Toxic Substances and Disease Registry (ATSDR), which is tasked with safeguarding public health has been criticised by the US government and pressure groups for shortcomings that have resulted in unresolved public health problems. A congressional hearing in 2009[1] raised many concerns about the way ATSDR functioned. Some of these concerns were institutional flaws in the way the work was conducted.

In other cases there were conflicts of interest, such as that regarding a formaldehyde exposure incident. The US Federal Emergency Management Agency (FEMA) housed survivors of hurricanes Katrina and Rita in temporary trailers on a site that was later found to be contaminated with formaldehyde and an ATSDR study on the matter absolved FEMA of any responsibility[2].

The congressional hearing raised other concerns regarding the way ATSDR studies consistently failed to identify public health risks from industrial activities, suggesting a combination of errors and conflicts of interest. A report in the early 1990s by a US pressure group suggests that many ATSDR studies are designed in such a way as to ensure that they do not yield a conclusion regarding a public health problem. Such inconclusive studies suggest conflicts of interest and result in a consistent failure to stem public health problems[3].

1 ATSDR: Problems in the Past, Potential for the Future. 111th US Congress. 11 (2009).

2 ATSDR: Problems in the Past, Potential for the Future. 111th US Congress. 13 (2009).

3 Russel, D., Lewis, S., & Keating, B., (1992). *Inconclusive by Design: Waste, Fraud and Abuse in Federal Environmental Health Research.*

### 2.2.1 Peacetime public health problems

The complexities surrounding the study of environmental health problems related to toxic substances in the environment can be further demonstrated by cases from Woburn, Massachusetts and Fallon, Nevada in the US (see Boxes 2 and 3).

The example from Fallon is particularly relevant as the problematic contamination relates to a military manufacturing facility. The contamination at Woburn emanated from an industrial facility, but the chemical in question, trichloroethylene (TCE), is a degreaser that is also used in military applications and is a well known carcinogen.

The juxtaposition of the relatively simple case of Woburn and the more complex and inconclusive situation in Fallon demonstrates the problems to be surmounted in the investigation of public health problems from environmental contaminants.

**BOX 2: Successful proof of causality: Woburn MA, USA.**

In 1986 a cluster of childhood leukaemia and birth defects was reported in the town of Woburn Massachusetts. Epidemiologists from the Harvard School of Public Health linked the illness to the contamination of drinking water by TCE from the nearby Woburn industrial plant. The epidemiology conducted was comprehensive and, when coupled with environmental measurements of the water wells in question, researchers were able to identify the wells as the source of the problem. The case was also associated with a civil action lawsuit.

A humanitarian-centred approach to the inconclusive Fallon case, and the poorly studied cases in Iraq and Quirra, would underscore the moral imperative of finding a solution that alleviates suffering and removes the source of the problems. In the face of uncertainty and incomplete evidence, acting in accordance with the Precautionary Principle[26] would be both prudent and humane.

In the cases cited, the concerns presented by health professionals, concerned activists and the media were commonly: *'…dismissed [by authorities] as unreal or unimportant…while further information was sought'.*

26 Applying the Precautionary Principle, based on the 'Wingspread Statement' would ban an activity if there were suspicions regarding environmental and health impact, even if the science was uncertain. The burden of proof would be on the proponents of the activity. The precautionary approach on the other hand, would require research into diminishing the impacts of an activity, but allow it to proceed at the same time while taking certain precautionary actions. This is based on weighing up the cost and benefits of an activity with its environmental impacts. There are arguments for either of the two approaches or principles.

This is a common official approach to such problems, whereas the absence of evidence regarding the real cause of a problem is not necessarily evidence that a problem is absent.

**BOX 3: Complicated causality: Fallon, NV.**

The childhood cancer cluster in Fallon, Nevada, home to a plant manufacturing tungsten alloy products, raises the question of complex and inconclusive causality. An ATSDR study concluded that there was no problem, and that the cases were a statistical anomaly (despite criticisms of ATSDR methodologies that were known to be 'inconclusive by design'). Yet a later statistical analysis of the Fallon cancer cluster deemed the outcome to be unlikely to have occurred by chance[1]. A recent study[2] maintained that there were limitations in the previously used case-control epidemiological methodology, which compares lifestyle and exposure between a cohort of cancer afflicted individuals (case) and a cohort of healthy individuals in the same location (control).

The authors suggest that an alternative application of the case-control methodology be used, where the case and control are taken to be whole populations of affected areas. Using this methodology, the health and lifestyle of a large sample from the population of an affected case town is compared to an equally large sample from an unaffected control town. A wide study of ecological exposure would complement such a study and aid in the investigation.

1 Steinmaus, C., Lu, M., Todd, R.L., & Smith, A.H. (2004). Probability estimates for the unique childhood leukaemia cluster in Fallon, Nevada, and risks near other U.S. military aviation facilities. *Environmental Health Perspectives*, 112(6), 766–771.

2 Pleil, J.D., Sobus, J.R., Sheppard, P.R., Ridenour, G., & Witten, M.L., (2011). Strategies for evaluating the environment–public health interaction of long-term latency disease: The quandary of the inconclusive case–control study. *Chemico-Biological Interactions*, 196(3), 68-78. doi.:10.1016/j.cbi.2011.02.020

According to Bradford-Hill, who laid out the rules on causality in the sphere of public and environmental health, when there is uncertainty regarding the cause of a problem (or if the effects of a substance are uncertain), a precautionary approach to problems is justified. Precaution means that: *'…causal judgements must not require perfect information and must be made in the context of available information and harm prevention[27].'*

In the context of military-origin contamination, prevention of harm using precaution could focus on primary measures (i.e improved toxicity testing during weapons development, not using a certain weapon or avoiding a chemical emission), it can also be of a secondary nature (e.g. monitoring the environment and humans for signs of toxins and contaminants) or of a tertiary nature (e.g. treating affected residents and remediating contamination).

A more detailed outlining of the use of the precautionary principle with regard to weapons' use can be found in ICBUW's publication, *Precaution in Practice*[28], which seeks to apply precautionary thinking to the acceptability, or otherwise, of the use of depleted uranium in conventional weapons.

While precaution can contribute to minimising suffering and environmental harm, in order to fully prevent harm and establish responsibility for minimising and remediating contamination, it remains necessary to have adequate knowledge of the risks associated with contaminants, and any resulting environmental and health problems.

## 2.3 SCIENTIFIC UNCERTAINTIES

In addition to the aforementioned difficulties in characterising environmental impacts and undertaking epidemiological studies in conflict zones, other causes of scientific uncertainty lie both in simplified assumptions regarding the toxicology of mixtures and in the significant gaps in toxicological and environmental data for many substances.

The use of toxicology in regulation has tended to focus on the toxic effects of individual substances. Recent reviews of toxicological practice, including by the European Commission[29], suggest it is erroneous to ignore the toxic effects of mixtures of chemicals, even if the concentration of each individual substance is below established safe concentrations or doses. The evidence thus far indicates that mixtures of chemicals can induce effects in the environment, organisms and humans that exceed the combined effect of the individual chemicals. While the EC review pertained to mixtures of chemicals resulting from industrial activities in peacetime, it is expected that similar effects of mixture toxicology would be observed from conflict-related pollution.

Further to the complexities of mixture toxicology, there exist issues regarding the lack of data fully characterising

27 Tickner, J.A., (2005). Prevention. In H. Frumkin (Ed.), *Environmental Health: From Global to Local*. San Francisco: John-Wiley and Sons.

28 Weir, D. (2012). *Precaution in Practice: challenging the acceptability of depleted uranium weapons*. Retrieved from http://www.bandepleteduranium.org/en/docs/195.pdf

29 European Commission, (2009). *State of the Art on Mixture Toxicity, Final Report*.

the harmful effects of many toxic substances in humans, and an overreliance on animal data. For example, the toxicology of White Phosphorous (WP), an obscurant which according to Human Rights Watch was used unlawfully during Israel's operation Cast Lead in the Gaza Strip[30], has not been fully studied in humans[31]. This can lead to the incorrect assumption that substances are safe to use, when the truth is that the data on harm are simply not available. It is therefore notable that a recent study in the Gaza Strip associated the use of WP and other military-origin contamination with the prevalence of birth defects[32].

Changes that occur in the chemical and physical makeup of substances entering the environment should also be considered. In some cases the original material (OM) will not be harmful, but high temperature combustion or other subsequent interactions in the environment could result in harmful and persistent products. High temperatures can result in the formation of small particles of heavy metals or their oxides, as is considered briefly in Table 1. Figure 1 outlines these potential changes to a substance

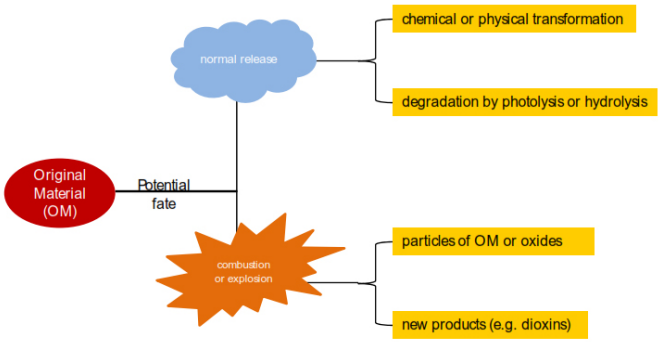



*Figure 1: Physical and chemical transformation and degradation processes that could occur to a substance released into the environment depending on its mode of release.*

entering the environment, some of which could lead to the generation of substances more toxic than the OM.

## 2.4 A HUMANITARIAN-CENTRED APPROACH TO TRW

As briefly introduced above, a humanitarian-centred approach to TRW would ensure that the welfare of civilians is paramount, both during and after conflict. In the case of military-origin contamination, such an approach could be based on several components: comprehensive testing of weapons and their constituents prior to use; state responsibility for clearance and remediation of contamination and the provision of health assistance for at risk populations; constraints on the use of certain weapons in particular scenarios or against certain classes of targets; and finally, practising precaution where there is uncertainty.

A humanitarian-centred approach has the potential to reduce the likelihood of contamination, or in the event of contamination, help prioritise the alleviation of the resultant suffering through treatment and other remedial measures. This is justified because on the timescale of human lifetimes, the environment is a finite resource and a clean environment is an *'underlying determinant of good health*[33]*'*. It therefore follows that environmental protection is vital to safeguard the basic human right to good health. Similarly, civilians do not choose to be caught up in conflict and should therefore be afforded the maximum level of protection from environmental exposures as a moral imperative.

Peacetime environmental and health protection measures set clear standards for harm prevention and have been accepted as necessary even where it places industry at a commercial disadvantage. Measures like this should also form a starting point for the regulation of military-origin contamination, particularly in the case of states with limited capacity or weak domestic regulations. Two examples of such measures are the EU regulations for the Registration, Evaluation, Authorisation and restriction of Chemicals (REACH)[34] and domestic legislation governing the management of contaminated land[35].

Three factors contributed to the emergence of the REACH system: the large number of chemical substances in the EU market that were untested for human toxicity; the evidence of exposure to such substances among consumers; and the growing body of laboratory evidence showing the potential for harm from these chemicals. REACH places the onus on manufacturers of goods to test the chemicals within them for potential harm prior to their introduction to

30 Human Rights Watch. (2009). *Rain of Fire: Israel's Unlawful Use of White Phosphorus in Gaza*. New York, USA. Retrieved from http://www.hrw.org/reports/2009/03/25/rain-fire

31 National Research Council, (1999). *Toxicity of Military Smokes and Obscurants Volume 2*. Washington, DC.

32 Naim, A ., Al Dalies, H., El Balawi, M., Salem, E., Al Meziny, K., Al Shawwa, R., Minutolo, R., & Manduca, P. (2012). Birth Defects in Gaza: Prevalence, Types, Familiarity and Correlation with Environmental Factors. International Journal of Environmental Research and Public Health, 9(5), 1732-1747. DOI: 10.3390/ijerph9051732

33 http://www.ohchr.org/Documents/Publications/Factsheet31.pdf

34 For more information on the REACH regulations visit http://ec.europa.eu/environment/chemicals/reach/reach_intro.htm

35 Contaminated land is land that contains substances that can be harmful to human and environmental heath. Such substances can be harmful through chemical toxicity or radioactivity and have potential to reach human and ecological receptors directly or through groundwater and food.

market, thus strengthening consumer protection.

Similarly, legislation for the control and remediation of contaminated land underscores the necessity of contaminated land identification and remediation. Part IIA of the UK Environment Act (EA) 1995 is one such example. The legislation stipulates that contaminated land that causes or has the potential to cause significant harm, or groundwater pollution, should be remediated[36].

It is acknowledged that internationally recognised standards on environmental quality (e.g. WHO guidelines for safe drinking water[37]) are not currently interpreted in a standard manner worldwide. Variations exist to allow for differences in local environments and other factors. Nonetheless, using such benchmarks is important in the pursuit of environmental justice for post-conflict communities, based on a combination of environmental, health and socio-economic factors.

At present, there appears to be a significant imbalance between the public health and environmental protection from contaminants afforded to the residents of those countries whose militaries may be involved in the generation of TRW, and the civilians who may be harmed by them during or after conflict. While warfare inevitably leads to environmental damage in most cases, there is scope for debate and action to reduce its public health and environmental legacy.

36 UK Environment Act. (1995). Retrieved from http://www.legislation.gov.uk/ukpga/1995/25/section/57

37 World Health Organisation. (2011). *Guidelines for Drinking Water Quality – 4th Edition*. Retrieved from http://www.who.int/entity/water_sanitation_health/publications/2011/dwq_guidelines/en/index.html

# 3. EXISTING LEGAL AND PRACTICAL MEASURES

This section introduces current practical and legal measures to protect, monitor and treat the environment from the effects of war.

While comprehensive legal protection for the environment during conflict is currently lacking, limited measures are in place. This section forms a brief review of the limited legal protection for the environment in times of conflict and also examines measures to prevent and study the toxic legacy of conflict. These measures encompass prospective assessments of potential problems from the use of certain military materials and practices, and retrospective work done in assessing the state of the environment and public health after military activities. The work described has been undertaken by a variety of states, international agencies and researchers.

## 3.1 ENVIRONMENTAL PROTECTION AND CONFLICT: LEGAL ASPECTS

It is widely accepted by experts and bodies in the field of international environmental and humanitarian law that environmental protection in times of conflict is currently inadequate and should be developed further[38,39,40]. This has helped contribute to a situation whereby the generation and subsequent lack of effective management of environmental damage and contamination from military activities has resulted in civilian harm.

In acknowledgement of the narrow coverage and perspective provided by the existing law of armed conflict, debate about the applicability of peacetime environmental law during times of conflict, in particular whether treaties and other aspects of international law pertaining to the environment apply during warfare, is ongoing[41]. More recently the TRW Project convened a workshop that sought to analyse the different branches of law that could be applied to environmental protection during conflict[42].

38 Bothe, M., Bruch, C., Diamond, J., & Jensen, D. (2010). International law protecting the environment during armed conflict: gaps and opportunities. *International Review of the Red Cross*, 92(879), 569-592.

39 United Nations Environment Programme. (2009). *Protecting the Environment During Armed Conflict: an Inventory and Analysis of International Law.*

40 Bruch, C. (2000). Existing and Emerging Wartime Standards. In J.E. Austin and C.E. Bruch (Eds.), *The Environmental Consequences of War: Legal, Economic and Scientific Perspectives.* Cambridge, Cambridge University Press.

41 United Nations. (2011). Report of the International Law Commission: Annex E. UN General Assembly, 66th session.

42 TRW Project. (2012). *Workshop Report: Exploring a Legal Framework for*

The TRW legal workshop discussed aspects of international humanitarian, human rights and environmental law that are relevant to the generation and management of TRW. Leading experts argued that legal protection for the environment in conflict should be further addressed and concretised. Furthermore, there was potential for the synthesis of different fields of existing law as a means of resolving some of the problems generated by military-origin contamination.

Historically, the field has been constrained to some extent by the high threshold of damage required before treaty-based international humanitarian law (IHL) becomes applicable (whereby damage must be *widespread, long-term and severe*) a situation complicated by the poor legal definition of each threshold. The workshop debate underscored the importance of focusing on provisions from customary international law[43]. This may be particularly important in circumstances where contamination may be locally intense and be associated with civilian harm yet still fall outside the scope of the thresholds outlined above.

Customary law provides an obligation for conflict parties to consider environmental aspects appropriately (the so called *due-regard* rule, see footnote 43), which can be derived from Additional Protocol I (API) to the Geneva Conventions; an obligation which, together with the so-called *duty of care* obligation (relating to environmental protection during armed conflict) could form the basis of a legal approach to TRW.

While elements of IHL or arms control treaty law can prohibit certain weapons, techniques or practices, in most cases they do not provide any mechanism for damage remediation or liability. A case in point is that of the 1976 treaty on Environmental Modification Techniques (ENMOD)[44]. The Chemical Weapons Convention, conversely, contains obligations on signatories for the destruction of abandoned stockpiles on territories of other state parties, as well as a structured implementation scheme under the auspices of the Organisation for the Prohibition of Chemical Weapons (OPCW).

Elsewhere, a study on strengthening protection for the environment during conflict published by the ICRC in 2011[45], argued that: '*As a result* [of environmental damage or contamination], *the civilian population no longer has safe access to resources that are indispensable to its survival. People may also suffer serious health effects. Extensive thought must therefore be given to possible mechanisms and procedures for addressing the immediate and long-term consequences of environmental damage.*' [see excerpt overleaf]

Having highlighted the potential for civilian harm from environmental contamination, the ICRC study argued for the consideration of obligations for remediation, international cooperation and victim assistance, even in cases of damage caused by lawful military activities. Perhaps predictably, given the current lack of civil society attention, there was reluctance from many states to undertake work on the environment, nevertheless the Nordic countries and the their national Red Cross societies pledged to pursue the topic[46].

At the current state of scientific knowledge, much work remains to be done on documenting the toxicity, usage, environmental behaviour and humanitarian impact of particular materials. The TRW Project believes that this research could, as part of the field of humanitarian disarmament, inform new and improved legal protection for the environment, and by extension, its human inhabitants during and after conflict. It is logical that any legal approach be guided by established principles in international environmental law (e.g. regulations governing the generation, transport and disposal of hazardous waste), domestic environmental law, and human rights law (e.g. the right to a healthy environment).

## 3.2 EXISTING PRACTICAL EFFORTS AND MEASURES

In addition to the study of the environment and human health after conflict, existing efforts and measures in environmental and health protection can be divided into two areas. Preventative measures taken prior to the use

*Toxic Remnants of War*. Retrieved from www.toxicremnantsofwar.info

43 Customary law is the body of international law that is not explicitly written, but can instead be derived from custom, and is at times derived from treaties, statements, UN resolutions etc. The ICRC has undertaken to endeavour to define customary international law relating to warfare (http://www.icrc.org/eng/assets/files/other/customary-international-humanitarian-law-i-icrc-eng.pdf) and there are specific rules pertaining to the environment. Particularly relevant is Rule 44 that states that: '*Methods and means of warfare must be employed with due regard to the protection and preservation of the natural environment,*' even if there is some scientific uncertainty on the full extent of the environmental effects.

44 Both ENMOD and Art.35 and 55 of additional protocol one to the Geneva Conventions specify that weapons or practices causing widespread, long-term and severe environmental damage are prohibited. The difference between ENMOD and API is that the provision of API is cumulative in nature using 'and' to join the conditions, whereas ENMOD is not.

45 ICRC, *Strengthening legal protection for victims of armed conflicts*, report submitted at the 31st ICRC Conference, Geneva, 2011.

46 PLEDGE P1290: Strengthening international humanitarian law. Retrieved from: http://www.icrc.org/appweb/p31e.nsf/pledge.xsp?action=openDocument&documentId=16A50358B3ED1677C1257958003CC786

## LACK OF MECHANISMS TO ADDRESS THE CONSEQUENCES OF DAMAGE TO THE ENVIRONMENT

Excerpt from International Committee of the Red Cross, *Strengthening legal protection for victims of armed conflicts*, report submitted at the 31st ICRC Conference, Geneva, 2011[1].

…damage to the environment due to armed conflicts may be extensive, largely exceeding the actual combat zone. It may also have long-term consequences that continue after the hostilities end. For instance, a considerable amount of environmental damage may emanate from chemicals and other pollutants leaking into the soil and groundwater as a result of military operations. These chemicals and pollutants can come from the destruction of power plants, chemical plants and other industrial installations but also from the rubble left by attacks against other types of military objectives. In some situations, hazardous substances have been abandoned by parties to armed conflict when leaving combat zones.

For example, in Astana, a small village in Afghanistan, land on which the inhabitants grazed livestock was polluted for years by hazardous chemicals used to fire missiles, exposing the local population to high risks[2].

As a result, the civilian population no longer has safe access to resources that are indispensable to its survival. People may also suffer serious health effects. Extensive thought must therefore be given to possible mechanisms and procedures for addressing the immediate and long-term consequences of environmental damage[3].

First of all, such mechanisms should be entitled to monitor the nature and extent of damage to the environment caused by violations of international humanitarian law, whether in international or non-international armed conflicts. They should also be empowered to investigate alleged violations of relevant international rules and to decide on the most appropriate forms of reparation in each situation. This could imply, for instance, an obligation to remove the source of harm from the affected area and to ensure decontamination.

Solutions and options in this respect should be considered within the wider framework of improving implementation of international humanitarian law and of providing reparation to victims of violations in general.

Secondly, from a strictly legal point of view, as parties to armed conflict scan be held to account for their acts only if they fail to comply with binding obligations, it would be advisable to consider whether new mechanisms should also assess the environmental damage resulting from lawful activities and how to remedy it. Such mechanisms should provide solutions in terms of victim assistance and restoration of the environment following armed conflict.

Lastly, given the complexity, for example, of repairing damaged plants and installations or cleaning up polluted soil and rubble, it would also be desirable to develop norms on international assistance and cooperation. Such norms could be developed in tandem with new mechanisms or, on the contrary, independently of them. They could apply to environmental damage caused by any military operation, whether lawful or unlawful. Such norms would open new and promising avenues for handling the environmental consequences of war.

A new system could be introduced that is based on similar rules recently created for dealing with the legacy of landmines and other explosive remnants of war[4].

1 Retrieved from: http://www.icrc.org/eng/assets/files/red-cross-crescent-movement/31st-international-conference/31-int-conference-5-1-1-report-strength-ihl-en.pdf

2 UNEP, Ground Contamination Assessment Report, Military Waste Storage Site, Astana, Afghanistan, December 2006

3 UNEP, Protecting the Environment During Armed Conflict: An Inventory and Analysis of International Law, November 2009, p. 53.

4 See Convention on the Prohibition of the Use, Stockpiling, Production and Transfer of Anti-personnel Mines and on their Destruction, 18 September 1997, Art. 6, and Protocol on Explosive Remnants of War (Protocol V to the 1980 Conventional Weapons Convention), 28 November 2003, Arts 7-8

of weapons systems in order to control and minimise the impact of conflict; and restorative measures, or those taken following an event in order to remedy and treat affected environments and communities.

### 3.2.1 Assessing and studying the impacts of war and war related activities

Work conducted in this regard has been performed by UN bodies such as the UN Environment Programme (UNEP), civil society and private firms, often with state funding. The UNEP Disaster and Conflict programme has produced extensive post-crisis environmental assessments (PCEAs) on many contemporary conflicts since 1999[47]. UNEP PCEAs aim to assess the environmental impact of emergency events, such as natural disasters and conflict and identify acute damage and courses of action for remediation.

Elsewhere, the fate of munitions dumped at sea has been the subject of an international process under the auspices of the International Dialogue on Underwater Munitions (IDUM)[48], including international conferences focused on regulatory and technical solutions.

Civil society actors have taken clear positions on the environmental ramifications of war, such as the position taken by Friends of the Earth (FoE) in opposing the 2003 Iraq war[49]. Other work assessing the impact of the 1991 Gulf War by the International Institute for Applied Systems Analysis (IIASA) found damage related to oil spills and burning amongst others[50].

Other civil society involvement has seen attention paid to the environmental impact of military bases in the US and overseas. The intense operations on bases mean that many have a large toxic footprint. In the US, the Military Toxics Project and others sought to highlight such hotspots of pollution, and ensure that affected communities received adequate redress from the US government.

On an academic level, interest in the matter is demonstrated through the variety of meetings and publications studying the environmental and ecological impacts of war[51,52]. On a practical level, attention has also been paid to legacy problems from conflict. For example in Viet Nam, Hatfield Consultants Ltd[53] performed a detailed assessment of environmental contamination and human exposure, focusing on dioxin contamination from AO spraying[54]. Hatfield found that there was a clear need for remediation as the contamination was both persistent and moving through the food chain and as such, was continuing to cause harm to Vietnamese citizens.

While dioxin contamination is a specific legacy issue that should continue to be addressed, the environmental fate of explosives is a potentially more widespread problem, which requires scientific attention. The Technical Cooperation Programme (TTCP)[55] *Energetic Materials* (EM)[56] *Environmental Fate Project* was an extensive study of the environmental fate and behaviour of explosive substances on heavily used firing ranges. The project noted that there was a tendency for certain explosives (e.g. TNT and RDX) to persist in the environment and migrate into the groundwater, depending on their solubility. The toxicity of EM is well established and one of the main recommendations was to conduct further studies to monitor transport to ecological receptors including humans. Sunahara and co-workers provide an extensive overview of the environmental fate and toxicology of explosives at heavily used firing ranges[57].

The work on the environmental fate of explosives in military facilities addresses important scientific questions. However, as it excludes contamination levels in populated post-conflict areas, such work has not reached its full potential in terms of addressing humanitarian concerns.

47 UNEP Disasters and Conflicts, retrieved from: http://www.unep.org/disastersandconflicts/

48 International Dialogue on Underwater Munitions, retrieved from: http://www.underwatermunitions.org/

49 Friends of the Earth, UK. (2003). *War in Iraq: Why Friends of The Earth is Opposed*. Retrieved October 15, 2012, from www.foe.co.uk/resource/briefings/war_iraq.pdf

50 Linden O., Jerneloev, A., & Egerup J. (2004). *The Environmental Impacts of the Gulf War 1991*. Retrieved from http://www.iiasa.ac.at/publication/more_IR-04-019.php

51 Machlis, G.E., Hanson, T., Špiriţ Z., & McKendry, J.E. (Eds.). (2009). Warfare Ecology: A New Synthesis for Peace and Security. Dordrecht, Netherlands, Springer.

52 Kassim, T.A., & Barcelo, D. (Eds.). (2009). Environmental Consequences of War and Aftermath. Heidelberg, Germany, Springer-Verlag.

53 With funding and in-kind support from Canadian and Vietnamese government agencies and the Ford Foundation.

54 Hatfield Consultants & Office of the National Committee 33, Vietnamese Ministry of Natural Resources and Environment. (2007). *Assessment of Dioxin Contamination in the Environment and Human Population in the Vicinity of Da Nang Airbase, Viet Nam. Report 3: Final Report.* Vancouver, Canada. Retrieved from http://www.hatfieldgroup.com/UserFiles/File/AgentOrangeReports/DANDI1283/DANDI1283_Final_Report.pdf

55 The Technical Cooperation Program (TTCP) is an international organisation that collaborates in defence scientific and technical information exchange, programme harmonisation and alignment, and shared research activities for Australia, Canada, New Zealand, the United Kingdom, and the United States (http://www.acq.osd.mil/ttcp/).

56 'Energetic materials' is a term used to encompass any chemical used as an explosive or propellant.

57 Sunahara, G.I., Lotufo, G., Kuperman, R.G., &, Hawari, J. (Eds.). (2009). Ecotoxicology of Explosives. Boca Raton, US, CRC Press.

While the TTCP EM environmental fate project is a good example of addressing the issue of military origin contamination, there remains limited access to specific data on weapons constituents and components. For example *Jane's Defence* rely on data aggregated from military sources, but civilian access to detailed sources, such as the US MIDAS database[58], is restricted.

It is clear that there is a slowly growing awareness of the generalised environmental and health impacts of conflict, but specific data on key questions relating to the potential for civilian harm from certain activities is missing. Notwithstanding the knowledge gaps, at times when environmental issues relating to warfare have come to light, there have been some limited efforts towards preventative controls and restorative actions to reduce its environmental impact, as outlined in the following two sections.

### 3.2.2 Minimisation and control of the toxicity of munitions

Given the concerns above regarding the toxic and environmental effects of munitions and their use, military planners, decision makers and manufacturers have undertaken limited efforts to address some matters of toxicity in weapon design. This has primarily been motivated by a need to ensure the sustainability of training and testing ranges, which may come under domestic environmental regulatory frameworks. Reducing the exposure of personnel to particular materials has also been a factor but civilian safety is rarely cited as a motivation.

Article 36 (Art.36) of Additional Protocol I (API) to the Geneva Conventions provides an important mechanism to ensure that new weapons and weapon systems brought into use do not violate IHL prohibitions, including some environmental aspects. Art.36 was intended to provide a process of review during the *'study, development, acquisition or adoption of a new weapon, means or method of warfare'*. The aim of this is that states have to be proactive about IHL restrictions during weapons development, as opposed to IHL having to be reactive once a weapon has been deployed. Art.36 reviews can encompass environmental and health problems, including, as the relevant ICRC Guide spells out, the question of the economic possibility to reverse the damage (under environment-related considerations), or alterations to the victims' psychology or physiology (under health-related considerations).

While 172 state parties have ratified AP 1, Art. 36 does have its limitations: among other things there is no formal procedural method for states to adhere to. It is the prerogative of states to decide how they will enforce it and how transparent they are about the procedure and the results of the reviews. For example, in 2011, the UK Campaign Against Depleted Uranium (CADU) found that the then Minister for the Armed Forces had misled the UK Parliament inadvertently by stating that an Art.36 review of the UK's CHARM3 DU tank ammunition had been completed when in fact it had not. An Art.36 review of the UK's CHARM3 DU ammunition system was eventually produced but only its conclusion published. The conclusion was criticised as '*flawed*' by CADU because it appeared to have ignored important findings from UNEP and the WHO and did not address the potential risk from DU's chemical toxicity[59].

Outside the Art.36 review process, it appears that concerns about the environmental effects of certain weapons could be contributing to changes in procurement policy. One such indicator was the preference in the US Department of Defence (DoD) for less toxic heavy metal alloys[60] during procurement for the F-35 Joint Strike Fighter. A main motivation for this change was because of fears that using more toxic metals – in this case nickel, beryllium or DU would be unacceptable to project partners.

Another example is the development of lead free rounds for small arms ammunition by Swedish manufacturer NAMMO. Despite environmental improvements from manufacturing lead free bullets, the work was not without its problems, such as an initial increase in zinc and copper emissions, which were later solved[61].

On a broader level, initiatives such as the Emerging Contaminants (EC) Program run by the US DoD Chemical and Material Risk Management Directorate are an example of military efforts to address environmental

58 The MIDAS database contains comprehensive information on all components and substances used in weapons systems used by the US military.

59 Campaign Against Depleted Uranium. (2012). *CADU response to latest MoD policy statement on depleted uranium*. Retrieved on January 10, 2013, from www.cadu.org.uk/cadu/cadu-response-to-latest-mod-policy-statement

60 Paper on JSF ammo U.S. Air Force Air Armament Center. 'Dual Purpose Ammunition for the F-35 Aircraft Gun System (GAU-22A) Final Requirements List', April 24, 2008. Federal Business Opportunities Solicitation Number AAC685ARSS080424. https://www.fbo.gov/utils/view?id=f934399b74944eb51de1ec687f89bba8.

61 Nammo Group. (No Date). We Have Improved Our Lead Free Ammunition. Retrieved on Nov. 15, 2012 from http://www.nammo.com/News/We-have-improved-our-lead-free-ammunition-/

problems from military materials. Established in 2005 with the aim of *'screening military materials for toxicity and environmental problems in order to safeguard mission readiness'*, the EC Program makes its primary purpose clear, which is to ensure that more stringent environmental or health protection legislation, akin to the EU's REACH legislation, does not impact on the ability of the US military to conduct wars for lack of materials or products. Setting aside the intended purpose, the programme could potentially contribute to reducing some of the environmental and chronic health impacts of war, but this remains to be seen. Nonetheless, it is a step in the right direction, particularly since it was a programme that convinced the US DoD to voluntarily consider the toxic legacy of the materials it uses.

Finally, the US military, NATO and other forces conduct their operations with some environmental guidelines in place. US DoD guidelines call for the adherence to either US or domestic environmental laws in areas of conflict, depending on which is more stringent. In reality such guidelines are rarely followed, particularly in developing countries[62]. As a result, harmful practices such as the use of controversial burn pits for waste disposal, and the dumping of hazardous waste and fuels by US bases and other military operations are common. Such practices have proven to be highly problematic, mainly for military personnel[63], but with potential to harm civilians too.

### 3.2.3 Remediation and safe demilitarisation and disposal

Aside from prospectively minimising the use and release of certain toxic and environmentally damaging materials in conflict, post-conflict remediation of contaminated environments and the safe disposal and demilitarisation of munitions is also vital.

While a legal obligation exists to restore land contaminated with explosive remnants of war under Protocol V of the Convention on Certain Conventional Weapons (CCW), there is no clear-cut legal obligation for the remediation of environmental contamination from military activities. Efforts remain *ad hoc* and are undertaken on a case by case basis. Some states have conducted limited clean-ups, such the UK's efforts to remove remnants of DU penetrators in Iraq after the 2003 war, a decision based on a claimed *moral obligation* recognised by the UK government[64]. Belligerent forces consistently argue that responsibility for decontamination lies with the administrations of affected states. However, without precise legal standards, disparities have developed in the extent to which states affected by conflict are provided with financial and technical assistance for remediation. For example, the US funded the cleanup of DU contamination on military bases in Kuwait following the 1991 Gulf War but the cleanup of DU contamination in some areas of Serbia and Montenegro was conducted by local experts with funding from the government at the time, with oversight by UNEP[65].

The lack of formalised mechanisms for remediation, and the refusal by the US to admit that there was a problem caused by AO delayed the US cleanup of the toxic legacy of dioxins in Viet Nam. Only recently has a US funded cleanup of sites around the Da Nang airfield begun. This major step that commenced in 2012 was the result of work by NGOs and environmental consultants in assessing the environment and proving without doubt the existence of a problem linked to AO spraying[54]. But this is decades late and covers only a few contaminated sites from a possible 26. As a result of the controversies cited in the background section regarding the epidemiology of AO associated birth defects, health assistance for victims is still absent.

As regards demilitarisation, the political will for action is more apparent, so more formal structures seem to exist. This increased motivation arises from the inherent risk caused by unsecured or poorly managed stockpiles of munitions, both in terms of the explosive risk - as demonstrated by the recent explosion in an arms dump in Brazzaville, DRC in March 2012, and other such accidents[66]. Furthermore, the risk of the military equipment becoming available to non-state actors or armed groups is seen as a major concern.

An additional motivation for demilitarisation operations lies in the recovery value of materials. However recovery

62 The Toxic Remnants of War Project. (2012). Defining the TRW Legal Framework: First Thoughts. Retrieved from http://www.toxicremnantsofwar.info/category/blog/

63 Institute of Medicine. (2011). Long-term health consequences of exposure to burn pits in Iraq and Afghanistan. Washington, DC: The National Academies Press.

64 McDonald, A. (2008). International and Domestic Remedies for Individuals Suffering Damage as a Result of Exposure to Depleted Uranium Weapons. In A. McDonald, J.K. Kleffner and B. Toebes (Eds.), *Depleted Uranium Weapons and International Law: A Precautionary Approach*. The Hague, Netherlands, TMC Asser Press.

65 Cullen, D., Weir, D. (2010). *A Question of Responsibility: Depleted Uranium Weapons in the Balkans*. Retrieved from http://www.bandepleteduranium.org/en/docs/134.pdf

66 Joint UNEP/OCHA Environment Unit. (2012). *UNDAC Emergency Environmental Assessment: Ammunition Depot Explosions*, Brazzaville, Congo, March 2012.

operations are at present only feasible in comparatively stable environments where the volume of munitions makes it financially viable to install recovery and processing capacity. In recent years it has become apparent to US DoD and other defence establishments that designing new munitions with safe and environmentally responsible demilitarisation in mind eases the simplifies future work, reducing the end of life costs and environmental impacts[67].

67 Programme Executive Office Ammunition. (2011). Design for Demilitarization. Retrieved Nov. 21, 2012, from https://peoammo.army.mil/PMJointServices/Divisions/PmDemilitarization/PmDemilitarizationDesignForDemil.aspx

## 4. CONCLUSION

The TRW Project was launched due to concerns over the risks to civilian and environmental health from both substances used in weapons, and particular military practices that may generate significant levels of environmental contamination. The history of weapons development, for example Agent Orange or depleted uranium, has demonstrated that particular materials or compounds may be deployed on the basis of perceived military need, with little knowledge of their potential impact.

It is readily apparent that our understanding of the risks posed by certain materials is currently limited, even for relatively well known substances such as White Phosphorous smokes. These uncertainties and data gaps should be of concern to military planners, policy makers and civil society alike; particularly where they involve commonly used substances such as explosives.

At present, scrutiny over the acquisition, assessment and use of particular substances is limited. Militaries often remain outside the regulatory frameworks in place to safeguard environmental and health protection, for example the EU's progressive REACH system contains exemptions for military materials. While parallel internal systems are in place, these lack transparency. A lack of transparency, external scrutiny, little standardisation and the influence of military need may all be contributing to the dispersal of conflict toxics that can harm civilians and ecosystems.

More broadly, past state practice demonstrates that legal restrictions on the targeting of industrial facilities are insufficiently robust, be they nuclear sites, chemical plants or oil storage depots. Similarly, military environmental compliance overseas is poorly regulated, which allows the prevalence of harmful practices such as burn pits or the uncontrolled dumping or abandonment of wastes.

This paper has shown that identifying harm following the use of particular substances is fraught with difficulties and in places, such as Viet Nam, this has delayed victim assistance and remediation. Even in relatively benign settings, establishing causality is a complex task, while factors common to many post-conflict environments pose major challenges to environmental assessment and public health research methodologies. As with peacetime public and environmental health protection, there is therefore an important role for precautionary thinking and values in

any approach on the issue.

There is a striking consensus among experts that an update of the legal standards for the protection of the environment during conflict is long overdue. Research by the TRW Project has suggested that any such update could be informed by principles found in customary IHL, environmental and human rights law. Given the broad scope of the topic, no single solution is likely, instead serious thought should be given to pragmatic and effective measures, including preventative actions to reduce the release of toxic substances, and restorative actions that limit post-conflict environmental and civilian harm.

The assessment and remediation of environmental damage will always be hampered by the logistical difficulties of conducting such work in unstable post-conflict environments. It is also the case that more immediate humanitarian issues, such as the removal of explosive remnants of war and infrastructure repair and redevelopment may take precedence. But as the 2011 ICRC review made clear, possible solutions for dealing with toxic materials and for clarifying state obligations for assistance have been advanced.

In considering how best to proceed, the TRW Project has proposed a humanitarian-centred approach, which safeguards environmental quality, and by extension civilian health. We believe that peacetime norms and values could make an important contribution to environmental justice and civilian protection in post-conflict settings. An additional moral imperative stems from the fact that civilians caught up in conflict have little choice over whether or not they are exposed to toxics.

The environment is a finite resource and there is mounting tension between the increasing level of protection afforded to it during peacetime, and the inadequate provisions of existing IHL. The TRW Project believes that adopting a humanitarian-centred approach could help provide the political impetus necessary for action.

While it may pose political and technical challenges, we believe that the developing TRW framing could offer the opportunity to help resolve some of the current inadequacies in civilian protection from conflict toxics, and provide a welcome opportunity to unite environmental protection with the emergent field of humanitarian disarmament.

# 5. APPENDIX: A FRAMEWORK FOR THE STUDY OF TOXIC REMNANTS OF WAR

As demonstrated above, there already exists an awareness of the health and environmental risks from toxic releases from military activities. However, efforts to quantify the extent of the health and environmental problems stemming from these releases and then remediating contamination are limited, inconclusive, and at best carried out on an *ad hoc* basis, depending on the political sensitivity of the problem (e.g. Kuwaiti bases or Da Nang cleanup). Adequately addressing these health and environmental problems is also impeded by a lack of field data, epidemiology, a lack of transparency from the military and the capacity of affected states.

With the limitations above in mind, the TRW Project has been working on a framework to complement the work already undertaken, and contribute to it, by assessing the risk to human health and the environment from chemicals resulting from military activities. A coordinated effort in this regard could improve efforts to reduce the chronic harm to civilians and military personnel arising from conflict, and help inform mechanisms for remediation and health assistance.

The framework is outlined below, firstly through the definition of what constitutes a TRW. It then examines potential sources and suggests a methodology for identifying those substances that are of most concern, by virtue of their environmental persistence, mode of use, propensity to bioaccumulate and travel through various environmental media to reach, and harm, human beings.

## 5.1 DEFINITIONS AND TERMINOLOGY

The TRW Project's working definition of a TRW is: *'any toxic or radiological substance used in or resulting from military activities that forms a hazard to humans and ecosystems*[68]*'*.

The definition used is broad in nature, a fact that has been subject to debate amongst parties interested in the problem of TRW. Proponents of a wide definition see it as a means of encompassing all potential public health and environmental problems that could result from conflict, while those in favour of a narrower definition

68 The emphasis on humans in this definition stems from the humanitarian-centred approach advocated by the TRW Project. This is not to discount the importance of the stewardship of ecosystems and other lifeforms both in and of themselves, and because of their importance to humans.

TABLE 1: An overview of some common military related contaminants together with their possible exposure pathways and toxicity.

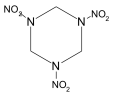
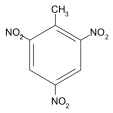
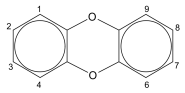
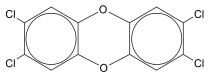
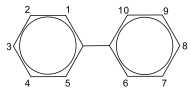
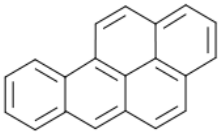
| Substance | Overview | Toxicity | Exposure |
|---|---|---|---|
| Organic energetic materials  Benzene | Organic compounds are formed of hydrogen and carbon atoms; these are often arranged in ring like structures (e.g. benzene shown to the left). Organic EM are based on benzene or similarly structured molecules with nitrogen (N) atoms and ($NO_2$) functional groups replacing some atoms in the structure. These functional groups are an important basis of the explosivity of these compounds and also contribute to toxicity. | | |
| RDX: Research Department Explosive  | Commonly used explosive developed in1898. | Possible carcinogen and genotoxin. Acute exposure causes seizures. | Contaminated soil, water or air. |
| TNT: Trinitrotoluene  | Another commonly used explosive. | Possible carcinogen and genotoxin. Long term exposure leads to anaemia and abnormal liver function. | Contaminated soil, water or air. |
| Organochlorine compounds  PCDD | The term organochlorine (OC) refers to organic compounds containing chlorine (Cl) functional groups; these are often polychlorinated meaning they have variable numbers of Cl atoms attached. Some of the most toxic (OC) compounds are those based on multiple benzene rings. A generic structure for a dioxin OC (polychlorinated dibenzo-p-dioxin, PCDD) is shown left, the numbers indicate the possible site of the Cl atoms. Variations in the site of Cl attachement results in a large number of possible compounds (congeners) with varying toxicity. | | |
| TCDD:  | There are 72 congeners of PCDD. 2,3,7,8-dibenzo-p-dioxin (TCDD) shown left is the most toxic and was a contaminant of the defoliant Agent Orange used in Viet Nam. | Carcinogen and teratogen (cause of birth defects). | Contaminated soil, water and food. |
| PCB: Polychlorinated biphenyls  | PCBs have 209 individual congeners. The compounds were used as hydraulic fluid in old army tanks and also as insulators in electrical power transformers. | Toxicity varies depending on the individual congener. PCBs are teratogens and probable carcinogens. | Contaminated food, water, soil. |
| TCE: trichloroethylene  | Industrial degreaser with widespread applications in military transport activities. | Carcinogen. | Contaminated water. |
| Other organic compounds | | | |
| PAH: Polycyclic aromatic hydrocarbons.  | A group of compounds produced from the incomplete combustion of coal, gas, solid waste (e.g. the use of burn pits to dispose of military waste) and motor vehicle exhausts. PAH are 'Polycyclic' because they are composed of multiple benzene rings (cycles) attached to one another in different configurations. Benzo[a]pyrene, shown (left) is one of the most toxic. | Carcinogens. | Contaminated air or contaminated food. |
| Propellants | | | |
| Hydrazine ($N_2H_4$) | Hydrazine and its variants (mono methyl hydrazine and unsymmetrical dimethyl hydrazine) have been used as rocket propellants since WW2. Its high toxicity means the aerospace industry is attempting to find replacements. | Toxic effects on the kidneys, lungs and nervous system and mucous membranes. | Inhalation, ingestion and dermal contact are all possible routes of exposure. |

TABLE 1: *Continued...*

| Substance | Overview | Toxicity | Exposure |
|---|---|---|---|
| Obscurants | Obscurants are used to create smoke screens that block visibility and thus hide military activity. | | |
| WP: White phosphorous ($P_4$) | When oxygen is present, WP burns violently to form droplets of phosphoric acid of varying size which serve to block light. | Contact with WP results in severe burns with toxic effects on many organs of the body. Heavy exposure to smoke from WP is toxic also. The chronic toxicity of WP in humans is uncertain. | Direct contact or inhalation during an attack with WP. |
| Toxic and heavy metals | | | |
| DU: Depleted uranium | DU is used in kinetic energy penetrator (KEP) rounds. DU is the by-product of the enrichment process for producing nuclear fuel. Its radioactivity is less than natural uranium, though increases over time, but it is just as toxic. | Carcinogen, teratogen and genotoxin. Also known to affect kidney function. | Inhalation of DU particles, ingestion of contaminated soil, shrapnel fragments embedded in body are all possible routes of exposure. |
| Tungsten alloys and compounds | Tungsten compounds (tungsten carbide) and alloys (tungsten/nickel/cobalt (W/Ni/Co) and tungsten/nickel/iron (W/Ni/Fe)) are used to manufacture KEP and armour piercing ammunition. | Tungsten carbide is a probable carcinogen and W/Ni/Co alloys have been found to be carcinogenic in rats. Inhaled particles from tungsten carbide are a risk factor for lung fibrosis. | Inhalation of dusts, shrapnel fragments. |
| Lead | Lead is a commonly used constituent of bullets. | Neurotoxin that impairs brain development and lowers IQ. Can also cause anaemia and other problems. | Ingestion or inhalation of particles. |
| Mercury | Mercury can occur in a variety of forms. Mercury fulminate (Hg(CNO)2) is used in the fuses of older weapons. Mercuric oxide batteries are used for some missile systems. Methyl mercury was used as a grain treatment and is associated with a mass poisoning in Iraq in the 1970s. | Toxicity varies depending on whether the mercury is part of an organic compound or in its elemental form. Toxic effects from mercury compounds include brain damage, kidney and lung problems. | Inhalation, ingestion of contaminated food. |

see it as a means of setting achievable objectives. A narrower definition could be achieved by introducing a temporal aspect to the definition, therefore limiting the scope of TRW to: *'military activities occurring within times and areas of conflict'*. For example, this definition would exclude all military bases in home countries and war production activities. Opponents of such a change have argued that narrowing the definition would narrow the field of potential stakeholders interested in working on the problem.

Another aspect of the definition that requires attention is the specific action of a substance that renders it of concern; as the definition stands, materials constituting: *'a hazard to humans and ecosystems,'* is the criterion for the substance to be classified as a TRW. Discussions at the TRW legal workshop suggested that the definition should be expressed differently, by focusing on substances that: *'can have damaging effects to humans and ecosystems,'* as the criterion. The difference between the two criteria lies in the fact that *'forms a hazard'* has a focus on the potential for harm or damage to the environment, whereas when using *'damaging effects'* as the criteria, the burden of proof could be higher, as proving harm could be more difficult than proving potential harm.

A broad definition is also useful with regard to expanding the state of knowledge of TRW from a variety of sources unconstrained by time and location. The broad working definition can be expanded into a detailed framework for the identification, assessment and classification of various materials that are TRW - and their sources and impacts on human health and the environment - as is detailed in the following sections.

## 5.2 SOURCES OF TRW MATERIAL AND TEMPORAL SCOPE

Contamination or environmental damage from military activities either originates intrinsically from military

activities (e.g. chemicals from explosives, emissions from the burning of military waste) or as a result of military action causing the release of contamination, or environmental damage (e.g. the 1991 Iraqi oil fires and the 1999 bombing of the Pancevo oil refinery in Serbia[69]). There are also situations where the use of munitions or military action can result both in environmental damage and contamination, as in the case of the spraying of AO contaminated with dioxins during the Viet Nam War. The defoliant AO caused widespread damage to the forest ecosystem, while simultaneous contamination by the dioxin TCDD has resulted in long lasting health problems in local populations.

Table 1 introduces pollutants that commonly occur as a result of munitions use and military activity; Table 2 associates specific examples of military activities and their resulting pollutants, along with a distinction based on whether they occur during or outside times of conflict.

TABLE 2: Military activities that are sources of TRW subcategorised according to whether they occur during or outside times of conflict, and examples of potentially problematic substances.

| | Military Activities Outside Times of Conflict | Military Activities During Conflict | Examples |
|---|---|---|---|
| Use of munitions in conflict | ✗ | ✓ | Heavy metals, RDX, TNT, white phosphorus. |
| Use of munitions in training and testing | ✓ | ✗ | Heavy metals, RDX, TNT, white phosphorus. |
| Attacks on infrastructure and industry (including defoliation and looting) | ✗ | ✓ | Dioxins, PCBs, PAH, heavy metals. |
| Military base and logistical activities | ✓ | ✓ | PCB, PAH, particulate matter, TCE, fuel. |
| Demilitarisation, reclamation and stockpiled and abandoned munitions | ✓ | ✓ | TNT, RDX, hydrazine, nitric acid. |

As shown in Table 2, TRW contamination may originate before conflict, or become a problem during or after conflict. Contamination scenarios can be exacerbated by looting or reclamation and other post-conflict activities. The importance of the distinction in the time a source of pollution occurs is important from both a scientific and legal perspective.

Understanding the temporal scope of certain activities or pollution is useful for information gathering. Some of the TRW sources that occur outside conflict could prove useful in providing information on pollution and health problems that would be hard to gather during conflict. As an example, environmental measurements and well designed epidemiological studies around heavily used weapon testing grounds could provide valuable data that could guide and focus studies in post-conflict settings. Furthermore, whether the pollution occurs during or outside conflict will determine responsibility for it, and will dictate the applicable branch of international or environmental law.

An adequate understanding of TRW sources is only the first step in any substantive study of military pollution. Once sources are identified, and examples of pollution are documented and scrutinised, a thorough and systematic assessment of such substances can be undertaken, as is outlined in the next section.

The phrase *substance of concern* is used to describe substances resulting from the activities listed in Table 2 because the extent to which a substance could cause a health or environmental problem is not only determined by its intrinsic toxicity or radioactivity.

Factors such as the environmental behaviour of a substance, its potential for bioaccumulation and ultimately whether susceptible organisms (humans or otherwise) could be exposed to the substance in quantities sufficient to cause harm must also be addressed. The assessment of substances for these criteria is presented and discussed below, along with possible confounding factors.

## 5.3 SUBSTANCES OF CONCERN AND ASSESSMENT METHODOLOGY

Peacetime regulatory processes and treaties to assess and control toxic and hazardous substances exist and can provide an important starting point for a humanitarian-centred approach to the prevention and management of military-origin contamination. As previously discussed, the EU's REACH legislation is one of the most far-reaching. Elsewhere, the US Toxic Substances Control Act of 1976 (TSCA), has been subject to ongoing criticism due to how limited the assessment of existing and new chemicals is. It has been proposed that TSCA be replaced by the more robust Safe Chemicals Act[70], proposed in 2011 by US Senator Frank Lautenberg.

On an international level, treaties such as the Basel Convention for the control of transboundary shipments of hazardous waste and the Chemical Weapons

69 UNEP and United Nations Centre for Human Settlements. (1999). *The Kosovo Conflict: Consequences for the Environment and Human Settlements.* Switzerland, UNEP.

70 The SCA aims to have more extensive testing of chemicals for toxicity in a process similar to the EU REACH regulations.

Convention both provide some guidance with regard to the identification of classes of materials that could be problematic. Indeed, many chemicals employed by the military (e.g. explosives) are subject to some controls under the Basel Convention.

The TRW Project does not aim to reinvent the wheel with regard to toxic substance control and assessment, however there is a gap as regards the environmental and exposure assessment of military toxics in civilian settings. Therefore the TRW Project is working on a methodology to comprehensively review substances used in, or resulting from military activities, in line with similar measures taken for consumer goods and other peacetime environmental norms. Such a review would then serve to both identify the substances of most concern, and guide the determination of potential case-studies of civilian health and environmental problems in post-conflict settings. The proposed methodology is outlined below.

### 5.3.1 Substance Identification

Materials and substances associated with the activities in Table 1 can be gleaned from information in the public domain on military activities and munitions to form an initial list of substances of concern. Substances in this initial list are those that are deemed to have the potential to cause harm and environmental damage based on a summary examination of toxicological, physical and chemical properties. Detailed information on substances of concern can be obtained from technical military literature, regulatory bodies, human rights publications, academic journals and other sources. However the availability of specific technical and environmental data can be a limitation because of the reliance on information in the public domain.

### 5.3.2 Substance assessment and ranking

Substances in the initial list that exhibit high hazard potential by virtue of high toxicity, bioaccumulation potential, widespread use and association with health problems are then subjected to a desk assessment based on their physical and chemical properties, which influence environmental fate and toxicity. Additionally, the mode, extent and area where munitions are used are taken into account as important weighting factors with regard to environmental risk, for example a substance used in small quantities will not be as problematic as a more widely used substance.

The collation of sufficient data on substances allows them to be subjected to a prospective source-pathway-receptor analysis. Here the main question posed is whether there is a viable route or pathway from the emission of a chemical in the environment, the source, to a receptor[71] that would suffer negative impacts from exposure to this substance; the basic tenets of a source-pathway-receptor analysis are illustrated in Box 4. If the criteria in Box 4 are fulfilled, then a substance is very likely to be of concern to human health.

BOX 4: A basic representation of the source-pathway-receptor model (Adapted from Butler, 1978).

| |
|---|
| ENVIRONMENTAL EMISSION |
| Y/N |
| IS THE MATERIAL MOBILE IN THE ENVIRONMENT? |
| Y/N |
| WILL LIVING THINGS BE AFFECTED? |
| Y/N |
| WILL THERE BE TOXIC EFFECTS IN LIVING ORGANISMS OR THE ENVIRONMENT? |

Subjecting many substances to a common and consistent assessment enables a ranking of the risk posed from them and a generic S-P-R analysis to be constructed. The generic nature is meant in the sense that at this stage the study of every environment possible could not be conducted, but the S-P-R analysis would focus on the potential for transport in the important environmental media (i.e. water, soil, air).

The outcomes of the analysis above could guide future work in the identification of case studies on TRW where instances of TRW in the field are studied both environmentally, and from a health perspective. The research performed by the TRW Project has the overarching aim of improving health and environmental protection from conflict toxics, whilst simultaneously calling for the international community to take responsibility for such problems. The scientific assessment of the harm caused by TRW from military activities could also support the strengthening of legal protection for the environment during conflict.

71 The receptor can be a living organism or an environmental compartment (e.g. soil or groundwater) where the contaminant accumulates and therefore poses an exposure hazard.