



**UNIDIR**

**Understanding the Reverberating Effects  
of Explosive Weapons**

**A Way Forward**

**Christina Wille and John Borrie**

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## Table of Contents

<b>Executive summary</b> .....	2
<b>1. Introduction</b> .....	3
Box 1: What are explosive weapons, and who uses them? .....	4
<b>2. Reverberating effects in explosive weapons research</b> .....	4
Box 2: Primary, secondary and tertiary effects of explosive weapons.....	5
Box 3: The e3e Monitor .....	6
<b>3. The reverberating effects of explosive weapons use in populated areas: a complex and interconnected humanitarian and development issue</b> .....	8
Graphic 1: ICRC graphic illustrating damage to and destruction of health, water and power infrastructure .....	8
Graphic 2: Damage and destruction at a transport hub following the damaging of a power plant, and the impact on food supplies and health care .....	9
Graphic 3: Consequences for education when schools, homes and utilities are damaged or destroyed.....	10
A framework for documenting reverberating effects of explosive weapons use.....	11
Box 4: Knowledge gaps on reverberating effects of explosive weapons use in populated areas .....	12
<b>4. Benefits for practice from improved knowledge of the reverberating effects of explosive weapons use in populated areas</b> .....	12
<b>5. Existing knowledge: how actors have approached the reverberating effects of explosive weapons use</b> .....	13
5.1 Information from humanitarian actors active in the explosive weapons discourse.....	13
5.2 Approaches among actors concerned with the reverberating effects of explosive weapons outside the explosive weapons discourse.....	17
5.3 Research on reverberating effects in relation to cross-cutting issues .....	18
<b>6. The way forward: advancing the research on the reverberating effects of explosive weapons</b> .....	19
Box 5: A suggestion for building the research agenda on reverberating effects .....	19
<b>7. Concluding thoughts</b> .....	20

# Understanding the reverberating effects of explosive weapons

## A research agenda for the way forward

### Executive summary

The use of explosive weapons in populated areas harms civilians. The effects created at the moment and point of detonation reverberate outward in space and time. These reverberating consequences are comparatively understudied.

This document reviews the existing approaches to documenting the reverberating effects of explosive weapons use in populated areas. It finds that, at present, documentation is scattered among different subject areas, such as, for example, concern for children and health care, along with some geographic case studies. There is no comprehensive overview of the full range of reverberating effects, no standard methodological framework that would bring the various elements together. The review also finds that some areas of reverberating effects are understudied (among them livelihoods, environment and economies), and that some key aspects of reverberating effects are not usually taken into account (notably resilience and time). The review further concludes that a holistic framework ought to include standard indicators of the reduction in service provision and the impact of this on people's lives and well-being.

As a way forward, the document suggests **developing a framework** that brings the existing pieces of the knowledge puzzle together; **improving information exchange** between actors already working on documenting the reverberating effects for different sectors, in order to share best practice; **improving engagement** with actors not yet engaged in the explosive weapons discourse but with expertise in areas of reverberating effects (such as cultural heritage or urban settlements); **identifying the appropriate indicators** using existing sources (notably the sustainable development indicators); and beginning **monitoring of damage to infrastructure**.

## 1. Introduction

Every day, the use of explosive weapons in populated areas harms civilians. International concern about the human impact of explosive weapons has increased in recent years. More and more evidence shows high levels of civilian harm from explosive weapons use that follows a recurrent pattern. There have been growing calls for more coherent and effective policy responses, including from many States.<sup>1</sup>

In a number of areas, a clearer understanding is emerging, in particular, about the norms governing explosive weapon policies and practices, the types of explosive weapons that are particularly problematic from the point of view of civilian protection, as well as aspects of human costs. The counting of explosive weapons events and monitoring of direct death and injury has been important, as are accumulating case studies that explore the consequences of specific explosive weapons events in greater depth.

The effects of the use of explosive weapons in populated areas extend beyond the immediate impact created at the moment and point of detonation, and reverberate outward in space and time. These reverberating consequences are comparatively understudied. Yet people's lives and development are affected long after the blast occurs. As noted in UNIDIR's preceding paper (*"The Implications of the Reverberating Effects of Explosive Weapons Use in Populated Areas for Implementing the Sustainable Development Goals"*)<sup>2</sup>, in addition to killing and maiming people, explosive weapons often destroy vital infrastructure, which affects the delivery of services on which communities critically depend.<sup>3</sup> Damage to housing and places of work can result in people losing shelter and livelihoods. Destruction of utilities reduces water and electricity supply which can affect public health. Damage to hospitals and schools creates difficulties in accessing health care and education. Damaged transport routes affect the availability of food and humanitarian access. The reverberating effects of damage and destruction can lead to severe humanitarian crises and usually hold back development as investors shun affected areas.

There is reason to suggest that the impacts of the reverberating effects of explosive weapon use in populated areas include contributing to higher indirect mortality, blighting opportunities for community recovery, and setting back development. Such effects are not as straightforward to measure as direct death and injury, which may be a contributing reason why no one has yet systematically documented them. Yet there are numerous methods and tools in disciplines such as epidemiology and public health, and among development indicators, that may be of considerable help in data collection and analysis of reverberating effects. Relevant and useful data may already be in the process of being gathered in the course of other humanitarian, developmental and public health-related activities.<sup>4</sup> The United Nations Secretary-General and the President of the ICRC have recognized the seriousness of indirect deaths and have demanded urgent attention and action from the international community.<sup>5</sup> Recognition of the impact on development of

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<sup>1</sup> ["More States support new standards on explosive weapons at UN debate"](#), *INEW News*, 27 January 2016.

<sup>2</sup> Christina Wille, [The Implications of the Reverberating Effects of Explosive Weapons Use in Populated Areas for Implementing the Sustainable Development Goals](#), UNIDIR, April 2016.

<sup>3</sup> Christina Wille, [The Implications of the Reverberating Effects of Explosive Weapons Use in Populated Areas for Implementing the Sustainable Development Goals](#), UNIDIR, April 2016.

<sup>4</sup> The list of SDG indicators, for example, will be considered by the Economic and Social Council in July 2016, and subsequently submitted to the General Assembly for adoption. See Economic and Social Council, [Report of the Inter-Agency and Expert Group on Sustainable Development Goal Indicators: Note by the Secretary-General](#), UN document E/CN.3/2016/2/Rev.1, 19 February 2016.

<sup>5</sup> For instance, on 31 October 2015, the United Nations Secretary-General, Ban Ki-moon, and the President of the International Committee of the Red Cross, Peter Maurer, issued a joint warning about the impacts of today's conflicts on civilians, including the need to stop the use of heavy explosive weapons in populated areas, and condemning those

explosive weapons has been less pronounced until now. Improved understanding of the reverberating effects of explosive weapons use in populated areas may offer further insight and practical ways in which policymakers can respond effectively to reduce harm.

### **Box 1: What are explosive weapons, and who uses them?**

There are many types of explosive weapons currently in use. These include air-dropped bombs, artillery projectiles, missiles and rockets, mortars, and improvised explosive devices. Some are launched from the air, while others are ground launched. While different technical features dictate their accuracy of delivery and explosive effect, these weapons generally create a zone of blast and fragmentation with the potential to kill, injure or damage anyone or anything within that zone. This makes their use in populated areas—such as towns, cities, markets and camps for refugees and displaced persons—particularly problematic. The problems increase further if the weapon’s effects extend across a wide area either because of the scale of the blast that they produce, their inaccuracy, the use of multiple munitions across an area, or a combination thereof.

Explosive weapons are used by State and non-State actors. Most explosive weapons are either deployed in the context of armed conflict or attacks commonly labelled by States and the media as acts of “terrorism”. Law enforcement services almost never use explosive weapons. There is evidence that use of explosive weapons in armed conflict is increasing.<sup>6</sup> The data collected systematically on civilian casualties from explosive weapons show a year-on-year increase in reported numbers of casualties.<sup>7</sup>

This paper discusses the current level of knowledge of reverberating effects, reviews some relevant research approaches developed by humanitarian actors over previous years, and suggests a way forward to improve understanding of reverberating effects of explosive weapons with a view to informing policy responses that could reduce the overall harm explosive weapons cause to civilians.

## **2. Reverberating effects in explosive weapons research**

The problem of explosive weapons use in populated areas emerged as a distinct policy and research agenda late in the last decade.<sup>8</sup> Since then, considerable work has been undertaken to understand its nature and extent, most of it by academics and humanitarian organizations rather than users of explosive weapons. Some of this research has examined norms governing explosive

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who commit serious violations of international humanitarian law, such as deliberate attacks on civilians and civilian infrastructure. See [“World at a turning point: Heads of UN and Red Cross issue joint warning”](#), *United Nations Office at Geneva News and Media*, 31 October 2015.

<sup>6</sup> Christina Wille and Larissa Fast, [Humanitarian Staff Security in Armed Conflict. Policy Implications for the International Community from Changes in the Operating Environment for Humanitarian Agencies](#), Insecurity Insight Fact Sheet, March 2013.

<sup>7</sup> [“Explosive Violence Monitor”](#), Action on Armed Violence.

<sup>8</sup> For an account, see John Borrie and Maya Brehm, [“Enhancing Civilian Protection from Use of Explosive Weapons in Populated Areas: Building a Policy and Research Agenda”](#), *International Review of the Red Cross*, vol. 93:883, September 2011.

weapons policies and practices, while some has investigated aspects of the human costs of explosive weapons use, or both.

Many explosive weapons analyses distinguish between primary, second and tertiary effects. The concept of the **reverberating effects of explosive force** (REEF) used in this paper encompasses the tertiary effects described in Box 2. It includes impacts on food security, water, sanitation, health care, education and shelter. It covers the environmental damage caused by the destruction of infrastructure, and the displacement that results from the destruction. The concept also extends beyond the impacts measurable in standard indicators and includes the impacts of explosive weapons on human behaviour, interaction, social capital and community resilience.

### **Box 2: Primary, secondary and tertiary effects of explosive weapons**

- The **primary effects** of explosive weapons are the direct impact of the weapons' components. They are caused by the high-pressure blast wave that results from the detonation, and fragmentation from the warhead. Measures of primary effects include detonation velocity, pressure, temperature and the velocity of fragments. In humans, the primary effects cause injuries such as bursting of hollow organs (ears, lungs and the gastro-intestinal tract), brain damage, when the brain crushes into the side of skull, burns and projectile wounds from weapon fragments.
- The **secondary effects** of explosive weapons result from the interaction of the blast wave and fragmentation with the surrounding environment. In open spaces, the blast wave, which pushes outwards at supersonic speed from the core of detonation, often causes surrounding material (such as earth or rocks) to become secondary fragmentation. In air, the blast wave decays quickly with time and distance. In built-up areas, however, the blast wave is partially absorbed, reflected, refracted and channelled into structures. This causes a variety of secondary effects including structural collapse, shattered windows and fire damage. Secondary effects cause multiple human casualties through injuries from flying glass, crushing, suffocation and burns. Because of their diversity, secondary effects are difficult to measure accurately, and are often simply described in terms of the type and extent of damage caused.
- The **tertiary effects** of explosive weapons are the long-term impacts of the damage caused by explosive weapons on human living conditions. Tertiary effects are caused by damage to or destruction of vital infrastructure, such as housing, utilities or health facilities. Tertiary effects include a wide range of consequences of reduced access to services and infrastructure that are vital to sustain lives and livelihoods. Tertiary effects are measured in terms of changes in access to services and the impact of reduced services on people's lives and well-being. The duration of tertiary effects depends on the time it takes to repair damage and resume services, which in turn depends on the extent of destruction to local infrastructure and economic activities, as well as the resilience of affected communities. Systems that had been well managed and resourced prior to being damaged usually recover more quickly than those that had been neglected before the event.

Notably, the Geneva International Centre for Humanitarian Demining has recently undertaken work examining aspects that relate mainly to the primary effects of explosive weapons, looking in depth into the particular characteristics of some forms of heavy artillery, medium and heavy mortars.<sup>9</sup> However, the characteristics of specific weapon types have not yet systematically been considered in relation to the long-term reverberating effects of their use in populated areas.<sup>10</sup> Moreover, in contrast to the small arms research agenda, explosive weapons research has not focused on quantifying the total global explosive stockpile and there has been little work on norms and practices in relation to transfers of explosive weapons.<sup>11</sup>

A British-based non-governmental organization (NGO), Action on Armed Violence (formerly Landmine Action), has played a lead role in explosive violence casualty monitoring.<sup>12</sup> This monitoring has generated a growing and widely cited body of data about direct death and injury reported in explosive weapons-related events. Other aspects of secondary effects have not received the same attention. For example, the impact of explosive weapons on animals is not well understood from an animal welfare perspective or for its implications for human livelihoods and access to food. Moreover, although there is widespread recognition that secondary effects include infrastructure damage and destruction, these effects have not been systematically recorded to date in open literature. The development of the “e3e Monitor” by scientists working at CERN (the European Organization for Nuclear Research) could help to fill this gap in the future (see Box 3).

### Box 3: The e3e Monitor

The first prototype of the e3e Monitor—the Explosion and Extreme Energy Event Monitor—was developed at Technology for Humanitarian Empowerment (THE) Port Hackathon at CERN.<sup>13</sup> The objective was to develop a cheap and simple to construct technical device no bigger than a shoe box, equipped with multiple technology detector systems to record all explosions within a radius of two to three kilometres in real time.<sup>14</sup> The vision for the e3e Monitor is to build a global network of detectors covering locations at risk from explosions. The prototype will undergo testing soon. The aim is also to link the evidence from the sensor to open source information, such as Twitter activity in the vicinity of the explosion, in order to triangulate information on the explosion and collect descriptions of the extent of the damage. Advances in natural language processing should help to automate these processes. This technological development has enormous potential to generate open source monitoring data on damage to infrastructure without putting human beings at direct risk.

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<sup>9</sup> The Characteristics of Explosive Weapons (CEW) project also set up an advisory group bringing together key people from the explosive weapon research community and has been important for information exchange and cross fertilization.

<sup>10</sup> The 2016 report by Action on Armed Violence combined details about the explosive weapons type used with details of the observed secondary effects. Action on Armed Violence (AOAV), [Wide Area Impact Explosive Weapons in Populated Areas](#), 2016.

<sup>11</sup> Reaching Critical Will of the Women’s International League for Peace and Freedom published [Trading Arms, Bombing Towns. The Lethal Connection Between the International Arms Trade and the Use of Explosive Weapons in Populated Areas](#) in September 2015. It remains to be seen whether this will be the start of more systematic research into trade in explosive weapons.

<sup>12</sup> [The Explosive Violence Monitor](#), maintained by Action on Armed Violence, uses the method developed by Robin Coupland and Nathan Taback, which generates data from text-based event descriptions. Setting up the monitoring system was facilitated by [Insecurity Insight](#).

<sup>13</sup> [THE Port Hackathon at CERN](#).

<sup>14</sup> A presentation of the vision for the project is available at <https://cds.cern.ch/record/2059758>.



Rather than being the focus of dedicated research to date, work on reverberating effects has been carried forward as an element of the broader research of a number of humanitarian actors, often in the context of case studies on explosive weapon impacts. As a consequence, it could be argued that the body of work on reverberating effects to date consists of scattered pieces of a larger puzzle. **At present, there is no comprehensive overview of the full range of reverberating effects and no standard organizational or methodological framework bringing the various elements together.**

This is striking as work on the reverberating effects of explosive weapons use started at least half a decade ago, when the lack of data on broader impacts was clearly recognized and several publications called for improved understanding of these. In 2010, the Secretary-General of the United Nations urged Member States and the United Nations and international and non-governmental actors to support “more systematic data collection and analysis of the human costs” of explosive weapons use in populated areas because “this is essential to deepening the understanding of the humanitarian impact of such weapons and to informing the development of policy and practice that would strengthen the implementation of international humanitarian and human rights law”.<sup>15</sup> In 2011, the authors of an IKV PAX Christi (now PAX) report noted that States affected by armed conflict “often lack the capacity or political will to accurately monitor armed violence and publicize its effects on the civilian population” and argued that this created “all the more reasons for the independent collection and analysis of such data”.<sup>16</sup>

Responding to the call for better data, several humanitarian organizations have begun to gather information about reverberating effects within their sector of expertise (such as child support, water or health), and most of their reports now include some reference to it. An increasing number of journalists also refer to reverberating effects, although they tend to focus on single incidents and provide only snapshot descriptions of one point in time. Overall, there has been some progress in improving data, but much remains to be done.

One productive approach might be for interested parties to discuss what common criteria and formats for reporting on reverberating effects would look like, and how these compare with the existing data available, as well as the best ways in which such information could be parsed.<sup>17</sup> This is important, as a significant challenge in observing and measuring reverberating effects is attributing causation the further out in space and time the effects occur from the initial explosive weapons event. Improved data collection and analysis, and cooperation between international agencies and humanitarian groups, should help.

This paper now turns to exploring sector-specific approaches developed over the past five years with a view to identifying how research and policy considerations of reverberating effects of explosive weapons might be taken forward.

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<sup>15</sup> Security Council, [Report of the Secretary-General on the protection of civilians in armed conflict](#), UN document S/2010/579, 11 November 2010, p. 11.

<sup>16</sup> Roos Boer, Bart Schuurman and Miriam Struyk, [Protecting Civilians from Explosive Violence. Defining the Humanitarian Problem](#), IKV Pax Christi, 2011, p. 34.

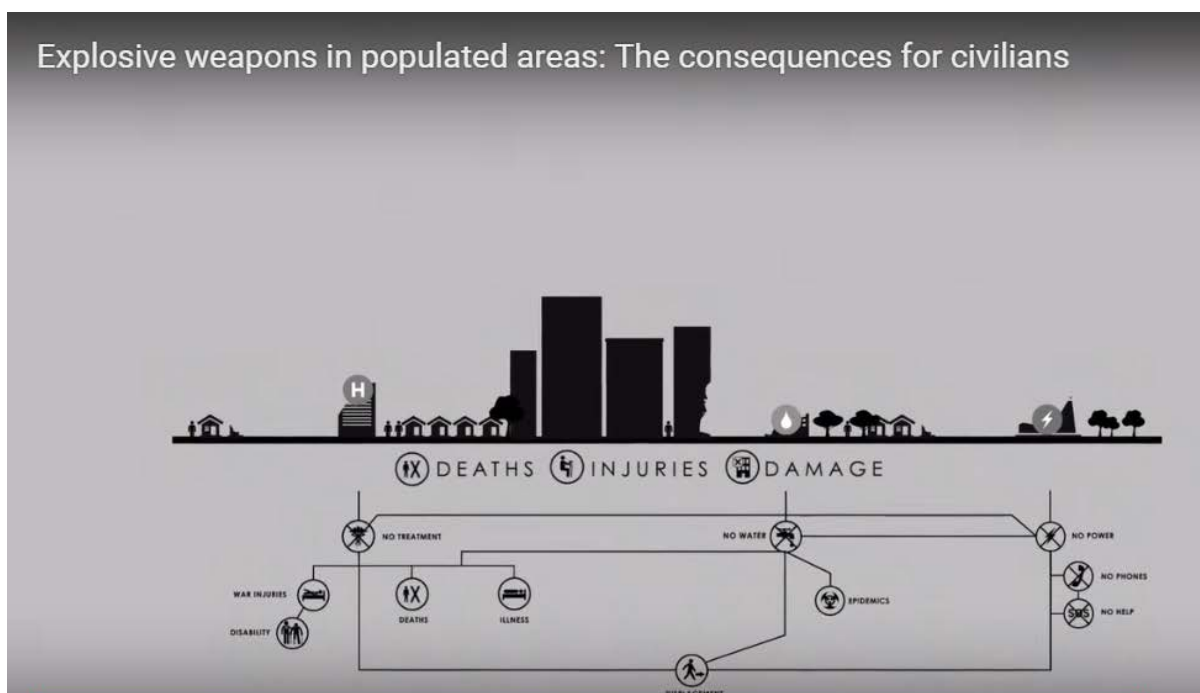
<sup>17</sup> In 2011, John Borrie and Maya Brehm made a similar observation, but this applied more broadly than reverberating effects and they did not propose specific criteria, categories or formats. See John Borrie and Maya Brehm, [“Enhancing Civilian Protection from Use of Explosive Weapons in Populated Areas: Building a Policy and Research Agenda”](#), *International Review of the Red Cross*, vol. 93:883, September 2011, p. 833.

### 3. The reverberating effects of explosive weapons use in populated areas: a complex and interconnected humanitarian and development issue

Most of our current understanding of the reverberating effects of explosive weapons comes from incident or case descriptions provided by humanitarian agencies and groups or by journalists. Humanitarian agencies and groups have documented the reverberating effects for sectors such as education, water and health, while journalists have focused on a broader range of subjects, but tend to discuss individual cases rather than cumulative impacts. Recently, UNIDIR has examined media accounts of incidents of explosive weapons use to consider additional kinds of reverberating effect in relation to the Sustainable Development Goals (SDGs). These include effects on food security, the environment, livelihoods and safe cities.<sup>18</sup>

This growing body of work has demonstrated that reverberating effects are complex and interconnected. For example, an [animated graphic](#) developed by the International Committee of the Red Cross (ICRC) was the first illustration of how the cumulative effects of damage to hospitals, water treatment plants and power stations all contribute to displacement (see Graphic 1).<sup>19</sup>

**Graphic 1:** ICRC graphic illustrating damage to and destruction of health, water and power infrastructure



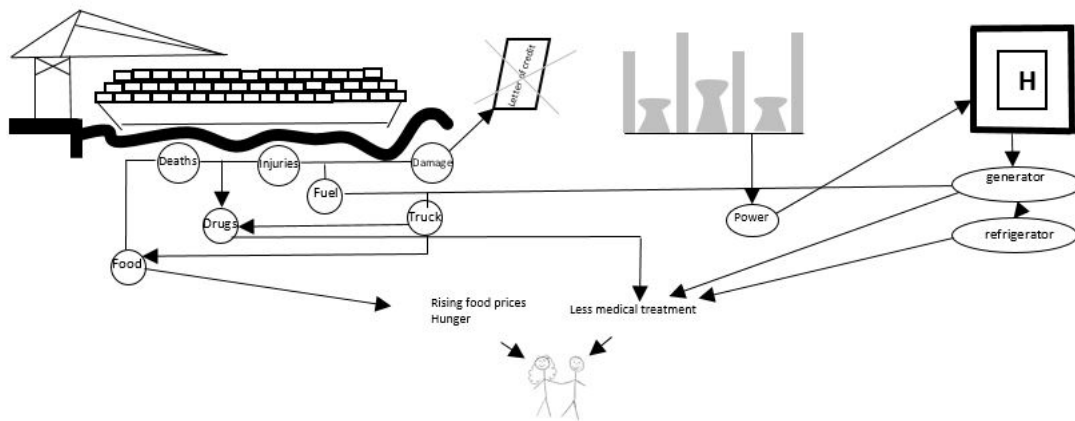
Numerous additional graphics would be needed to describe the full range of reverberating effects. Graphic 2 illustrates the consequences of damage and destruction at key transport hubs, in this case the destruction of cranes and cargo at a port. The damage to port infrastructure affects the

<sup>18</sup> Christina Wille, [The Implications of the Reverberating Effects of Explosive Weapons Use in Populated Areas for Implementing the Sustainable Development Goals](#), UNIDIR, 2016.

<sup>19</sup> The animated graphic is available at <https://www.icrc.org/en/document/explosive-weapons-populated-areas-consequences-civilians>.

import of food, drugs and fuel. Damage to cargo often affects the availability of credit for further shipments, reducing the quantity of food imports. All of this leads to an increase in food prices, and eventually the risk of hunger that affects the poor the most. The effects are made worse when fuel is imported through the affected hub because this reduces transport capacity and pushes up prices even further. Fuel shortages also affect health care and any other sector requiring the use of generators.

**Graphic 2:** Damage and destruction at a transport hub following the damaging of a power plant, and the impact on food supplies and health care

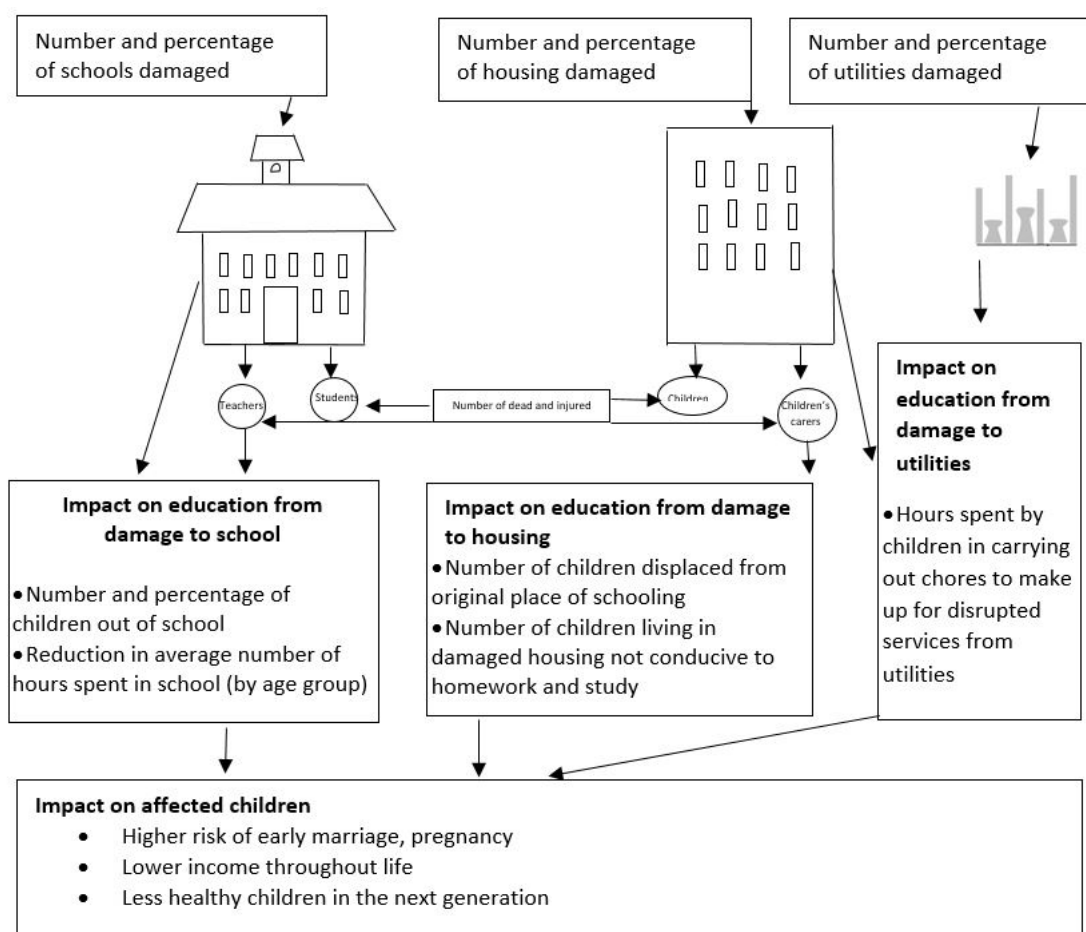


Graphics 1 and 2 visualize a simplified understanding of much more complex and interconnected reverberating effects. However, they do not quantify the extent to which services are affected by the damage or destruction. The third graphic, below, shows how the consequences of the damage can be quantified using the example of how explosive weapons use affects access to education, based on information gathered by the United Nations International Children's Emergency Fund (UNICEF) and Save the Children.<sup>20</sup>

Explosive weapons kill and injure teachers and students and damage or destroy schools. Very often, the damage will reduce the hours of schooling that can be provided. If private homes are damaged or destroyed, children are often displaced and stop attending their original school. Destruction of housing may also kill and injure children and their care givers. The consequences for education from damage to and destruction of schools and houses can be quantified in terms of the number of children out of school or the reduction in the average number of hours spent learning for a specified age group. If additional infrastructure is destroyed, it is likely that this will reduce further the hours spent learning. If no water is pumped into homes, children are often sent to collect water or queue for food. This reduces time for playing and homework. If there is no electricity at night, children will be less able to prepare schoolwork for the following day. Trauma caused by the experience of loss of housing or family members also often affects children's ability to learn effectively. The combined consequences are a loss of multiple hours of acquiring essential formal skills.

<sup>20</sup> United Nations International Children's Emergency Fund (UNICEF) UK, [Keeping Children Safe in Emergencies](#), 2015; Save the Children, [Explosive Weapons and Grave Violations Against Children](#), Position Paper, 2013, p. 12.

**Graphic 3: Consequences for education when schools, homes and utilities are damaged or destroyed**



Graphic 3 is an example how the reverberating effects on education can be quantified. It also includes what is currently known about the long-term impacts if education is interrupted. General work on how levels of education affect people over a lifetime has shown that children who do not complete education are at higher risk of child marriage and pregnancy,<sup>21</sup> and earn less throughout their lives.<sup>22</sup> The children of mothers with less education are also more at risk of stunting and infant mortality.<sup>23</sup> No work has yet been carried out to confirm that these general observations also apply to children whose education has been interrupted through the destruction of school infrastructure and housing. However, it highlights how general development indicators can be used to quantify and describe the likely impact of the reverberating effects of explosive weapons damage.

These three graphics illustrate our conceptual thinking, but they only cover selected areas of reverberating effects. Several additional graphics would be needed to describe how explosive weapons affect health, livelihoods, the environment and gender relations, among others, if we wanted to show the full impact of the use of explosive weapons on people's lives and well-being

<sup>21</sup> United Nations Educational, Scientific and Cultural Organization (UNESCO), *Education Transforms Lives*, 2013.

<sup>22</sup> Save the Children, *The Cost of War: Calculating the Impact of the Collapse of Syria's Education System on Syria's Future*, 2015; United Nations Educational, Scientific and Cultural Organization (UNESCO), *Education Counts: Towards the Millennium Development Goals*, 2010.

<sup>23</sup> United Nations Educational, Scientific and Cultural Organization (UNESCO), *Education Transforms Lives*, 2013.

beyond direct death and injury. The true complexity and interconnectedness of the various reverberating effects cannot be shown on a single graphic.

However, with the exception of education and health, there are no systematic data on the extent of damage to infrastructure, the extent to which service provision is interrupted and how this affects people. For most areas, our understanding of the reverberating effects is usually limited to the recognition that there can be a direct consequence for essential services if certain infrastructure is damaged. At present, it is rare for data to be systematically collected, categorized and analysed on the **extent to which the services are interrupted, let alone measuring the extent to which this actually affects people's lives and well-being**. In addition, resilience and time are not usually considered in discussions on reverberating effects.

**Resilience** within a society determines how quickly damage can be repaired or effective alternative service provisions put in place that halt, or at least reduce, the harm from reverberating effects. Resilient societies will experience less severe reverberating effects than people living in fragile States. This helps to explain why explosions set off by "terrorists" in more resilient and or developed societies often cause direct deaths and injuries, but fewer tertiary effects. This is because the emergency services are often capable of preventing downstream impacts, and because the public administration is capable of managing resources effectively to ensure that there is investment into repairing infrastructure and restoring essential services quickly. Explosive weapons use during conflict, by contrast, usually hits societies already weakened by conflict and this amplifies the consequences of the impact. "Terrorist" attacks in fragile States can also have detrimental reverberating effects if the response capacity is weak.

**Time** matters too. The longer reverberating effects persist, the more marked the impact on people's lives. At present, there are hardly any recent comparative data on how long disruption to services due to explosive weapons use in populated areas persists.

### **A framework for documenting reverberating effects of explosive weapons use**

As a starting point for consideration of further research on reverberating effects, it is suggested that efforts to document and analyse these effects focus on four key aspects of the consequences of explosive weapons use:

- 1. The extent of damage to infrastructure.** *At present, we do not know how many schools, hospitals, power plants, private homes, key transport hubs, essential food production facilities and other buildings and essential elements of infrastructure have been damaged or destroyed.*
- 2. The extent to which the damage affects service provision.** *At present, there are only snapshots of incidents causing damage with some information on how the damage affected the provision of services. There are few data to show for how long and to what extent the services were interrupted.*
- 3. The consequences of reduced services provision on people's well-being and livelihoods.** *With a few exceptions in the field of education and some rare individual case descriptions, we have little information on how the reduction in services affects people's lives and well-being.*
- 4. The capacity to halt and reverse reverberating effects.** *There is little knowledge on the factors that determine whether services are able to resume quickly or remain disrupted for long periods of time.*

To obtain this information, more **systematic monitoring of damage and destruction** to infrastructure, the **identification and regular use of indicators** on the level of changes to **service provision**, as well as **indicators** showing the **impact** of the reduced service provision on **people's well-being** and **resilience** are needed.

#### **Box 4: Knowledge gaps on reverberating effects of explosive weapons use in populated areas**

- *There are some reverberating effects we know too little about, among them effects on livelihoods, environment and economies.*
- *We currently do not understand how to describe and measure the capacity to respond and how to factor time into our description of the scale of reverberating effects.*
- *There is no systematic practice of measuring with standard indicators the extent of reduction in services and the outcome for people's well-being as a consequence of reduced services.*
- *The information on the reverberating effects of explosive weapons use in populated areas is scattered among many different actors and clusters of interest, and we lack a holistic framework and systematic overview.*

#### **4. Benefits for practice from improved knowledge of the reverberating effects of explosive weapons use in populated areas**

The full impact of explosive weapons use in populated areas cannot wholly be described with reference to the casualty rate. It has to include the reverberating effects too. One of the benefits of a wider understanding of reverberating effects would be to help humanitarian organizations and civil defence units to anticipate and prepare effective responses to save lives and to support local resilience in the face of explosive weapons use. Recent work on preparedness has shown that greater anticipation and better planning of responses makes an enormous difference to the efficiency of humanitarian assistance.<sup>24</sup>

Being able to anticipate reverberating effects from explosive weapons use is also critically important for military forces planning attacks involving the use of explosive weapons. International humanitarian law<sup>25</sup> (also known as the law of armed conflict), contains important rules for the protection of civilians and civilian objects, including from the effects of explosive weapons. Among these rules, the rule of proportionality prohibits attacks which may be expected to cause incidental loss of civilian life, injury to civilians, damage to civilian objects, or a combination thereof, which would be excessive in relation to the concrete and direct military advantage anticipated. It should be noted that not only are excessive civilian casualties and injuries prohibited, but so is excessive damage to civilian objects. Moreover, the rule of proportionality does not limit the incidental harm to the immediate or "direct" effects of the

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<sup>24</sup> World Food Programme and United Nations International Children's Emergency Fund (UNICEF), [UNICEF/WFP Return on Investment for Emergency Preparedness Study](#), 2015. Work that is being taken forward in this regard is available at <http://www.humanitarian-preparedness.org/>.

<sup>25</sup> International Committee of the Red Cross (ICRC), "[Explosive Weapons in Populated Areas—Humanitarian, Legal, Technical and Military Aspects](#)", presentation at the Explosive Weapons in Populated Areas—Humanitarian, Legal, Technical and Military Aspects expert meeting, Chavannes-de-Bogis, Switzerland, 24–25 February 2015.

attack. Hence, the foreseeable indirect or “reverberating” effects of an attack must also be taken into account, even if they are not a direct or immediate consequence of the attack.

Information based on documented evidence will be more compelling than references to general and likely consequences. Monitoring is a central part of gathering this body of evidence. Monitoring data provide the information needed to verify assumptions about the connections and thereby provide a basis for predicting an expected impact.

## **5. Existing knowledge: how actors have approached the reverberating effects of explosive weapons use**

As noted, most of our current understanding of the reverberating effects of explosive weapons use comes from incident or case descriptions by either humanitarian agencies and groups or journalists.<sup>26</sup> Some have communicated their concerns in relation to explosive weapons use in populated areas, although not all have identified the weapon at the origin of the destruction in documenting the reverberating effects. Common to all is that they address the issue from one specific concern such as child support, water, disability, women, cultural heritage or urban settlements, and so use a sector-specific framework.

This section reviews some of the existing approaches to documenting reverberating effects as a first step to bringing them together into a common framework. It is not intended as a complete review of all existing work but as a means of developing a common framework based on existing approaches. Such a framework could also be used to bring other actors, not currently engaged in an explosive weapons discourse, into the discussion.

### **5.1 Information from humanitarian actors active in the explosive weapons discourse**

Motivated by the harm they have witnessed, the United Nations Secretary-General, civil society organizations, United Nations and other humanitarian agencies, and some States have advocated that parties to conflict refrain from or avoid the use of explosive weapons in populated areas. The review presented below shows that most of their documentation has made some reference to at least one aspect of the reverberating effects of explosive weapons. However, systematically documented knowledge of the full range of reverberating effects has not yet been brought together. Moreover, it is rare for research to document the extent to which service provision declined as a result of the damage. References to the consequences of service delivery reductions are even more rare. No research reviewed here included information on the long-term consequences of reverberating effects.

**The United Nations Secretary-General** has repeatedly voiced his concern at the impact of explosive weapons on civilians in the context of protection of civilians<sup>27</sup> and children in armed conflict<sup>28</sup> and has perhaps taken the most comprehensive approach to covering the breadth of

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<sup>26</sup> Christina Wille, [The Implications of the Reverberating Effects of Explosive Weapons Use in Populated Areas for Implementing the Sustainable Development Goals](#), UNIDIR, 2016.

<sup>27</sup> Security Council, [Reports of the Secretary-General on the protection of civilians in armed conflict](#), UN documents S/2009/277, 29 May 2009); [S/2010/579](#), 11 November 2010; [S/2012/376](#), 22 May 2012; [S/2013/689](#), 22 November 2013; and [S/2015/453](#), 18 June 2015.

<sup>28</sup> General Assembly, Security Council, [Children and armed conflict: Report of the Secretary-General](#), UN document [A/68/878-S/2014/339](#), 15 May 2014; General Assembly, [Report of the Special Representative of the Secretary-General for Children and Armed Conflict](#), UN document [A/68/267](#), 5 August 2013; General Assembly, Security Council, [Children and armed conflict: Report of the Secretary-General](#), UN document [A/66/782-S/2012/261](#), 26 April 2012; General

reverberating effects by highlighting in his latest report his concerns regarding damage to schools, hospitals, “essential infrastructure” and places of worship. The Secretary-General’s 2013 report on children in armed conflict also mentions displacement as a consequence of the violence. Generally, however, his reports do not elaborate on the consequences of the damage and destruction. For reasons of space and the limited easily available data, these reports also do not provide information on the extent to which, for example, health or education services are reduced and the consequences of this for long-term health and education outcomes.<sup>29</sup>

**PAX**, in cooperation with the **United Nations Office for the Coordination of Humanitarian Affairs**, has provided a detailed description of how damage to infrastructure affected the provision of essential services in Libya<sup>30</sup> and Ukraine,<sup>31</sup> based on personal testimonies collected from affected people. This work strongly implies that damage and disruption caused by explosive weapons use in populated areas in conflicts in these countries is a cause of population displacement. In addition, it provides a useful sense of the kinds of indicator against which information could be systematically collected.

Specialized United Nations agencies and NGOs have researched and described specific areas of their concern and have gone deeper into the chain of events causing the reverberating effects. **UNICEF** has developed an approach to documenting the impact of explosive weapons use on children. In 2015, UNICEF specified the direct death toll among children, and also quantified the impact on children’s education, measured in terms of the number of schools that can no longer be used across Iraq, Libya, the Syrian Arab Republic and Yemen, because they are damaged or occupied (8,850). This estimate was used to help generate a broader estimate of the number of out-of-school children (34 million worldwide) in conflict-affected countries.<sup>32</sup> UNICEF also included information on selected health outcomes—such as 300,000 children in Gaza requiring psychological support.<sup>33</sup> The NGO **Save the Children** has also prepared documentation on reverberating effects on education<sup>34</sup> and children’s health.<sup>35</sup> These reports discuss both infrastructure damage and its consequences, measured in terms of reduced access to education or health care, such as the reduction in hours spent in school.<sup>36</sup>

The work by UNICEF and Save the Children demonstrates that it is possible to provide quantified estimates of changing levels of service provision, as well as the outcomes for people. It is an example of good practice for other sectors. However, because documentation of this harm has taken place predominantly in the last five years, neither entity has yet been able to measure the long-term consequences of explosive weapons use. While they have been able to demonstrate the reduction in hours spent in school, there is no available information on the consequences of this for educational achievements and on long-term impacts on children’s lives. However, work is

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Assembly, Security Council, [Children and armed conflict: Report of the Secretary-General](#), UN document A/6/820-S/2011/250, 23 April 2011.

<sup>29</sup> Security Council, [Protection of Civilians in Armed Conflict. Cross-Cutting Report](#), Security Council Report no. 3, 20 December 2013, p. 5.

<sup>30</sup> PAX and United Nations Office for the Coordination of Humanitarian Affairs (OCHA), [Shattered Lives. Civilians Suffer from the Use of Explosive Weapons in Libya](#), 2015, pp. 29–30.

<sup>31</sup> PAX and United Nations Office for the Coordination of Humanitarian Affairs (OCHA), [Collateral. The Human Cost of Explosive Violence in Ukraine](#), 2015.

<sup>32</sup> United Nations International Children's Emergency Fund (UNICEF) UK, [Keeping Children Safe in Emergencies](#), 2015, p. 3.

<sup>33</sup> United Nations International Children's Emergency Fund (UNICEF) UK, [Keeping Children Safe in Emergencies](#), 2015, p. 3.

<sup>34</sup> Save the Children, [Explosive Weapons and Grave Violations Against Children](#), Position Paper, 2013, p. 12.

<sup>35</sup> Save the Children, [Nowhere Safe for Yemen's Children. The Deadly Impact of Explosive Weapons in Yemen](#), 2015.

<sup>36</sup> Save the Children, [Explosive Weapons and Grave Violations Against Children](#), Position Paper, 2013, p. 12.



ongoing and based on existing research, Save the Children and UNESCO now know that children who do not complete education are at higher risk of child marriage and pregnancy,<sup>37</sup> and earn less throughout their lives.<sup>38</sup> The children of mothers with less education are also more at risk of stunting and infant mortality.<sup>39</sup> This highlights how much important information can be obtained by linking up with experts studying and monitoring social development more generally.

As mentioned earlier, **Action on Armed Violence (AOAV)** monitors the number of reported direct deaths and injuries from explosive weapons. It has discussed the use of different categories of explosive weapons on the civilian death toll.<sup>40</sup> AOAV was the first entity to quantify the harm caused by explosive weapons.<sup>41</sup> However, in view of a lack of data, its research generated reports of 100 incidents on the basis of quantified profiles, and AOAV pointed out that this remained an unrepresentative selection of case studies reflecting particular elements of the problem of explosive weapons use in populated areas. Since then, AOAV has discussed reverberating effects in a number of country- or topic-specific publications on Pakistan,<sup>42</sup> the Syrian Arab Republic,<sup>43</sup> the Boston Marathon bombing,<sup>44</sup> the London Underground bombing<sup>45</sup> and wide area impacts in Jordan, Ukraine and Yemen.<sup>46</sup> These case descriptions provide useful examples of the wider consequences of explosive weapons use in the absence of a standard framework.

**Handicap International** has also contributed to the existing information on secondary and tertiary impacts by providing a description of damage and the extent of contamination with explosive devices, and the consequences of displacement, in its publications on the Syrian Arab Republic.<sup>47</sup> Its current work on victim assistance has the potential to develop methodologies for the measurement of long-term impact.<sup>48</sup>

**The ICRC** mentioned the impact of explosive weapons use on health care for the first time in a 2011 report that provided the basis for the “Health Care in Danger” campaign, but at that point

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<sup>37</sup> If all girls had secondary education child marriage would fall by 64% and there would be 59% less pregnancy among girls under 17 years of age, according to UNESCO (United Nations Educational, Scientific and Cultural Organization (UNESCO), [Education Transforms Lives](#), 2013).

<sup>38</sup> Before the conflict, Syrian children who failed to complete their primary school education were likely to earn 32% less in their first job than Syrian children who completed secondary school and 56% less than Syrian children who completed university (Save the Children, [The Cost of War: Calculating the Impact of the Collapse of Syria's Education System on Syria's Future](#), 2015); According to a UNESCO study, one year of schooling increases an individual's earning by up to 10% (United Nations Educational, Scientific and Cultural Organization (UNESCO), [Education Counts: Towards the Millennium Development Goals](#), 2010).

<sup>39</sup> If all mothers completed primary education maternal mortality would fall by 66%; if all mothers had secondary education 12.2 million children would be saved from stunting and the lives of 3 million children under 5 years would be saved, according to UNESCO (United Nations Educational, Scientific and Cultural Organization (UNESCO), [Education Transforms Lives](#), 2013).

<sup>40</sup> Action on Armed Violence (AOAV), [Wide Area Impact Explosive Weapons in Populated Areas](#), 2016.

<sup>41</sup> Esther Cann and Catherine Harrison, [100 Incidents of Humanitarian Harm. Explosive Weapons in Populated Areas](#), Action on Armed Violence, 2011.

<sup>42</sup> Henry Dodd, [Anatomy of a Suicide Bombing: Investigating the Moon Market Attack in Lahore, Pakistan](#), Action on Armed Violence, 2014.

<sup>43</sup> Robert Perkins. [Syria's Shockwaves: The Consequences of Explosive Violence](#), Action on Armed Violence, 2014.

<sup>44</sup> Jane Hunter, [Blood on the Streets of Boston. Reviewing the Response to the April 2013 Marathon Bombings](#), Action on Armed Violence, 2014.

<sup>45</sup> Action on Armed Violence, [The London Bombings Ten Years on: Why More Needs to Be Done to Tackle IED Attacks](#), 2015.

<sup>46</sup> Action on Armed Violence, [Wide Area Impact Report](#), 2015, <https://aoav.org.uk/category/wide-area-impact-report/>.

<sup>47</sup> Handicap International, [Factsheet May 2015. Kobani: A City of Rubble and Unexploded Devices](#), 2015; Handicap International, [The Use of Explosive Weapons in Syria. A Time Bomb in the Making](#), 2015.

<sup>48</sup> Handicap International, [Victim Assistance in the Context of Mines and Explosive Remnants of War](#), 2011.

was not able to specify the impact of explosive weapons use on health outcomes.<sup>49</sup> A 2015 expert meeting convened by the ICRC on issues around explosive weapons use addressed the effects of explosive weapons on health care from an ICRC humanitarian and legal viewpoint.<sup>50</sup> This work was followed by the 2015 “Challenges report”<sup>51</sup> which discussed the applicability of international humanitarian law in more detail.

The ICRC’s report, “Bled Dry—How War in the Middle East Is Bringing the Region to the Brink of a Water Catastrophe”, provided an insight into the impact of damage to water and sanitation systems.<sup>52</sup> While the ICRC warned of health consequences, it did not provide specific figures on how health deteriorated as a result of the damage. The report on “Urban Services During Protracted Conflicts” provided further useful information on the impact of explosive weapons without specifically focusing on explosive weapons.<sup>53</sup>

**Reaching Critical Will**, the disarmament programme of the **Women’s International League for Peace and Freedom**, an NGO, has discussed explosive weapons from an arms trade perspective and advocated more restrictions on the international transfer of explosive weapons, highlighting death and injury of civilians and damage and destruction of civilian infrastructure without specifying the reverberating effects that resulted from the damage and destruction.<sup>54</sup> Reaching Critical Will has also provided information on State positions and international action on the development of political commitment to end the use of explosive weapons in populated areas.<sup>55</sup>

**Human Rights Watch** has documented civilian deaths from explosive weapons and has discussed the events, such as the unlawful airstrikes on Saada, from a legal perspective.<sup>56</sup> In a report jointly published with the Harvard Law School’s International Human Rights Clinic, Human Rights Watch discussed possible normative solutions and advocated a new non-binding agreement to reduce the harm from explosive weapons, and offered options for developing such an agreement.<sup>57</sup>

**In summary**, the examples cited above show that research on reverberating effects has advanced as a result of parallel initiatives by many different actors in different fields. Collectively, it indicates the further potential for those with sector-specific expertise to document the extent to which service provision is affected by damage and destruction. There are also promising efforts to measure the reduction in services on people’s lives and well-being that could be developed further and extended into further sectors. Overall, however, reverberating effects research currently lacks

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<sup>49</sup> International Committee of the Red Cross (ICRC), [Healthcare in Danger. A Sixteen-Country Study](#), 2011; ICRC, [Healthcare in Danger. Making the Case](#), 2011, p. 5.

<sup>50</sup> International Committee of the Red Cross (ICRC), [“Explosive Weapons in Populated Areas—Humanitarian, Legal, Technical and Military Aspects”](#), presentation at the Explosive Weapons in Populated Areas—Humanitarian, Legal, Technical and Military Aspects expert meeting, Chavannes-de-Bogis, Switzerland, 24–25 February 2015.

<sup>51</sup> International Committee of the Red Cross (ICRC), [International Humanitarian Law and the Challenges of Contemporary Armed Conflicts](#), 2015, Chapter VII, part 2.

<sup>52</sup> International Committee of the Red Cross (ICRC), [Bled Dry—How War in the Middle East is Bringing the Region to the Brink of a Water Catastrophe. An ICRC Report](#), March 2015, p. 5.

<sup>53</sup> International Committee of the Red Cross (ICRC), [Urban Services During Protracted Armed Conflict. A Call for a Better Approach to Assisting Affected People](#), 2015.

<sup>54</sup> Reaching Critical Will of the Women’s International League for Peace and Freedom, [Trading Arms, Bombing Towns. The Lethal Connection Between the International Arms Trade and the Use of Explosive Weapons in Populated Areas](#), 2015.

<sup>55</sup> Ray Acheson, [Political Action to End the Use of Explosive Weapons in Populated Areas](#), Reaching Critical Will of the Women’s International League for Peace and Freedom, Peace in Progress no. 26, 2016; Reaching Critical Will of the Women’s International League for Peace and Freedom, [States Move to Stop Bombing and Bombardment in Towns and Cities](#), 2015.

<sup>56</sup> Human Rights Watch, [“Targeting Saada: Unlawful Coalition Airstrikes on Saada in Yemen”](#), 30 June 2015.

<sup>57</sup> Human Rights Watch, [“Making a Commitment: Paths to Curbing the Use of Explosive Weapons in Populated Areas”](#), 19 June 2015, <https://www.hrw.org/news/2015/06/19/civilian-harm-explosive-weapons>.

a unifying framework and standard way of collecting, categorizing and analysing relevant data, and has not yet covered some important areas such as food security and livelihoods in depth.

## 5.2 Approaches among actors concerned with the reverberating effects of explosive weapons outside the explosive weapons discourse

There are several agencies whose mandate is affected by the use of explosive weapons in populated areas, but which have not identified the contributing role of explosive weapons. This is a missed opportunity, and an improved understanding of reverberating effects would benefit from closer engagement with these actors.

The **development community** implementing the SDGs has generally not discussed the SDG targets with reference to explosive weapons. Yet the work by UNIDIR examining five central development goals showed that explosive weapons constitute a severe obstacle to global achievement of several of the targets. Engagement with the SDGs from an explosive weapons perspective also highlighted important areas of reverberating effects that had not yet been considered by the explosive weapons community, notably hunger. Future collaboration between the development and the explosive weapons communities is likely to identify more areas of reverberating effects not yet covered by development agencies. In addition, the SDGs are accompanied by the development of key indicators that would be of use in defining measures of reverberating effects both in terms of the extent of interruption of services and the impact on people's lives and well-being.<sup>58</sup>

The "Urban Themes"<sup>59</sup> of the **United Nations Human Settlements Programme (UN-HABITAT)** directly relate to the reverberating effects of explosive weapons use, but UN-HABITAT and its partners do not appear to be aware of explosive weapons concerns. UN-HABITAT has indirectly referred to reverberating effects by drawing attention to the 42 million people displaced by conflict and persecution (2011 figure).<sup>60</sup> UN-HABITAT's responsibilities for strengthening the capacity of governments and local authorities and civilian society "to manage human-made (...) disasters affecting human settlements"<sup>61</sup> is central to the missing "resilience piece" in the puzzle of describing the long-term impact of the reverberating effects. In addition, the work of UN-HABITAT also directly relates to sectors such as water and sanitation, and energy, which are often heavily affected by explosive weapons use in populated areas.

The mandate of the **United Nations Educational, Scientific and Cultural Organization (UNESCO)** to protect world heritage led the agency to identify explosive weapons as the cause of destruction of several World Heritage Sites. UNESCO has mentioned explosive weapons in the Bonn Declaration on World Heritage of 2015, which "deplores the indiscriminate use of weapons and explosives" in drawing attention to the numerous World Heritage Sites that have been destroyed.<sup>62</sup> The Declaration is part of a global coalition, "Unite for Heritage", which seeks to mobilize actors beyond the cultural and heritage communities. It seeks to sensitize the general public and young

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<sup>58</sup> The list of indicators will be considered by the Economic and Social Council in July 2016, and subsequently submitted to the General Assembly for adoption (see Economic and Social Council, [Report of the Inter-Agency and Expert Group on Sustainable Development Goal Indicators: Note by the Secretary-General](#), UN document E/CN.3/2016/2/Rev.1, 19 February 2016).

<sup>59</sup> United Nations Human Settlements Programme (UN-HABITAT), "[Urban Themes](#)".

<sup>60</sup> United Nations Human Settlements Programme (UN-HABITAT), "[Reconstruction](#)".

<sup>61</sup> United Nations Human Settlements Programme (UN-HABITAT), "[Reconstruction](#)".

<sup>62</sup> United Nations Educational, Scientific and Cultural Organization (UNESCO), "[The Bonn Declaration on World Heritage](#)", Article 18.

people in particular to culture's unifying force.<sup>63</sup> There may be potential linkages between explosive weapons work and the UNESCO campaign.

**The World Health Organization (WHO)** developed a tracking system on attacks on health care, which it uses to draw attention to violence against health infrastructure, personnel and patients.<sup>64</sup> It has identified various explosive weapons as having caused the damage and destruction to hospitals, but has not articulated the resulting concerns using the concepts and terms of the explosive weapons discourse.

**In summary**, there are agencies whose work relates to the reverberating effects of explosive weapons, but which do not frame this within an explosive weapons discourse. The overall understanding of the reverberating effects would benefit from closer collaboration among these actors.

### **5.3 Research on reverberating effects in relation to cross-cutting issues**

Research on the reverberating effects of explosive weapons is relevant to cross-cutting issues, such as gender and human rights.

There can be little doubt that explosive weapons violence affects gender relations. Reaching Critical Will recently produced the first overview of known information on how explosive weapons affect women.<sup>65</sup> However, the topic has not yet been taken up by gender researchers. Case studies by gender researchers have made important contributions to the understanding of other aspects of gender and armed violence. More engagement by the gender research community could further this work and help inform the understanding of reverberating effects.

Human rights considerations have been largely absent from the debate on how explosive weapons affect people. However, human rights law is a relevant legal framework because human rights protection does not cease in times of armed conflict,<sup>66</sup> something noted since the emergence of the explosive weapons policy and research agenda.<sup>67</sup> The use of an explosive weapon risks having a negative impact on the enjoyment of a wide range of human rights, including, most immediately, the right to life. The destruction of homes can amount to a violation of the right to respect for private and family life and for one's home, or a violation of the right to freedom of movement and residence if it forces people to leave their homes. In addition, the reverberating effects of explosive weapons can also affect a host of economic, social and cultural rights, for example through their impact on health and education infrastructure or the destruction of cultural monuments. Moreover, human rights also offer the possibility for redress. Discussing explosive weapons from a human rights perspective would strengthen engagement with the SDGs, which are grounded in human rights and the wider human rights community.

**In summary**, a comprehensive view of reverberating effects will require more engagement by other research communities, notably on gender and human rights.

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<sup>63</sup> United Nations Educational, Scientific and Cultural Organization (UNESCO), "[Launch of Global Unite for Heritage Coalition in Bonn](#)", 29 June 2015.

<sup>64</sup> World Health Organization (WHO), "[Tracking Attacks on Health Workers—Don't Let Them Go Unnoticed](#)", December 2015.

<sup>65</sup> Reaching Critical Will of the Women's International League for Peace and Freedom, [Women and Explosive Weapons](#), 2014, p. 17.

<sup>66</sup> Maya Brehm, "The Human Cost of Bombing Cities", *Sur International Journal on Human Rights*, vol. 22, December 2015.

<sup>67</sup> Richard Moyes, *Explosive Violence: The Problem of Explosive Weapons*. Landmine Action, 2009.

## 6. The way forward: advancing the research on the reverberating effects of explosive weapons

This brief review of some existing practices and gaps in our knowledge suggests that in taking forward a research and policy agenda on reverberating effects, interested parties could usefully focus on the following:

- **development of a framework** that brings the existing pieces of the knowledge puzzle together;
- **better information exchange** between actors already working on documenting reverberating effects so that different sectors can share best practice;
- **improved engagement** with actors not yet engaged in the explosive weapons discourse but with expertise in areas of reverberating effects;
- **identification of the appropriate indicators** to document the changes in service delivery and their impact on people's lives and well-being; and
- **monitoring of damage to infrastructure.**

To date, different actors have moved along slightly differing paths in their research on the reverberating effects of explosive weapons use in populated areas. Finding a way forward thus suggests **bringing together the existing knowledge and utilizing existing resources** as much as possible while developing a common framework and identifying appropriate indicators to measure reverberating effects.

It would be useful to have a group of knowledgeable practitioners develop a **joint framework, exchange best practice information** and **decide on the most appropriate indicators** to be used within a standard framework. While there are no obvious candidates in this regard, a **Group of Experts** set up by Geneva International Centre for Humanitarian Demining to advise the Characterization of Explosive Weapons project is notable for having strengthened contacts between researchers from different organizations on various issues, including reverberating effects. Some sort of working group in this mould, adequately supported and meeting perhaps twice a year, could be envisaged as a means of **developing a joint framework, exchanging best practice** information and **deciding on the most appropriate indicators** to be used within a standard framework.

### Box 5: A suggestion for building the research agenda on reverberating effects

- Set up a working group on this theme.
- Within the working group, develop and approve the common framework on reverberating effects and identify and decide on the appropriate indicators to measure changes in service delivery and people's lives and well-being.
- Set up monitoring of damage to infrastructure.
- Seek to bring in natural allies such WHO, UN-HABITAT and UNESCO.
- Promote updates on the subject of explosive weapons among gender and human rights researchers.

## 7. Concluding thoughts

This paper has discussed the reverberating effects of explosive weapons use, and suggests that a framework to conceptually unify various approaches to documenting and analysing these effects would be useful. Moreover, the progress already made in understanding the problem of explosive weapons use in populated areas suggests that such a framework would be feasible, and that the data and findings it generates might provide additional political impetus to enhancing civilian protection. Use of standard indicators on the extent to which critical service provision is affected and the impact this has on people's well-being is possibly further advanced than many realize. The education sector in particular has identified the necessary information to be fed into a comprehensive framework that monitors the impact on services and the impact of reduced education on children. Moreover, if work on SDG indicators is utilized, it may be possible to identify appropriate indicators to help to populate the reverberating effects framework on many other aspects of reverberating effects. Irrespective of this, dedicated work within a working group and improved sharing of best practices and information would benefit understanding of reverberating effects by drawing attention to common methodological challenges and possible approaches to overcoming these challenges.

It is striking that, at present, there is **no systematic monitoring of damage to infrastructure from explosive weapons use**. Media reports and press releases by humanitarian organizations report some of the damage in an ad hoc way, but this is far from systematic or timely. Current technological developments, such as the e3e Monitor, suggest that monitoring could become a reality, and at low cost, if the explosive weapons community and funders recognize its potential and support it.

In conclusion, more focused and systematic research on the reverberating effects of explosive weapons use in populated areas would contribute to a fuller picture of the human costs. It may be that the direct death and injury from explosive weapons use—as serious as it is, standing at least 33,307 civilians in 2015, according to AOAV<sup>68</sup>—is just the tip of the iceberg in terms of measurable harm. The research community on explosive weapons has already made important progress. Its continued efforts could benefit from a unifying framework and common indicators on reverberating effects that are understood and used by the different entities involved in the grim business of documenting the harm caused by the use of explosive weapons in populated areas.

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<sup>68</sup> Action on Armed Violence (AOAV), [Unacceptable Harm: Monitoring Explosive Violence in 2015](#), 2016.