

Study
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Death Sentence to Civilians: The Long-Term Impact of Explosive Weapons in Populated Areas in Yemen



Humanity & Inclusion

Humanity & Inclusion (HI), also known as Handicap International, has supported physical and functional rehabilitation services for persons with disabilities in Yemen from the early 2000s up to 2012. Since 2015, HI has been offering direct services to all individuals affected by the ongoing conflict. HI provides rehabilitation services and assistive devices and technologies, offers psychosocial support, and works to ensure that the most vulnerable have access to humanitarian aid.

As a co-founder of the International Network on Explosive Weapons (INEW), HI has been active in the international process toward a political declaration on protecting civilians from the use of explosive weapons with wide area effects in populated areas. HI has been working with States, United Nations agencies, and civil society organisations to ensure that the political declaration includes clear commitments to strengthening the protection of civilians from explosive weapons, and strong provisions on victim assistance (VA), building on internationally-recognised victim assistance obligations.

Acknowledgements

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Glossary

AOAV	Action on Armed Violence	INEW	International Network on Explosive Weapons
CIMP	Civilian Impact Monitoring Project	INGO	International non-Governmental Organisation
EWIPA	Explosive Weapons in Populated Areas	OCHA	Office for the Coordination of Humanitarian Affairs
GEE	The Group of Eminent Experts on Yemen	UN	United Nations
HI	Humanity & Inclusion (also known as Handicap International)	UNIDIR	The United Nations Institute for Disarmament Research
ICRC	International Committee of the Red Cross	WASH	Water, Sanitation and Hygiene
IDP	Internally Displaced Person	WFP	World Food Programme
IED	Improvised Explosive Device		

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Executive Summary

Yemen is entering its sixth year of conflict and remains one of the world's worst humanitarian crises. **The importance of public services and infrastructure** in the midst of a crisis cannot be understated. This is even clearer as the world adapts to the new paradigm imposed by the COVID-19 pandemic. Public health, the provision of safe water, the capacity to deliver food to a population, and the ability to freely move and transport goods or people are critical services for survival.

In Yemen, the massive use of explosive weapons with wide area effects in populated areas has not only had deadly consequences for civilians, but has also had a dramatic impact on the infrastructure and systems that civilians depend upon to **access essential services**. Yemen shows how the **long-term** or **reverberating effects** of explosive weapons use, referring to how the destruction of infrastructure has implications for the wider systems of services in a country, are just as deadly in a crisis as injuries from the explosion and even impact a greater number of people than those in the vicinity of the original attack. The damage inflicted on the **infrastructure and services** necessary for food, transport, health, and water threaten civilians and prolong suffering long after the bombing has ended.

The reverberating or long-term effects of explosive weapons use touch on every resource and system in a country. This can include civilians' homes, transportation networks, water and sanitation systems, electricity and power grids, telecommunications systems, hospitals and health facilities, and public buildings. Damage to and destruction of these systems and structures have severe and long-lasting effects. **Lack of services** caused by the destruction of facilities or infrastructure, as well as the **restriction of movement** influenced by **long-term contamination**, are all reverberating effects of explosive weapons when used in populated areas.

In Yemen, where nearly **three-quarters of the population is considered in need of humanitarian aid**, all infrastructure and public services are indispensable to the survival of the population. The consequences of reverberating effects of

explosive weapons use in Yemen have been amplified by in-country **pre-existing conditions**, including reliance on imports, weak infrastructure, water scarcity, and poverty. Damage to infrastructure by explosive weapons throughout Yemen has an interrelated impact on other services.

In Yemen, **16 million people** are severely **food insecure**.⁽¹⁾ Infrastructure, including ports on the Red Sea and storage facilities for offloading imports, are vital to ensuring that Yemen can import and distribute necessary goods, including food, fuel, and medicine. This can be clearly seen when damage caused by aerial bombardment of the cranes at Hodeidah Port in 2015 limited the port's ability to offload containerised cargo, thereby endangering the supply of critical food stores that could enter Yemen. In 2018, **WFP humanitarian food aid was blocked for 6 months at the Red Sea Mills by ongoing conflict, including shelling and airstrikes in Hodeidah**. The impact of this was restricted food access for **half a million households**.⁽²⁾

Transport systems, including roads and bridges, both critical infrastructure components needed to ensure the provision of supplies and a population's access to services, have been extensively damaged by the use of explosive weapons. The impact of road closures and the destruction of transportation networks makes it harder to transport humanitarian aid, to trade economic goods, to maintain livelihoods, and to access health facilities. The formerly two-day journey between Yemen's major seaports to Sana'a and other large cities can now take up to five days, contributing to the tripling of the price of key commodities such as wheat, flour, and steel since 2015.⁽³⁾ **Airstrikes that damaged bridges on the main road to Sana'a in 2016 disrupted the link for 90% of WFP's food supplies delivered from Hodeidah**.⁽⁴⁾

Health services compromised through the destruction of health facilities and the disruption in the transport of essential medical supplies are another example of the reverberating effects of explosive weapons. In Yemen, **49 % of the health facilities are no longer fully functional**.⁽⁵⁾ The

destruction of health facilities in Yemen has denied access to health services for up to **200,000 people in one fell swoop.**⁽⁶⁾ When key transport hubs are destroyed or made unsafe due to contamination by unexploded explosive weapons, then critical medical supplies and medicines are not delivered. Even the threat of contamination by unexploded ordnance restricts patients from coming to health facilities when needed. Some patients reaching HI-supported medical facilities may have a journey of up to 16 hours. **Yemen cannot afford the severe and long-lasting effects of explosive weapons on health facilities while 19.7 million people lack access to adequate healthcare.**⁽⁷⁾

The destruction of **water infrastructure** is another illustration of the long-term consequences of explosive weapons. Sa'ada, a governorate that has experienced some of the most focused explosive weapons violence throughout the conflict, has suffered significant damage to water infrastructure facilities, with an estimated **35,000 households** affected in 2018 alone.⁽⁸⁾ **Yemen cannot afford the incidental or targeted destruction of water infrastructure when over two-thirds of the population currently requires WASH support to meet their basic needs.**⁽⁹⁾

Despite the recent UNSG global call for a ceasefire,⁽¹⁰⁾ conflict in Yemen continues unabated. The conflict in Yemen is known for the extensive use of nearly every form of explosive weapon, including **aircraft bombs and missiles, artillery, mortars, and IEDs.** Prohibited weapons such as landmines and cluster munitions are also widely used in Yemen and contribute **to long-term contamination by explosive weapons.** Many of these weapons have been used in populated areas such as towns, villages, and cities, where they have an indiscriminate effect on civilians.

Due to the inaccuracy inherent in their design and use, some explosive weapons have wide area effects that cause **death, injuries, wide-scale destruction of infrastructure, and long-term contamination** that have an indiscriminate impact on civilians. As evidenced in this report on the Yemeni context, parties to the conflict,



Physical therapy at a HI supported Sana'a rehabilitation center.
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States, international agencies, and humanitarian actors cannot turn a blind eye to this systematic pattern of harm. For this reason, States, UN agencies, international organisations, and civil society, including HI and other members of the International Network on Explosive Weapons, are working to end the harm caused by explosive weapons in populated areas by setting international norms against their use and are calling on all States to support the development of a strong **political declaration against the use of explosive weapons with wide area effects in populated areas.**

1.

Introduction



Destroyed telecommunications Center on Kamaran Island in Hodeidah Governorate. March 2020. © HI

In five years of conflict, Yemen has been heavily hit by the widespread use of explosive weapons. Bombing and shelling do more than kill on impact; they destroy the infrastructure and systems that people rely on to survive. The destruction of infrastructure and essential services causes **reverberating effects** that disrupt every aspect of people's lives, including shelter, food security, health, and livelihoods, while also contributing to displacement. These **long-term effects of explosive weapons use** continue to cause additional casualties and increase the long-term vulnerability of people.

In Yemen, the **effects of explosive weapons use in populated areas have exacerbated the world's largest humanitarian crisis**. The destruction of essential infrastructure has contributed to hunger and disease, and dramatically reduced the ability of the population to access essential services such as clean water and electricity, and to move freely between their homes and even between cities.

In Yemen, **24.1 million people require humanitarian support** and are facing severe food insecurity — compounding risks of malnutrition and water-borne diseases — and a crippling economic blockade.⁽¹¹⁾ In this context, where more than three-quarters of the population are in acute humanitarian need, the reverberating damage of explosive weapons to infrastructure and civilians' homes directly undermines the population's chances for survival.

There is currently no legal prohibition against the use of explosive weapons in cities or other populated areas. However, explosive weapons use must comply with IHL, which prohibits the indiscriminate use of weapons and their disproportionate impact on civilians. Because of the high population density in towns and cities, weapons with wide area effects cannot be used discriminately. Globally, **90% of casualties from explosive weapons used in populated areas are civilians**.⁽¹²⁾ For this reason, many non-governmental organisations and 109 States and territories have publicly acknowledged the harm caused by explosive weapons in populated areas in their statements.⁽¹³⁾ The President of the ICRC and the UN Secretary General have issued a joint appeal on the use of explosive weapons in cities, calling for an end to the devastation and civilian suffering.⁽¹⁴⁾

This report provides an overview of how long-term or **reverberating effects** of explosive weapons use have contributed to the collapse of the critical systems and infrastructure upon which civilians depend to survive. In showing case studies of the reverberating effects of explosive weapons in Yemen, this report seeks to add to the momentum toward a strong political declaration to end human suffering caused by the use of explosive weapons with wide area effects in populated areas.

Defining Explosive Weapons and Reverberating Effects

Explosive Weapons

Explosive weapons are a category of weapons that project an explosive blast, heat, and fragmentation around a point of detonation.⁽¹⁵⁾ These include **aircraft bombs and missiles, artillery shells, mortars, and rockets, and multi-barrel rocket launchers, as well as improvised explosive devices (IEDs)**. These weapons are often launched from airborne vehicles such as airplanes, helicopters, and drones, leading to high dispersal areas and ineffective targeting. They may also be launched from ground-based vehicles or by hand.⁽¹⁶⁾ In Yemen, nearly every form of explosive weapon has been used.

Explosive weapons with wide area effects are devastating because of their large blast radius and fragmentation effect, inaccuracy of the delivery of the weapons, and the frequent practice of simultaneously releasing multiple explosive weapons munitions across an area. These wide area effects cause death, injury, and wide-scale destruction of infrastructure in areas far beyond the initial point of impact. This ensures that even if weapons are aimed at military targets, the use of such weapons in villages, towns, and cities will likely risk indiscriminate civilian casualties and disproportionate damage to vital infrastructure.

Reverberating Effects – The Long-Term Effects

Reverberating effects are the long-term impacts of explosive weapons use. The term captures effects beyond the initial high-pressure blast wave caused by the detonation of explosive weapons. Often understood as tertiary effects or indirect effects, these reverberating effects capture the extent of damage that occurs after the bombing.

Effects caused by explosive weapons can be categorised in three stages as explained by the United Nations Institute for Disarmament Research (UNIDIR):⁽¹⁷⁾

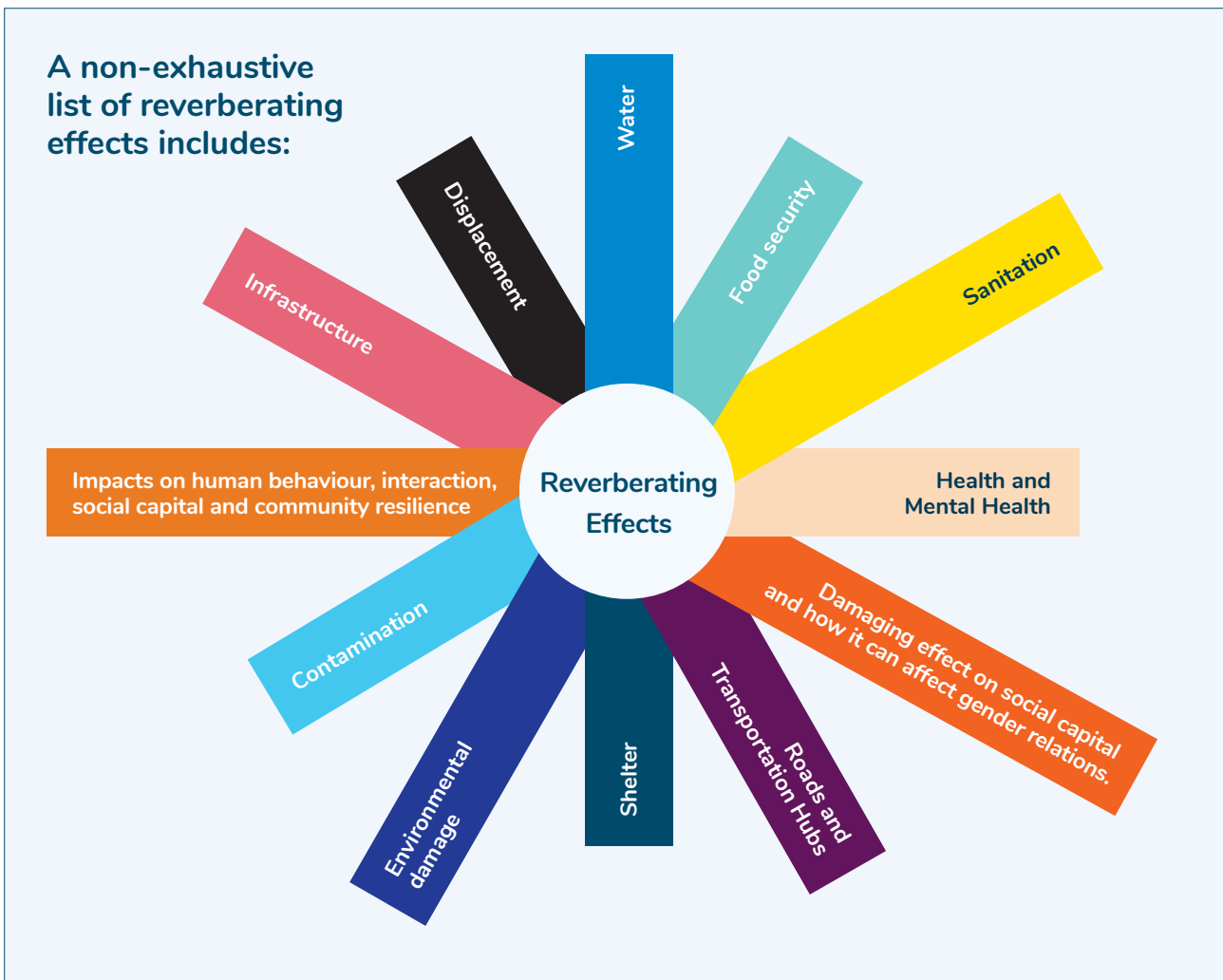
- **Primary** effects are the immediate impacts caused by the high-pressure blast wave resulting from the detonation of explosive weapons. This can include the immediate physical injuries and fatalities caused by fragmentation, explosives, and the release of thermal heat.
- **Secondary** effects are those created by the interaction of the blast wave and the environment in which the explosive weapons detonate. For example, as the blast wave travels through the air it can be absorbed by surrounding structures, causing the collapse or destruction of buildings. Civilians may then suffer injuries or fatalities from the structural collapse of the building, shattered glass, or fire.
- **Tertiary** effects are the long-term impacts on people's living conditions caused by explosive weapons damage. These effects are caused by damage to or destruction of vital infrastructure, such as shelter, sanitation systems, health facilities, and livelihoods. It also includes the wide range of consequences caused by reduced access to services and the destruction

of infrastructure that people need to survive.

For many practitioners, these tertiary effects are understood as long-term, indirect, or reverberating effects.

This report explores such tertiary or long-term effects of explosive weapons under the terminology of reverberating effects. This report has been heavily inspired by the definition of reverberating effects used by the International Network on Explosive Weapons (INEW): “encompassing the capacity for damage explosive weapons can cause where damage to one component of infrastructure has implications for other systems and services.”⁽¹⁸⁾ For this report, the terminology **reverberating or long-term effects** will be used. In other literature, 'indirect' or 'tertiary' are also common terms for describing the same range of effects.

Reverberating effects include damage to systems and structures such as civilians' homes, transportation networks, water and sanitation systems, electricity and power grids, telecommunications systems, hospitals and health facilities, and public buildings. It also entails the impact caused by the lack of access to services that occurs after the destruction of facilities or infrastructure involved with health, education, cultural and religious practices, livelihoods, and food security. These long-term impacts can affect civilians for decades after the explosive weapons event. The legacy of contamination by unexploded ordnance from explosive weapons, as well as forced displacement due to insecurity or the destruction of services, are also reverberating effects caused by the use of explosive weapons.



The Wide Area Impact of Explosive Weapons in Yemen

Over 40,000 armed conflict events⁽¹⁹⁾ have been recorded in Yemen since the beginning of the conflict. Among these instances of armed violence, nearly every form of explosive weapon has been used, including aircraft bombs, artillery shells, mortars, and IEDs. Prohibited weapons such as landmines and cluster munitions – which also cause long-term contamination – are likewise widely used in Yemen. Action on Armed Violence (AOAV) found that in 2015 during the first year

of conflict, “Yemen saw more civilian deaths and injuries from air-dropped bombs than anywhere else in the world.”⁽²⁰⁾ Throughout the conflict, such weapons with wide area impacts have been used extensively in populated areas such as villages, towns, and cities with devastating impact. From their data on Yemen, AOAV has found that in cases of explosive weapons used in populated areas, **95% of casualties were civilians.**⁽²¹⁾

Methodology

Access for conducting field research and collecting data is highly constrained in Yemen, as such data on explosive weapons comes from mostly open-source reporting that cannot be independently verified. For this report, HI relied on a secondary data review, as well as 17 key informant

interviews conducted with INGOs, UN agencies, and stakeholders to document critical examples of reverberating effects of explosive weapons in Yemen. The interviewees were selected based on their specific expertise in Yemen and their thematic specialties to cover a wide array of potential

impacts. These interviews and research took place from January to March 2020.

While this study has tried to broadly assess the topic of reverberating effects, it does not seek to provide an exhaustive list of all these effects in Yemen. The focus is on demonstrating significant examples that are indicative of long-lasting damage throughout Yemen.

This study likewise does not **address the intentionality of specific explosive weapons**

uses. In describing the extent of reverberating effects, this report shows the indiscriminate impact of any explosive weapon in view of the critical humanitarian needs in Yemen. The case studies in this report show that the intentionality factor (meaning the intentional nature of the attack) becomes secondary when compared to the extent of the humanitarian impact and long-term consequences of explosive weapons, especially those with wide area effects.

Measuring Reverberating Effects of Explosive Weapons Use in Yemen: A Difficult Task

Documenting the indirect and long-lasting effects of explosive weapons use is challenging during crises. While the link between explosive weapons with wide area effects and civilian casualties is clear, there remains no single standard approach or methodology that brings the “full range of reverberating effects” together in one analysis.⁽²²⁾ Data on explosive weapons focuses primarily on the immediate effects of the destruction and not on the long-term impacts on the population. It is also difficult to assess the impact of explosive weapons separately from the interlinked effects of conflict.

This report does not attempt to provide a methodology for assessing the full range of reverberating effects. It may take decades to fully capture the long-term impact of explosive weapons. Instead, this report presents indicative data on existing needs, vulnerabilities, and potential long-term impacts to demonstrate the significance of reverberating effects of explosive weapons use in Yemen. When contextualised with an understanding of the humanitarian crisis, the case studies in this report show how devastating the impact of explosive weapons is for civilians and how reverberating effects will continue to drive civilians’ vulnerability for years after the event.

Though this report does not propose a research methodology for assessing reverberating effects, the following points are critical guidance for analysing these effects in Yemen.

Pre-Existing Conditions

When infrastructure is limited or resources such as water or food are scarce, the potential impact of explosive weapons is amplified.⁽²³⁾ Yemen has long faced structural challenges concerning water

scarcity, food insecurity, and poverty.⁽²⁴⁾ The Group of Eminent Experts on Yemen (GEE) have noted that “the destruction and damage the conflict has caused to the already limited infrastructure and access to basic services, such as medical care, education and justice, have significantly affected the resilience of vulnerable communities.”⁽²⁵⁾ This report will highlight the pre-existing conditions in Yemen as evidence of the severe repercussions on the country's limited resources and infrastructure.

Compounding Effects in a Humanitarian Crisis

Bombs do not fall in isolation. The wide area effects of explosive weapons exacerbate the existing factors already driving the crisis in a country. The crisis in Yemen is highly influenced by economic and access challenges, including the sustained blockade, non-payment of public sector salaries, and a devaluation of the local currency, critical factors that increase the vulnerability of populations. Data on humanitarian needs in Yemen is presented to show how intensely felt the impact of explosive weapons will be among civilians given the existing crisis.

Interrelated Effects

Explosive weapons cause massive damage in populated areas. Their effects often cannot be limited to a single structure or service. For this reason, there is frequent overlap between the reverberating effects documented in the case studies presented. The infrastructure used to import food is impacted by damage to the roads in much the same way as a population's access to hospitals can be hindered by the destruction of roads and bridges.

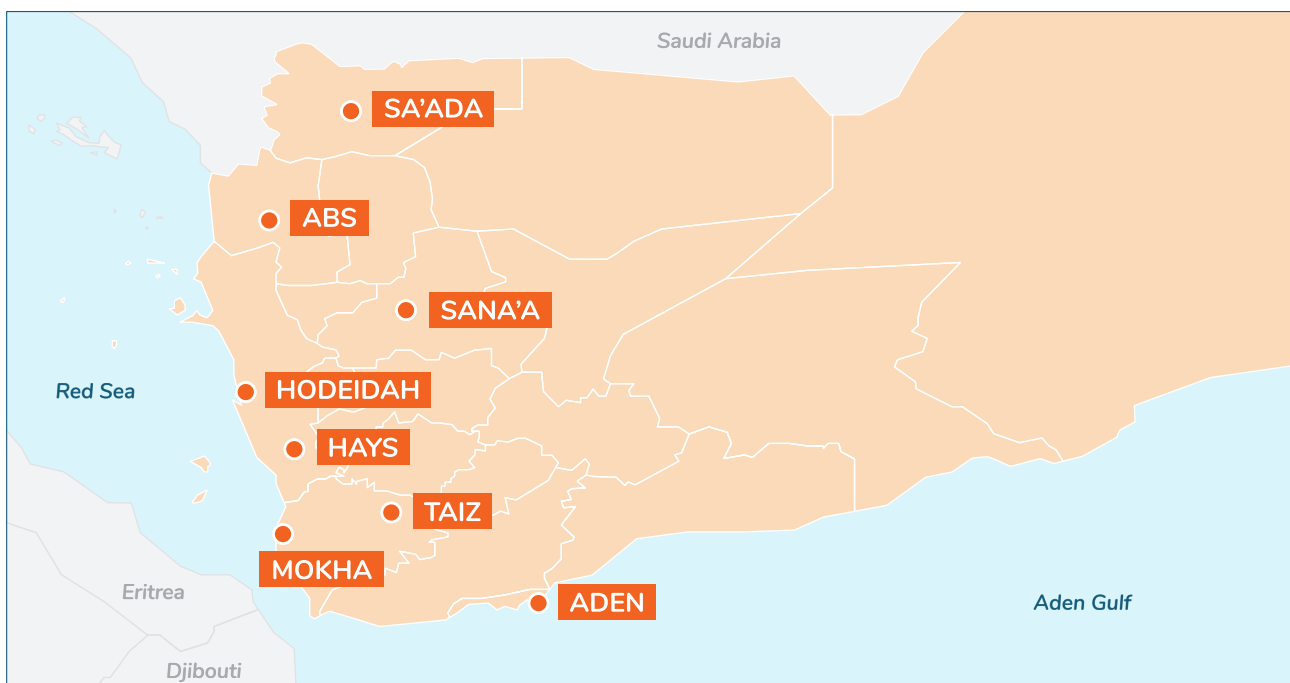
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Reverberating Effects of Explosive Weapons Use in Yemen: Case Studies

Civilians houses destroyed by airstrikes in Hodeidah. September 2018. © HI

In a country where nearly **three-quarters of the population are considered in need of humanitarian aid**, all infrastructure and public services are indispensable for the survival of the population. The following shows how the reverberating effects of explosive weapons use have direct consequences on civilians' needs, the infrastructure they rely on, and their access to basic services during a humanitarian crisis. Using critical examples of damage inflicted on the structures, infrastructure, and facilities necessary for **food, transport, health, and water**, this report shows how damage from explosive weapons has exacerbated the humanitarian crisis in Yemen.

The case studies included in the report do not capture the full extent of explosive weapons use in Yemen. The examples included here are symbolic of the long-term impact of explosive weapons, but there remain many dimensions of reverberating effects that are not captured in this study. The cases studies chosen often overlap, as the impact of the destruction of one infrastructure component directly affects the provision of other services. The purpose of this report is to provide only a snapshot of what explosive weapons, especially those with wide area effects, have destroyed and how that destruction affected the population beyond the initial impact.



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2.1 Hodeidah Port and the Red Sea Mills: The Impact of Explosive Weapons on Food Security in Yemen



Destroyed telecommunications Center on Kamaran Island in Hodeidah Governorate. March 2020. © HI

Over 50% of Yemenis (16 million people), are severely food insecure.⁽²⁶⁾ In a crisis, food security is largely driven by economic and access factors. The use of explosive weapons in populated areas and near critical infrastructure can have a

significant impact for ensuring food security. Two cases in Yemen, damage to Hodeidah Port and incidents affecting the Red Sea Mills, illustrate how single uses of explosive weapons can have dramatic effects.

Hodeidah Port

Hodeidah Port is Yemen's largest port and a vital lifeline for food security. Yemen is highly dependent on imports delivered principally through sea channels. Before the conflict, Yemen imported nearly 90% of its necessary goods including food, medicine, and fuel. The ports on the Red Sea are the only harbours in Yemen with sufficient berthing space to receive large container ships and storage facilities to receive large quantities of necessary goods such as fuel.

In August 2015, Hodeidah Port was heavily damaged by airstrikes that destroyed the port's control towers, main gantry cranes, and several of the warehouses. This damage immediately reduced the port's capacity to receive critical imports, including the food, medicine, and fuel upon which Yemen depends. After the incident, it took six weeks for one crane to be repaired.

Overall, there was a reported **28% rise in food prices across** Yemen in the period between August and September 2015.⁽²⁷⁾ Reduced port capacity meant that not only was Yemen receiving less food, but also smaller amounts of the fuel needed to power generators that enable Yemen's water systems, health facilities, and even the transport of goods.

The sustained blockade in Hodeidah and frequent conflict escalation in the city have continued to hamper the port's ability to unload much-needed supplies. Yet there is no substitute for Hodeidah Port, which is the logistics hub and transportation gateway to northern Yemen.⁽²⁸⁾ Overall, Hodeidah Port is responsible for 70 to 80% of all of Yemen's commercial imports.⁽²⁹⁾ Whenever the port is endangered by conflict, including the use of explosive weapons, food security is threatened.

The Red Sea Mills

Located in Hodeidah, the Red Sea Mills is a central storage and processing facility for food supplies. The mill and its silos are critical components of the UN's World Food Programme (WFP) humanitarian assistance in Yemen. However, the Red Sea Mills is located near opposing forces in Hodeidah and have therefore been frequently impacted by the wide area effects of artillery fire, shelling, and mortars.

Between August and October 2018, the Red Sea Flour Mills was hit by a combination of shelling and airstrikes due to the ongoing conflict in Hodeidah. For **six months**, WFP was wholly unable to access the mills due to insecurity and ongoing clashes. During this period, the Civilian Impact Monitoring Project (CIMP), a service under the UN Protection Cluster, estimated that “**half a million households were experiencing restricted access to food.**”⁽³⁰⁾

When WFP lost access to the Red Sea Mills they were unable to access approximately 51,000 tons of grain, one-quarter of WFP's in-country stock and an amount that could provide food for more than **3.7 million people for a month.**⁽³¹⁾

In January 2019, two silos and the food stores within them were damaged at the Red Sea Mills by

a fire reportedly started by a mortar.⁽³²⁾ By the time the WFP regained access in February 2019, only 70% of the wheat was considered salvageable.⁽³³⁾ Humanitarian assistance such as the grain stored at the Red Sea Mills is critical to the survival of the most vulnerable in Yemen. Yet less than a year later on 26 December 2019, **artillery fire again damaged WFP grain stores** at the Red Sea Mills, though milling resumed at 50% by early January 2020.⁽³⁴⁾ Throughout 2020, access to the Red Sea Mills remains restricted as the facilities continue to come under fire due to their proximity to conflict hotspots on the outskirts of the city.

By damaging essential infrastructure used for the import and delivery of food and other necessities such as fuel, the wide area effect of artillery fire and mortars not only limits the direct provision of food to meet the needs of the Yemeni population, but also impedes the ability of humanitarian actors to deliver aid to populations most in need. The examples of the Red Sea Mills and Hodeidah Port show both the direct and indirect consequences of damage incurred by different types of explosive weapons with wide area effects.

2.2 Transport and Access: Damage to Yemen's Roads and Bridges



A bridge on the Sana'a – Hodeidah road damaged by airstrike. June 2017. © HI

Yemen is highly dependent on roads to transport goods and allow people, especially from rural areas, to access markets, health, education, and livelihoods.⁽³⁵⁾ Yet even before the recent conflict, Yemen's road system was underdeveloped; of 50,000 km of roads throughout the country, only 14,000 km were paved.⁽³⁶⁾ Yemen's roads and bridges are among the key infrastructure systems that have been damaged through the wide area effects of explosive weapons. In 2019,

the World Bank estimated that more than 24% of Yemen's road network has been either partially or fully destroyed due to the crisis.⁽³⁷⁾ An earlier damage assessment by the Road Maintenance Fund, a unit of Yemen's Ministry of Public Works and Highways, found that 1,241 km of roads have been heavily damaged in conflict-impacted governorates, and 62 bridges targeted by airstrikes suffered either partial or total destruction.⁽³⁸⁾

The Extent of Destruction on Yemen's Bridges and Roads

The CIMP, as a service of the UN Protection Cluster in Yemen, has been gathering open-source reports on protection incidents since 2018. CIMP data has recorded **91 airstrikes incidents** affecting main **roads** that collectively are estimated to have hindered access or restricted freedom of movement for **over 1 million households**.⁽³⁹⁾ As these figures are cumulative, many of these households are likely to have been impacted in repeat instances when roads in the same districts were damaged. CIMP has also recorded **16 shelling incidents** directly affecting roads that had an estimated impact on over **66,000 households**. According to these estimates, a single shelling **incident could affect between 2,000 and 14,000 households** at a time.⁽⁴⁰⁾

For bridges, the CIMP recorded **13 airstrikes incidents** that were estimated to have affected **over 100,000 households**.⁽⁴¹⁾ One airstrike affecting a bridge near Eiraym in Lahj governorate in 2018 may have affected as **many as 18,000 households**. Again, the household impact of these incidents was likely cumulative, as bridges hit in the same district will affect the same populations repeatedly. With respect to **shelling**, repeated incidents affecting **bridges in the Hays district in Hodeidah** were estimated to affect up to **9,620 households per incident**.⁽⁴²⁾

Impacts of Reduced Access

When roads are destroyed, all services suffer as goods and people can no longer move efficiently or safely. The journey between Yemen's major seaports to the capital Sana'a and other large cities, which used to take two days before the war, can now take up to five days, causing the cost of key commodities such as wheat, flour, and steel to triple since 2015.⁽⁴³⁾ Critical routes have been disrupted by attacks on bridges. For example, in 2016, airstrikes damaged bridges on the main road to Sana'a, a road that serves as the principal link for bringing 90% of WFP's food supplies delivered from Hodeidah.⁽⁴⁴⁾

Beyond the impact on food security in Yemen, the impact of road closures and the destruction of transportation networks make it harder to transport humanitarian aid, to trade economic goods, to maintain livelihoods, and to access health facilities, as is made clear in other case studies throughout this report. Destroyed roads also restrict the movement of affected populations seeking essential services.

2.3 Destruction and Disruption to Health Services

Health facilities damaged through the wide area effects of explosive weapons have directly reduced the quality of healthcare available to the Yemeni population. When facilities are destroyed, health services are interrupted. Furthermore, the

destruction of broader infrastructure such as roads endangers both the population's access to services and the medical supply chain necessary to keep hospitals operating.

The health of Yemen's population is already highly vulnerable due to the limited medical infrastructure that existed before the conflict. Yemen's medical infrastructure was weak and located primarily in urban areas.⁽⁴⁵⁾ Due to the limited number of health facilities and the fixed location of these health services, more than half the Yemeni population, and up to two-thirds in rural areas, lacked access to healthcare services.⁽⁴⁶⁾

Yemen's health system cannot afford the severe and long-lasting reverberating impact of explosive weapons use. An estimated **19.7 million people lack access to adequate healthcare.**⁽⁴⁷⁾ At the same time, **49% of Yemen's health facilities are no longer fully functional.**⁽⁴⁸⁾ Medical specialists and health workers are also scarce in Yemen, with only ten health workers per 10,000 people.⁽⁴⁹⁾



Hayden Hospital in March 2016 after months of airstrikes.
© Atsuhiko Ochiai, MSF

Destroyed Health Services

Since the beginning of the conflict, medical facilities have been some of the hardest-hit civilian structures. Mwatana for Human Rights has documented **35 aerial attacks on 32 health facilities across 10 governorates in the period between 2015 and 2018.**⁽⁵⁰⁾ Sa'ada was the most affected governorate, with 27 attacks on health facilities. Amongst the many incidents affecting health services, the following are examples of when explosive weapons use resulted in restricted access to lifesaving medical services in Yemen.

- **Hayden Hospital, Sa'ada (26 October 2015):** An MSF-supported hospital in Hayden District, Sa'ada, in northern Yemen, was destroyed after 2 hours of airstrikes in October 2015. Damage to the hospital included the destruction of the inpatient and outpatient departments, the maternity ward, the lab, and the emergency room. Hayden Hospital is located in one of Yemen's least-served governorates and a region characterised by a lack of public services. On average, this hospital treated 200 war-wounded people per month in the emergency room.⁽⁵¹⁾ As the only hospital within an 80-kilometre radius, the reverberating impact from the loss of this hospital was **200,000 people with no access to lifesaving medical care.**⁽⁵²⁾
- **Abs Rural Hospital, Hajjah (15 August 2016):** Another MSF-supported facility in Hajjah governorate in northwestern Yemen was hit by an aerial bomb⁽⁵³⁾ in August 2016. The attack

destroyed the emergency room and caused significant structural damage to the building.⁽⁵⁴⁾ Abs hospital was the centrepiece for mass casualties in the region and the sole hospital designed to serve civilians in the area, with a catchment of more than **150,000 people.**⁽⁵⁵⁾ The hospital was shut down for 3 months, denying the population access to care.⁽⁵⁶⁾ Without the Abs hospital surgical centre, the next available option for civilians was Hajjah, which is 100 km from Abs.

- **Al Mokha Hospital (6 November 2019):** An MSF-supported hospital was partially destroyed in November 2019 when missiles hit a military warehouse near the hospital. The wide area effects of the missiles destroyed the hospital and pharmacy. The hospital provided emergency surgical care for patients suffering from conflict-related injuries, as well as other necessary surgical emergencies such as caesarean operations for complicated deliveries. The MSF hospital had been the only free-of-charge facility offering such services for civilians in the Mokha area. Since January 2019, the hospital had treated 1,787 patients and performed 2,476 surgical procedures, including 201 caesarean sections. Operations were moved to Aden, as the site cannot be re-opened until demining activities have cleared the **area of contamination.**⁽⁵⁷⁾

■ **Al Jafra Hospital and Al Saudi Field Hospital (7 February 2020):** On 7 February 2020, the Al Jafra Hospital and Al Saudi field hospital in Majzar District in Marib were hit by artillery shells.⁽⁵⁸⁾ The hospitals, located 75 kilometres northwest of Marib City, serve a population of about **15,000**, including a high proportion of displaced people. The facilities have been badly

damaged, including the intensive care unit, occupational therapy unit, inpatient unit, and the pharmacy at Al Jafra Hospital, which is the main hospital in the area. The nearby Al Saudi field hospital, a mobile clinic, was structurally damaged. Given ongoing hostilities in the area, the hospitals were closed for the safety of staff and patients.⁽⁵⁹⁾

Access to Health Facilities: For Patients and Supplies



Al-Joumhuri Hospital in Taiz February 2016. © HI

The destruction of health facilities by explosive weapons immediately reduces access to health facilities for people in crisis and increases the population's vulnerability to malnutrition, water-borne diseases, and life-long impairments from conflict-related injuries.⁽⁶⁰⁾ The World Bank has identified the disruption of immunisation campaigns, the spread of diseases facilitated by vulnerability caused by malnutrition, inadequate water and sanitation, and an increasing vacuum of services caused by health staff deserting due to insecurity as impacts from the conflict.⁽⁶¹⁾ Though not all of these impacts can be attributed solely to explosive weapons, the destruction of even a few health facilities in this context contributes to the worsening public health situation in Yemen.

However, explosive weapons use has long-term impacts on health beyond the destruction of facilities. Health facilities not physically damaged by explosive weapons are nonetheless impacted by damage caused through explosive weapons use on the wider civilian infrastructure such as roads or ports. When key transport hubs are destroyed or roads damaged, the transport of medical goods and humanitarian supplies cannot be maintained. Disruptions to transport and supply chains caused by the broader conflict in Yemen has also caused severe shortages of medical supplies and medicines.⁽⁶²⁾ Suppliers and those involved in transport may also feel it is unsafe to travel through areas potentially contaminated by unexploded ordnance from explosive weapons, resulting in critical medical supplies not being delivered.

Damage to roads, ongoing conflict, and the threat of contamination by unexploded ordnance also restrict civilians' ability to reach medical services long after the bombing ends. Some patients at HI-supported medical facilities reported having travelled up to 16 hours to access services. Delays in reaching health services can lead to

life-long impairments, particularly for victims with complicated injuries caused by explosive weapons. Humanitarian actors have highlighted that contamination and ongoing armed conflict in the vicinity of health facilities may be increasing women's pregnancy complications, as patients cannot safely reach health services.⁽⁶³⁾

2.4 Endangering Yemen's Access to Water



Aden, destruction by airstrikes. October 2017. © HI

Yemen has limited water resources and weak water infrastructure. Over 90% of Yemen is considered to possess an arid to hyper-arid climate with limited groundwater resources.⁽⁶⁴⁾ Before the conflict, water infrastructure was also underdeveloped, with only 52% of Yemenis having access to safe drinking water.⁽⁶⁵⁾ Now after years of conflict, **over two-thirds of the population require WASH support** to meet their basic needs in Yemen.⁽⁶⁶⁾ Of this number, 12.6 million are in acute need.⁽⁶⁷⁾

Damage from explosive weapons use can affect any point in the water infrastructure system, including water pumping stations, water treatment facilities, damage to points throughout the pipe distribution system, disruption in water supply caused by electricity blackouts stopping water pumping, and contamination of water resources by unexploded ordnance.⁽⁶⁸⁾

Despite the high levels of WASH needs in the country, water infrastructure systems have suffered throughout the conflict from explosive weapons impact. Water facilities in heavily bombed governorates have been particularly impacted. Oxfam found that in the “first seven weeks of airstrikes in Yemen, 40% of the water supply systems in Hajjah and Al Hodeidah governorates were damaged by conflict incidents depriving an estimated 3 million people of clean water.”⁽⁶⁹⁾ The CIMP has collected reports of over 40 incidents of airstrikes, shelling, or IEDs that affected water infrastructure including stations, pumps, wells, tanks, water trucks, drills, sewage stations, and desalination plants.⁽⁷⁰⁾ Collectively, these incidents had the potential to have **restricted access to water infrastructure for as many as 184,776 households across 23 districts.**⁽⁷¹⁾

The following examples show the immediate impact of damage to water infrastructure in some of the conflict-impacted governorates, as well

as indicating potential indirect effects from other impacts of explosive weapons.

Nushour Facility in Sa'ada

Sa'ada governorate in the North is both one of the most underdeveloped regions in Yemen and one of the most severely bombed areas in the country. In 2018, Sa'ada experienced the highest level of impact from explosive weapons on water infrastructure of any governorate, including **13 airstrikes and 1 shelling incident** that affected access to water for an estimated **35,581 households**.⁽⁷²⁾

The Nushour water facility in Sa'ada has been repeatedly impacted by explosive weapons, including damage by airstrikes three times throughout 2018.⁽⁷³⁾ In March 2018, the water project was damaged by airstrikes twice in one week. Later, on 24 July of the same year, the facility was hit for a third time, destroying the

water pumps, an electric generator, and a nearby solar energy system. It was estimated that repairs would take anywhere from 6-12 months and cost more than USD \$600,000.⁽⁷⁴⁾ As a UNICEF-funded facility, Nushour supplies water to more than 12,000 beneficiaries in the As Safra district. The immediate impact of the destruction of this facility was to cut **10,500 people off from safe drinking water**.⁽⁷⁵⁾ In October 2019, the Nushour facility was yet again impacted by an airstrike only 70m away from the facility, disrupting water services to 12,000 people once more.⁽⁷⁶⁾ The Nushour facility is particularly important for its role serving a large IDP population displaced by heavy explosive weapons use throughout the governorate.

Damage to Water Infrastructure in Hodeidah Governorate

Hodeidah is both a critical frontline in the conflict and one of Yemen's governorates with the gravest humanitarian needs. On 27 July 2018, airstrikes hit the Al-Mina District water station, which serves as the main water station and the principal source of drinking water for Hodeidah city. Once hit, it began **pumping at a 30% loss**. An estimated 86,362 households were affected by damage to the water station.⁽⁷⁷⁾

Further conflict near Hodeidah in early August again damaged sanitation and water infrastructure. This included the Al-Saleef water

tank, which **deprived 10,000 people of water** after it was hit.⁽⁷⁸⁾ At the time Lise Grande, the Humanitarian Coordinator for Yemen, characterised Hodeidah as just "one airstrike away from an unstoppable epidemic" given the ever-present risk of cholera and water-borne diseases.⁽⁷⁹⁾ Throughout 2018, CIMP recorded 12 incidents affecting water infrastructure in the Hodeidah governorate that **restricted 183,866 households' access to water facilities**.⁽⁸⁰⁾

Further Indirect Impacts from Explosive Weapons: Fuel and Sanitation

Access to water in Yemen is impacted by more than just the destruction of water facilities. The rising price of fuel, influenced by the blockade in Yemen but also by the destruction of roads and ports necessary to import goods, affects the affordability of clean water for those without access to functioning water infrastructure and who rely on trucked or bottled water. The price of bottled or trucked water has risen by 45% in some areas of Yemen.⁽⁸¹⁾ The price of fuel also determines the affordability of generators to power water stations within the remaining infrastructure network.

The destruction of water and sanitation systems contributes to a worsening sanitation environment in Yemen at a time when over half of the districts in Yemen require acute sanitation support.⁽⁸²⁾ More than half the population of Yemen currently lacks access to safe water sources that are critical to countering the risk of water-borne diseases.⁽⁸³⁾ The destruction of water infrastructure in combination with the rising cost of fuel necessary for trucking water reduces food security, and the scarcity of healthcare services throughout Yemen increases

the vulnerability of the population to water-borne diseases, including cholera. Explosive weapons use, whether it destroys water infrastructure

or roads or damages Yemen's ports, is an exacerbating driver for these broader health risks.

2.5 The Long-Term Impact on People: A Glimpse at the Reverberating Impact of Explosive Weapons on Specific Populations

Disruption to critical services accelerated by the destruction of infrastructure extracts a medical, psychosocial, economic, and social toll, particularly from groups already marginalised by society. With the reduction of already limited services, vulnerabilities among these groups will continue to deepen. In focusing on populations already marginalised within Yemen, it is possible to glimpse what the future will entail for Yemen's surviving population even after the use of explosive weapons ends.

Internally Displaced Persons

Some 3.65 million people have been displaced in the course of the conflict, with more than 80% having been displaced for longer than a year.⁽⁸⁴⁾ IDPs in Yemen are among the most vulnerable to the impact of explosive weapons. IDPs were often driven from their homes by bombings. Explosive weapons continue to endanger the resources and services IDPs need to survive during displacement. IDPs in Sa'ada governorate, one of the most heavily bombed governorates, are among the most heavily dependent on the Nushour water facility, which has been hit no less than 4 times by explosive weapons.

Hosting sites for IDPs also frequently come under attack. On 26 January 2019, a service centre for IDPs in Haradh District, Hajjah Governorate, was

Persons with Disabilities

Persons with disabilities are also among the most marginalised in crisis-affected communities.⁽⁸⁶⁾ Services for persons with disabilities are often disrupted by conflict, and in the case of Yemen, resources available for this group have decreased substantively in the past five years. Persons with disabilities are disproportionately impacted by damage to health services and increasing risks



A mother carrying her child in Sana'a, 2019.
© ISNA Agency/HI

shelled, killing 8 and wounding 30.⁽⁸⁵⁾ Whether directly under attack or endangered by the destruction of services and infrastructure, IDPs are heavily affected by the impact of explosive weapons.

The destruction of homes and infrastructure prevent a return to normal life for IDPs. Even when the conflict ends, the long-term impacts of damage to hospitals, schools, businesses, power plants, and water infrastructure stop people from returning home.

and barriers to safe movement. In discussions with populations at risk in Yemen, including persons with disabilities, HI has found that **86% experienced problems in accessing services** due to barriers such as physical access and safety during travelling, along with economic and social discrimination.

The pre-conflict estimate of persons with disabilities was **three million people**.⁽⁸⁷⁾ Since the conflict began, more than **an additional 1 million people with specific needs have been identified**, including persons with disabilities, female and child heads of households, unaccompanied elderly, survivors of trauma, and other women and children at risk.⁽⁸⁸⁾ After five years of conflict and the corresponding rate of conflict-related injuries, rates of psychological trauma and malnutrition have risen substantially, thus adding to the number of persons with disabilities and consequently increasing the demand for services. Health facilities have already reported more than **70,000 conflict-related casualties**, the survivors of which will likely need specialist care to avoid life-long impairments.⁽⁸⁹⁾

Injuries from explosive weapons cause complex cases among survivors, such as spinal cord injuries and amputation. Addressing these

Women

The impact of explosive weapons on women and girls has been well documented, including specific research on Yemen by Oxfam.⁽⁹⁰⁾ In societies such as Yemen, where domestic and caretaking roles are considered a woman's responsibility, the destruction of essential infrastructure makes the practical tasks expected of women and girls more burdensome.⁽⁹¹⁾ Disruptions to water, electricity, roads, and rising food costs directly affect the daily tasks expected of women and can even make these daily tasks more dangerous amid conflict. Women can also be disproportionately affected by disruptions to health services. For example, 1.14 million pregnant or lactating women in Yemen are facing acute malnutrition.⁽⁹²⁾ The destruction of health services, as well as infrastructure affecting food security and water, puts these women at even greater risk.

Children

The destruction of schools and education services will undermine children's futures long after the conflict ends. As of 2019, an estimated 2000 schools are unfit for use due to the conflict, during which **256 schools were destroyed by explosive weapons**, including **airstrikes or shelling**.⁽⁹⁵⁾ Another **167 schools** were not in use because they were being used to **shelter IDPs fleeing the conflict**. Children are also some of the most



Sana'a residents, including persons with disabilities, 2019.
© ISNA Agency/Hi

injuries requires long-term specialised services whose availability is limited in Yemen. Without rehabilitation care, prosthesis, and physical therapy, people will not be able to resume their social and economic roles, an effect that will last a lifetime for them and their families.

Explosive weapons often cause long-term displacement for families forced to flee to safety. In Yemen, women disproportionately make up the population of IDPs: though estimates vary from year to year, **women and children typically account for three-quarters of IDPs**.⁽⁹³⁾ In displacement, women spend even longer hours in unpaid care work with even fewer resources. Displacement also exposes women to greater risks of gender-based violence and exploitation.

The end of the conflict will not be the end of the impact for women and girls, as they are often expected to play the role of primary caregiver to injured family members who may live with life-long impairments. Long-term, these demands on women's time reduce women's ability to participate in public life.⁽⁹⁴⁾

dependent on Yemen's fragile health infrastructure. An estimated 2.1 million children under five are acutely malnourished in Yemen.⁽⁹⁶⁾

Several long-term impacts of explosive weapons can already be anticipated. Children are among the populations most at-risk from contamination by explosive weapons because they are naturally risk-takers and often will handle unexploded

ordnance and even IEDs without recognising the danger. Children are also less likely to survive blast injuries from explosive weapons due to the smaller physiological makeup of a child's body. When children do survive, they will have greater needs for follow-up care, as they will grow out of their prosthetics, assistive devices, or wheelchairs. The emotional impact of explosive violence will be life-long, not only for children, but for their parents, siblings, and caregivers.⁽⁹⁷⁾

With injuries from contamination, many children will need emergency rehabilitation care to avoid life-long impairments. Beyond the physical effects, there are long-term effects on children's mental health. In 2020, Save the Children found that over half of the children they surveyed in Yemen reported feelings of sadness and depression.⁽⁹⁸⁾ The trauma and mental health implications of the conflict, including years of exposure to explosive weapons in civilian areas, will have a long-term impact on an entire generation.

2.6 The Deadly Legacy of Contamination



Fatehia was 8 years old when planes dropped two bombs near her school. There were limited medical services available to Fatehia until two years later when her family fled to Sana'a. September 2019. © ISNA Agency/HI

Contamination by unexploded ordnance will affect Yemen's population for decades. The extensive use of air-delivered explosive weapons has dropped large quantities of ordnance across Yemen. Even if the conflict ends, reverberating effects will be felt throughout the stabilisation and reconstruction process. In particular, air-dropped ordnance is difficult and time-consuming to clear. It can take decades of clearance work after cities are bombed. Some of the air-dropped explosive weapons

leave unexploded ordnance that will pose a long-term risk to Yemen. The failure rate of explosive weapons in similar contexts such as Iraq and Syria has been estimated to be as high as 10%.⁽⁹⁹⁾

Contamination has a significant impact on people's ability to meet their basic needs: if areas are suspected to be contaminated, populations adjust their movements significantly to avoid danger, thereby disrupting trade, livelihoods, access to health facilities, and daily commutes. Populations that do not alter their movements and cross contaminated areas expose themselves to the risk of death and life-long injuries where unexploded ordnance lies in wait.

When people have run out of options for seeking safety, they may choose to return home even when they are risking returning to areas contaminated by unexploded ordnance. Populations most at risk for unexploded ordnance are IDPs, the frontline workers involved in rubble removal or construction, agricultural workers, and children. There is little ongoing risk education and clearance in Yemen to mitigate these risks owing to a lack of access, resources, trained staff, and infrastructure.

Conclusion and Recommendations

3.

Road in Aden, February 2020. © HI

The case studies presented in this report demonstrate how the indirect damage incurred from the use of explosive weapons directly threatens people's survival in Yemen. When infrastructure is destroyed, the impact reverberates far beyond the geographical area of the initial attack and over a prolonged time. These effects may last for decades in Yemen.

Yemen's experience also shows how reverberating effects are interconnected, as the impact on infrastructure systems are compounded by different explosive weapons incidents. Destroyed roads and bridges represent not only delays in food supplies, but a direct barrier to quick and safe access to health services. Destruction of a port's capacity to bring in cargo limits not only food and medicine, but also the fuel necessary to keep all other infrastructure systems functioning in Yemen. Damage to water systems may increase the risk of water-borne diseases to a population already at risk. One bombing incident has repercussions for the entire system of infrastructure in Yemen and by extension, for the survival of its people.

With an understanding of the impact of reverberating effects, it is clear that regardless of the intentionality of the attack, the use of explosive weapons with wide area effects in populated areas has indiscriminate and disproportionate consequences for civilians. With their large destructive radius, their capacity to spread multiple munitions over a large area, and their inherent lack of accuracy, explosive weapons with wide area effects endanger both civilian lives and the infrastructure upon which they depend.

- The international community must acknowledge the severe and long-lasting indirect or reverberating effects of explosive weapons use, which devastate the economic, health, and social dimensions of a society.
- A strong commitment by all States to avoid the use of explosive weapons with wide area effects in populated areas, as urgently called for by the UN Secretary General and ICRC,⁽¹⁰⁰⁾ cannot wait. States must undertake strong commitments in a political declaration to prevent situations like Yemen where the extensive use of explosive weapons, especially those with wide area effects in populated areas, has direct and indirect effects and constitutes a decades-long death sentence. A political declaration should describe and acknowledge the humanitarian harm from explosive weapons, particularly in situations of crisis such as Yemen, and commit actors to avoiding the use of explosive weapons with wide area effects in populated areas.
- Both the direct and indirect effects of explosive weapons use must be recognised in this declaration. The declaration must further recognise the rights and needs of all victims—critically injured people, survivors, families of those injured and/or killed, and affected communities—to receive adequate assistance based on their needs in a non-discriminatory manner, including in the form of emergency medical care, physical rehabilitation, psychosocial support, and socio-economic inclusion, as well as support towards the full realisation of their rights and full participation in their societies.

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