The compound impact of extreme weather events and COVID-19

An update of the number of people affected and a look at the humanitarian implications in selected contexts

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It is clearly still a preliminary analysis of an ongoing crisis. We are grateful to EM- DAT for the data from their important disaster database, the IFRC GO Platform, UNOCHA's ReliefWeb and the other sources of information cited in the paper.

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Executive summary

From the start of the COVID-19 pandemic until August 2021, **extreme weather events have affected at least 139.2 million people and killed at least 17,242 people in at least 433 unique events**. These figures are certainly an underestimate, as they do not include estimates of numbers of people affected by extreme temperatures, or mortality during drought events.

One dimension of the compound risk of COVID-19 and climate extremes was the **additional challenge of preparing for and responding to disasters during the pandemic**, such as the constraints of physical distancing during evacuations and response operations.

But more importantly, **COVID-19 and climate extremes have had severe and often simultaneous impacts on livelihoods, creating compound impacts the past year, and reducing resilience to future shocks**. The pandemic and the measures taken to control it have made people poorer and more vulnerable to extreme weather events. Food insecurity has been aggravated, and people have struggled even more to recover after a disaster, given the economic impact of the pandemic.

Both types of challenges are clearly visible in specific cases where these compound impacts have already played out. In Kenya, the combination of COVID-19, floods in one year and droughts in the next, as well as a locust infestation, aggravated food insecurity for the most vulnerable in both rural and urban contexts. In Honduras, the devastating consequences of subsequent hurricanes Eta and Iota were aggravated by the impacts of the pandemic. In Bangladesh, early action before typhoon Amphan, and later ahead of massive flooding, was adjusted to reduce infection risk, and saved countless lives. In Afghanistan, the double threat of climate and COVID-19 played out in the context of conflict, creating even more threatening circumstances. But climate risks also intersect with COVID-19 in the richest countries. In Canada and the northwestern US for instance, an unprecedented heatwave that would not have happened without global warming, killed at least hundreds of people. Options for vulnerable groups to seek shelter posed trade-offs with the risk of infection.

From the start of the pandemic, calls have been made for a **green, resilient and inclusive recovery** from COVID-19, which would allow us to recover from the economic impact of the pandemic while creating a safer, more resilient future. So far, only a small portion of the trillions of dollars invested has found its way to the highest priorities for such resilience. But experience so far points to a few clear priorities.

During many disasters playing out during the pandemic we saw the impact of actions to manage risk. **Anticipatory action** ahead of extreme weather events, adjusted for the conditions of the pandemic, saved countless lives and were successfully adapted to avoid spread of the pandemic.

The past year also demonstrated the value of **safety nets**, from formal social protection programs to humanitarian cash assistance. Such systems have helped to absorb a range of shocks, from pandemics to climate extremes to other surprises. However, even cash programs and social protection systems were hampered by the pandemic. Only systems that have been set up in advance and can build on existing local capacity have a chance when systemic shocks, such as COVID-19 and/or climate change, emerge.

But both anticipatory action and an effective response right after an event requires preparedness, and capacity for **local action** in each country and each community. Local capacity is always faster and more attuned to local needs, but COVID-19 travel restrictions have highlighted the value of investments in local capacity for crisis management more than ever.

Finally, the many risks associated with COVID-19 and disasters were amplified in **urban settings**. Urban poor were doubly hit by the rising cost staples and limited wage-earning options due to COVID-19 shutdowns. The urban setting not only amplifies risk, it also amplifies opportunity and creates immense potential to adapt and build urban climate resilience in COVID-19 recovery endeavours.

We must recognise the **differentiated needs and impacts of the most vulnerable**. COVID-19 has acted as an X-ray of our societies, displaying our vulnerabilities and showing how marginal groups were hit hardest. We must recognise and address their needs, working with them to find solutions that will last in the face of the rising risks in our changing climate.

1. Introduction

In September 2020 we published an initial analysis of the overlapping risks of extreme weather events that had occurred during the COVID-19 pandemic[1]. A year on, despite initial progress with vaccinations in some parts of the world, the pandemic continues to wreak havoc, with direct health impacts for millions of people around the world, but also a massive indirect impact, in part due to the response measures implemented to contain the pandemic.

Unfortunately, therefore, an update of last year's analysis is warranted, both to recognize the growth in numbers of people affected by these overlapping and compounding risks, but also to explore what this has meant in practice for people coping with those challenges.

We thus update our analysis from last year with numbers for people affected up to August 2021, but also explore several specific case studies where such overlaps have played out, drawing from operational insights from Red Cross and Red Crescent operations, as well as initial insights from a major forthcoming study on the socio-economic impacts of the pandemic[2].

1 Walton, D. and M.K. van Aalst (2020). *Climate-related extreme weather events and COVID-19. A first look at the number of people affected by intersecting disasters*. IFRC, Geneva. 21 pp. ISBN ISBN/EAN: 978-90-818668-1-10.

2 Université catholique de Louvain (UCL) - CRED, D. Guha-Sapir, 2021. EM-DAT: The Emergency Events Database. Brussels, Belgium. www.emdat.be. Accessed 13/09/2020.

2. Methods

The methods and assumptions applied in this study largely follow the analysis presented last year[3]. The detailed methods are described in Annex B.

Our main analysis utilises the Centre for Research on the Epidemiology of Disasters (CRED) Emergency Events Database (EM-DAT)[4] and covers disasters from March 2020 up to 15 August 2021. All disaster events in this period were considered overlapping with COVID-19, given that while infection rates of course dramatically varied from place to place and moment to moment, the indirect impacts of the pandemic and the response measure to control it did affect all countries during this period.

The following event types are considered as extreme weather events within this analysis: droughts, floods, storms, extreme temperatures (heatwaves), and wildfires. Disasters not clearly defined as extreme weather events (for example, insect infestation and epidemics), and weather-related disasters that are diminishing due to climate change (for example, cold waves) are excluded. The main differences with last year's analysis is that it now includes EM-DAT's much improved coverage of drought events.

We have also updated our own estimates of people affected by extreme heat and wildfires, again using the same methodology as in the initial analysis last year, as described in Annex B.

Case studies in Section 4 were mainly based on reflections from Red Cross and Red Crescent operations and analyses, as well as initial insights from a forthcoming IFRC analysis of the socio-economic impacts of the pandemic.[5]

3 Walton, D. and M.K. van Aalst (2020). *Climate-related extreme weather events and COVID-19. A first look at the number of people affected by intersecting disasters*. IFRC, Geneva. 21 pp. ISBN ISBN/EAN: 978-90-818668-1-10.

4 Université catholique de Louvain (UCL) - CRED, D. Guha-Sapir, 2021. EM-DAT: The Emergency Events Database. Brussels, Belgium. www.emdat.be. Accessed 13/09/2020.

5 IFRC, The socioeconomic consequences of the COVID-19 pandemic, forthcoming (October 2021).

3. Results

3.1 Impact of extreme weather events during the COVID-19 pandemic

During the COVID-19 pandemic, from March 2020 until 15 August 2021, extreme weather events recorded by EM-DAT affected at least 139.2 million people and killed 17,242 across 433 unique events. Significantly, these figures do not include estimates of numbers of people affected by extreme temperatures, or number of people killed in drought events.

Table 1: Extreme weather events overlapping with COVID-19 up to 15 August 2021, by region

Region	Total Affected	Total Deaths	Number of events
East Asia and Pacific	24,549,246	2,290	115
Sub-Saharan Africa	46,385,202	1,369	91
Europe and Central Asia	965,047	6,782	48
Latin America and Caribbean	9,691,101	766	70
South Asia	42,369,624	4,649	39
Middle East and North Africa	15,144,498	317	30
North America	98,915	1,069	48
Total	**139,203,633**	**17,242**	**433**

Source: EM-DAT.

Notes: Due to very limited data on deaths due to drought events and people affected by extreme temperatures, estimates are not included for events of this type. Number of events does not sum to total as several events are counted across multiple regions.

Table 2: Extreme weather events overlapping with COVID-19 up to 15 August 2021, by type

Disaster Type	Total Affected	Total Deaths	Number of events
Drought	65,309,507	*Unknown*	22
Flood	43,741,936	7,613	277
Storm	49,578,751	2,497	108
Extreme temperature*	*Unknown*	6,964	2
Wildfire	807,272	168	21

Source: EM-DAT.

Notes: Due to very limited data on deaths due to drought events and people affected by extreme temperatures, estimates are not given for these totals. The sum of total affected is greater than the 139.2 million listed above as events may overlap in their affected populations.

* EM-DAT figures limited to Belgium, France, Netherlands, UK in 2020, and USA and Canada in 2021.

3.2 The most severe climate-related events during the COVID-19 pandemic

In terms of numbers of people affected, the most severe event was Cyclone Amphan in 2020, which hit Bangladesh, India, and Sri Lanka and affected 20.6 million people. It is notable that thanks to very effective early action, this disaster does not feature in the list of most deadly events below (see also the case study in Section 4.4) .

The four next most severe events are all ongoing droughts: the Southern Africa drought, which began in October 2018, has affected at least 12.3 million people across five countries in sub-Saharan Africa; the water crisis and drought affecting Iraq and Syria, which began in August 2021, has affected at least 12 million people; the Eastern Africa drought has affected 11.4 million people in Ethiopia, Kenya, and Somalia; and the Northern Afghanistan drought has affected an estimated 11 million people.

Table 3: Most severe events overlapping with COVID-19 by total affected

Disaster Type	Countries Affected	Event	Period	Total Affected
Storm	Bangladesh, India, Sri Lanka	Cyclone Amphan*	June-August 2020	20,601,100
Drought	Lesotho, Mozambique, Namibia, Zambia, Zimbabwe	Southern Africa Drought	October 2018-ongoing	12,342,000
Drought	Iraq, Syria	Mashriq Drought	August 2021-ongoing	12,000,000
Drought	Ethiopia, Kenya, Somalia	Eastern Africa Drought*	March 2021-ongoing	11,420,000
Drought	Afghanistan	Northern Afghanistan Drought*	February 2021-ongoing	11,000,000
Flood	China	Sichuan Floods	June-July 2020	10,000,000
Storm	Central America, Caribbean, USA	Hurricane Eta*	November 2020	7,152,272
Drought	Mali	Malian Drought	January 2020-ongoing	6,800,000
Flood	Bangladesh	Monsoon Floods	June 2020	5,448,271
Storm	Philippines, Viet Nam	Typhoon Ulysses	November 2020	4,945,461

Source: EM-DAT. Cases in light grey are discussed in the case studies in section.
* Events marked with an asterisk are case studies in Section 4 of this report.

The list of deadliest extreme weather events recorded during this period features a very different list of events. The most deadly was the Western Europe Heatwave in 2020, which killed at least 6,340 people across Belgium, France, UK, and Netherlands. This total is more than triple the next most deadly disaster recorded: monsoon flooding in India in 2020 which killed 1,922 people. An important caveat is that many heatwaves around the world are underreported, including in terms of mortality. The mortality from droughts is also not well reported.

Table 4: Most severe events overlapping with COVID-19 by total deaths

Disaster Type	Countries Affected	Event	Period	Total Deaths
Extreme temperature	Belgium, France, UK, Netherlands**	Western Europe Heatwave 2020*	June-September 2020	6,340
Flood	India	Monsoon Floods	June 2020	1,922
Extreme temperature	Canada, USA	North America Heatwave 2021*	June-July 2021	624
Flood	Nepal	Nepal Floods	June 2020	448
Flood	Pakistan	Monsoon Floods	August 2020	410
Storm	Caribbean, USA	Hurricane Eta*	November 2020	394
Flood	China	Central China Floods 2021	July 2021	352
Flood	Kenya, Uganda	East Africa Floods*	April 2020	290
Storm	Cambodia, Lao PDR, Thailand, Viet Nam	Tropical storm Linfa	October 2020	289
Flood	China	Central China Floods 2020	May 2020	280

Source: EM-DAT.
Due to very limited data on deaths due to drought events, estimates are not known.
* Events marked with an asterisk are case studies in Section 4 of this report
** EM-DAT data limited to Belgium, France, Netherlands, UK.

3.3 Supplementary analysis: heat and wildfires

3.3.1 Extreme heat

Given the limited data for numbers of people affected and killed by extreme temperature events, this additional analysis provides rough figures based on a consistent global definition of extreme temperature event (heatwave), their overlap with vulnerable populations, and estimates for their associated excess mortality. See methodology (Annex B) for more details.

In total, we estimate that 658.1 million people in vulnerable age groups worldwide have experienced extreme temperature events during the COVID-19 pandemic.

Table 5: Vulnerable people experiencing extreme temperature events overlapping with COVID-19

Region	Total vulnerable people experiencing extreme temperature events (millions)
East Asia and Pacific	188.1
Sub-Saharan Africa	134.3
Europe and Central Asia	125.8
Latin America and Caribbean	62.1
South Asia	57.7
Middle East and North Africa	59.0
North America	27.1
Other	3.9
Total	**658.1**

Source: Analysis based on 3CS and SEDAC up to 15 August 2021.

Notably, different magnitudes of extreme temperature events result in greatly different mortality rates: whereas in summer 2020, 24 million people in vulnerable groups living in North America were exposed to extreme temperatures, no deaths were directly linked to the heat; in 2021 to date, 9.2 million people in vulnerable groups have been exposed, with an estimated 1,695 deaths associated with the June-July heatwave event based on excess mortality analysis.[6]

Excess mortality analysis also provides supplementary estimates for the European heat in August 2020. Looking at mortality data from the European CDC, and various national statistics offices, an estimated 11,009 excess deaths were associated with the heatwave period in Belgium, France, Germany, Netherlands, Switzerland, and the UK.[7] As noted, in the tables above, these numbers make this event by far the deadliest extreme weather event overlapping with the COVID-19 pandemic to date.

6 Note that these numbers are without taking account of the so-called harvesting effect, which compensates for slightly reduced mortality in the period immediately following a heatwave (because people with severe illness would already have passed away during the heat), given complications of calculating such compensation in times of COVID fluctuations. Including that effect does not change the order of magnitude of the mortality, but would somewhat reduce the absolute number.

7 Ibid.

3.3.2 Wildfires

Based on data available from the International Federation of Red Cross and Red Crescent Societies (IFRC) disaster response platform IFRC GO and the United States Forest Service web information system InciWeb, this section presents supplementary figures for the numbers of people affected and killed by wildfire events not included or with limited information in EM-DAT.

This analysis identifies over 770,000 people affected and 136 people killed by wildfires in addition to those recorded in the EM-DAT repository. The majority of those affected are derived from the Western United States wildfires in 2020, which saw evacuation orders placed on 640,012 people. The Northern Algeria wildfires of August 2021 have resulted in at least 90 deaths, making them the deadliest wildfires overlapping the COVID-19 pandemic.

Table 6: Selected wildfire events overlapping with COVID-19

Region	Period	Total Affected	Total Deaths
Northern Algeria	August 2021	25,000	90
Syria and Lebanon	October 2020-May 2021	64,685	3
Western United States	August-December 2020	640,012	43
Western United States	June 2021-ongoing*	42,531	0

Source: IFRC GO, InciWeb.

* Data are presented up to 15 August 2021.

4. Case studies of intersecting disasters

4.1 Honduras

In November 2020, two subsequent powerful hurricanes wreaked havoc in Honduras and neighbouring countries, killing 100 people and displacing millions. More than 4.5 million people were directly affected. The hurricanes destroyed homes, bridges, roads, and crops, with an estimated economic impact of US$1.9 billion.[8] The two hurricanes were named Eta and Iota – letters from the Greek alphabet which are used when the 26 pre-agreed names for Atlantic hurricanes in a particular season run out (normally a boy's or girl's name starting with the letter A and going through to Z). This signals the extremely active 2020 hurricane season, but all those storms are, of course, still spread over a large region. Honduras and Nicaragua were particularly unlucky, however, as the very same area was hit twice in just two weeks by very powerful hurricanes – Category 4 and 5 respectively, fitting a pattern of more intense hurricanes expected with global warming, according to the Intergovernmental Panel on Climate Change.

Already during the emergency the compound nature of the event was obvious. First of all, the first hurricane left people terribly exposed to the second one. Carlos Colindres, National Risk Manager of the Honduran Red Cross, said: "The second hurricane, Iota, made everything worse, leaving 1.2 million people exposed to the disaster," he recalled.

Hurricane Eta was the 28th named storm of the 2020 Atlantic hurricane season, tying the 2005 record for the most named storms in a season. It caused severe flooding and landslides and damaged infrastructure, homes and crops in Nicaragua, Honduras (*pictured*) and Guatemala. (Photo: Honduran Red Cross via IFRC)

8 World Bank, 2021 (https://www.worldbank.org/en/news/feature/2021/01/11/respuesta-honduras-desastre-huracanes-eta-iota)

The compound effect was, of course, not generated just by two subsequent hurricanes. Their impact was also aggravated by the ongoing pandemic. Dr. María Tallarico, IFRC Health Coordinator in the Americas, warned: "There are thousands of homeless people, in temporary refuges or shelters facing many vulnerabilities. Right now, preventing the spread of COVID-19 is essential despite the enormous challenges of the emergency." Additional challenges emerged from interruptions of water supply and sanitation systems caused by storm damage which made handwashing and other basic hygiene measures more difficult. But wider compound effects emerged quickly through the combined impact on livelihoods. Dr Tallarico also noted that "[t]he long-term effects of this climate disaster will push communities already struggling to cope with the health and economic impacts of the coronavirus pandemic over the edge". It will take communities years to recover from the economic losses, which is even harder now that livelihoods have also been hit by the pandemic, leaving many people poorer and more vulnerable to future shocks.

4.2 Kenya

As this report was issued (mid-September 2021) the Kenyan government had just declared the country's worsening drought a national disaster. The National Drought Management Authority indicated over two million people were facing acute food insecurity following below-normal rainfall in the October to December 2020 short-rain season and the March to May 2021 long-rain season.[9] Poor rains have resulted in decreased crop production, reduced vegetation cover, worsening livestock conditions and reduced household water access. This national average varies at a sub-national level with the arid to semi-arid lands hardest hit.

This has led to a mixed picture regarding staple food prices. Maize prices countrywide are generally at or below average, due to the ongoing harvest and supplemental imports from Uganda and Tanzania. An exception to this is the pastoral areas in north-east Kenya where prices are between six and 32 per cent above average. Beans prices, on the other hand, are 17 to 41 per cent above average across urban reference markets, with Eldoret as the only exception.[10]

COVID-19 restrictions have compounded the impacts of reduced production and increased staple food costs by restricting alternate income-earning opportunities. This confluence is most acutely felt in pastoral areas and amongst the urban poor, among whom negative coping strategies associated with IPC 3 and IPC 4, such as asset liquidation and reduced food consumption, are seen.[11]

However, just a year ago it was a different climate hazard that was wreaking havoc when the March to May rainy season led to flooding throughout Djibouti, Ethiopia, Kenya, Somalia and Uganda, affecting an estimated 2.4 million people.[12] WFP said the intense March-May rainfall ranked "among the wettest in 40-year

9 Government of Kenya, 2021. Long Rains Season Assessment Report.

10 FEWS NET, 2021. Kenya Food Security Outlook Update.

11 Ibid.

12 IGAD 2020. FOOD SECURITY AND NUTRITION RESPONSE STRATEGY, 2020-2022, In the Context of COVID-19, Desert Locust Invasion and Floods.

record in parts of Kenya, Ethiopia and Somalia."[13] By June 2020, all but four of Kenya's 47 counties were impacted with over 250,000 people affected.[14] This flooding followed soon after one of the largest desert locust outbreaks in recent memory and occurred early in the pandemic, coinciding with strict restrictions and a generally fluid situation. The flood response throughout East Africa was complicated "by the severe COVID-19-related restrictions which slowed down outreach and response to affected populations, creating a multi-layered vulnerability in affected regions."[15]

In Kenya, the Red Cross launched a humanitarian cash intervention in response to this compound disaster, targeting vulnerable households in Turkana, Mandera and Garissa counties who were not covered by government social safety nets. The intervention registered a 99 per cent satisfaction rate among cash recipients. However, the pandemic introduced new challenges and further highlighted existing barriers to financial inclusion. For example, while the intervention was largely remote, recipient selection had to be completed in-person using appropriate personal protection equipment (PPE) and safety precautions while respecting physical distancing protocols. These meetings afforded the opportunity to dispel myths about the COVID-19 pandemic, but in some locations meetings had to be cancelled due to safety concerns.

Post-distribution monitoring was conducted remotely by telephone rather than face-to-face, but had to overcome the unique challenge of competing with an increase in pandemic-related telephone scams and associated mistrust regarding phone calls on mobile fund transfers. Financial inclusion challenges that were amplified by the pandemic include the cost of reaching M-Pesa agents from remote areas, phone sharing between recipients, and digital literacy.[16]

Looking at broader social protection systems, a World Food Programme study focused on the East Africa region overall found that COVID-19 restrictions resulted in "[l]imitations on using social protection as a response to climate-related shocks and stresses...because operations [were] disrupted or delayed whilst programme implementers ensured that social protection targeting, verification and delivery mechanisms did not themselves become a source of infection. In particular, this led to a temporary halt to the use of biometrics, or where [they were] still being used much slower processes that allow for disinfecting of equipment." This underscores the need for robust social protection systems to be in place before a crisis hits, and highlights potential challenges to scaling up the response to shocks in the event of future compound crises of health and climate.

13 WFP 2020. Social Protection Learning Facility Policy Brief #2, SOCIAL PROTECTION AND COVID-19 AMIDST CLIMATE SHOCKS.

14 Kenya Red Cross, British Red Cross 2020. Case study: Multipurpose Cash for Multi-Hazard Response in Kenya.

15 IGAD, op. cit.

16 Kenya Red Cross, British Red Cross, op. cit.

4.3 Afghanistan

Afghanistan is currently experiencing its second severe drought in four years, the impacts of which are hitting amidst heightened vulnerability, stemming from conflict and the ongoing COVID-19 pandemic. On 22 June 2021 the government declared a state of emergency, indicating 80 per cent of the country was affected by severe drought.[17]

On 7 September 2021, an IFRC press release calling for aid to address an escalating humanitarian crisis stated that "18 million Afghans – half of the population – are in need of humanitarian assistance as severe drought compounds hardships caused by years of conflict and the pandemic." According to UNOCHA, this is a doubling in the number of people in need compared to 2019.[18]

The combination of ongoing conflict and below-average rainfalls have had myriad impacts, including below-average wheat production, delayed planting of second-season staples (maize and rice), and diminished pasture and livestock.[19] This confluence of events is leading to rising food prices and reduced purchasing power at a time when the COVID-19 pandemic is diminishing alternate wage earning opportunities and remittances are below average.

This is resulting in negative coping mechanisms such as high-risk debt, asset liquidation, livestock reduction, skipped meals, risky migration, child labour, and early marriage.[20] In a recent assessment the International Rescue Committee also indicates that the ongoing drought is causing water resources to become increasingly scarce and there is an increase in incidence of diarrhoeal disease in children under five.[21]

A cash programme underway in Afghanistan's northern Balkh province in June 2021, intended for IDPs who were drastically affected by drought, conflict and COVID-19. Each family got the equivalent of 130 US dollars. (Photo: Afghan Red Crescent via IFRC)

17 IFRC, 4 August 2021 (press release). 'Afghanistan: Over 80% of country in serious drought.'

18 OCHA, April 2021. 'Nine things you need to know about the crisis in Afghanistan.'

19 FEWS NET, July 2021. Afghanistan Key Message Update. Second-season planting area likely below average due to atypically dry conditions and conflict.

20 Ibid.; UNDP, 2021. The Impact of COVID-19 on Remittance; UN Flash Appeal for Afghanistan, September-December 2021.

21 International Rescue Committee, June 2021. Drought assessment report.

Furthermore, according to OCHA, nearly 600,000 people were internally displaced in Afghanistan as of 5 September 2021 – 59 per cent children. This is substantially higher than recent years, with 155,000 people displaced in 2020, for example. More than 200,000 were displaced in July 2021 alone, raising concerns that this could lead to a fourth surge of the COVID-19 pandemic at a time when vaccination campaigns are diminished and the country's health system is under heavy strain due to the suspension of development assistance affecting approximately 2,300 health facilities.[22]

In May 2021, floods impacted six provinces, displacing thousands including some who had been feeling the effects of drought. The Afghan Red Crescent Society (ARCS) continues to aid 31,000 people using a near half-million Swiss franc IFRC DREF allocation. In late July, Nuristan Province – which is experiencing serious drought and for years was impacted by conflict – was affected by flash floods which washed away an entire village. The ARCS is delivering relief to 4,200 people using 265,440 Swiss francs from the DREF.

Reflecting on the current situation (IFRC 2021), Dr Mohammad Nabi Burhan, ARCS Acting Secretary General, said: "After living through decades of hardships, Afghans now face the ravages of a climate crisis, a global pandemic and internal displacement. Urgent international action is needed to support millions of people with the necessities of life through the coming months and Afghanistan's harsh winter. Red Crescent teams are ramping up efforts across the country, providing emergency relief, cash grants and basic health care, but we know that more support is needed to enable families to plant crops, re-establish livelihoods and build a brighter future."[23]

4.4. Bangladesh

One of the biggest examples of climate and COVID-19 colliding in Bangladesh was cyclone Amphan, in May 2020. A Bangladesh Meteorological Department weather bulletin issued on 19 May 2020 forecasted 'super cyclone' Amphan in the Bay of Bengal with a possible northeastern trajectory over Bangladesh. On 20 May 2020, Amphan made landfall in India and crossed into Bangladesh that evening. In Bangladesh, 2.4 million people were evacuated prior to the storm hitting thanks to a robust cyclone early warning system, an extensive shelter network and 70,000 volunteers. To reduce the risk of COVID-19 spread, the Government of Bangladesh opened over 14,000 shelters – three times the normal number to help ensure physical distancing.[24, 25]

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22 Reuter, 6 September 2021, 'Hundreds of health centres at risk of closure in Afghanistan - WHO'; UN Flash Appeal for Afghanistan, September-December 2021.

23 IFRC, 7 September 2021 (press release). 'Aid critical as Afghanistan faces escalating humanitarian crises.'

24 IFRC Go, ND. https://go.ifrc.org/emergencies/4398#details

25 American Red Cross, May 2020. https://www.redcross.org/about-us/news-and-events/news/2020/cyclone-amphan-in-bangladesh-preparedness-paid-off.html

Sadly 26 people died in the storm in Bangladesh – a glass half empty but also half full in light of the immense death tolls of prior storms, with up to hundreds of thousands of lives lost in single similar storms in the 1970s. At the same time, the destruction was enormous, with over 200,000 homes, 149,000 hectares of crops, 18,000 water points, and 74% of household foodstocks destroyed or damaged.[26] Devastated livelihoods had a lasting impact on people's resilience, and recovery was significantly affected by the economic impact of the pandemic. In addition, Amphan would sadly not be the last climate-related disaster of 2020 for Bangladesh.

In June, at the height of the first wave of COVID-19, floods again threatened millions of people across large areas of the country that were already grappling with the pandemic.[27] An international flood forecast of a more than 50 per cent probability of a severe 1-in-10-year flood submerging some areas for at least three days had been issued. The probable severity of the event was confirmed in a five-day forecast by Bangladesh's own Flood Forecast and Warning Centre, triggering early action in Bangladesh to protect vulnerable communities from further impacts.

Overall, as seasonal flooding worsened in South Asia, the IFRC released more than three quarters of a million US dollars to help National Societies in Bangladesh, India and Myanmar scale up preparedness to support affected communities. The Bangladesh Red Crescent Society (BDRCS) used more than US$240,000 from the IFRC's designated fund for anticipatory action, Forecast-based Action by the Disaster Relief Emergency Fund, to protect the lives, property and livelihoods of more than 16,500 people most at risk from the floods in the districts of Kurigram, Gaibandha and Jamalpur. As part of the large-scale evacuations, precautionary measures were taken to reduce the risk of COVID-19 by pre-positioning facemasks and hand sanitizers.

Bangladesh Red Crescent teams rescued people and provided support to survivors in July 2021 after heavy monsoon floods and landslides. This year alone the camps in Cox's Bazar were hit with COVID-19, house fires and most recently a relentless monsoon. (Photo: Bangladesh Red Crescent via IFRC)

26 Reliefweb, May 2020. https://reliefweb.int/report/bangladesh/bangladesh-cyclone-amphan-operation-update-report-dref-operation-n-mdrbd024

27 www.climatecentre.org/521/ifrc-early-action-to-save-lives-in-bangladesh-amid-severe-flood-forecast/

Special challenges appeared in the world's biggest camps for displaced people, in Cox's Bazar. The government included the displaced people from Rakhine in the national COVID-19 vaccination campaign that began in August 2021, prioritizing people over age 55. In collaboration with UNHCR and health authorities, some 500 Red Crescent staff and volunteers took part in rolling out vaccination in 34 camps (out of a total of 15,000 staff and volunteers involved in COVID-19 response and vaccination centres nationwide). The Red Crescent ran an isolation and treatment field hospital in Cox's Bazar to support people from both the local and displaced communities. Simultaneously, the Bangladesh-Myanmar border region where nearly a million people are living in camps has been badly affected by earlier seasonal rain, stranding some 306,000 people and submerging at least 70 villages.[28]

4.5. Extreme heat (Europe/USA/Canada/Syria/Iraq)

In the 2020 and 2021 northern summers, the prospect of responding to COVID-19 and extreme heat was a particularly complex mix for authorities across Europe, North America, the Middle East, India and elsewhere.

People most vulnerable to extreme heat include older individuals; those with pre-existing medical conditions, such as heart, respiratory and kidney illnesses; people who are socially isolated; the homeless; people living with disabilities and children.[29] Highest-risk groups to the impacts of COVID-19, especially early in the pandemic, included substantial overlaps.[30]

Extreme heat is deadly, and actions to prevent heat deaths include: drinking plenty of water, active and passive indoor home cooling, (in-person) check-ins with high-risk individuals, relocating to a cooling centre or other cool space for a few hours a day, and seeking medical care, especially when experiencing signs of heat stroke.[31, 32]

Unfortunately, many of the protective measures for COVID-19 are the opposite of those for reducing the deadly impacts of extreme heat. For example, physical isolation is one of the clearest ways for older and/or medically high-risk individuals to protect themselves from COVID-19. In contrast, physical isolation with a lack of indoor cooling and heightened risk factors, such as age and pre-existing medical conditions, substantially increases the risk that a person will be affected by extreme heat and will not receive emergency medical attention. Confusion and disorientation are one of the early signs that a person is in need of emergency medical attention, but the same symptoms reduce the chance that an individual will recognize and act on that need on their own.[33, 34]

28 According to local authorities as reported by AFP, https://www.france24.com/en/live-news/20210730-20-dead-300-000-stranded-in-flood-hit-bangladesh-region

29 Singh, R., Arrighi, J., Jjemba, E., Strachan, K., Spires, M., Kadihasanoglu, A., Heatwave Guide for Cities. 2019. Red Cross Red Crescent Climate Centre.

30 WHO, Aug 2021. https://www.who.int/westernpacific/emergencies/covid-19/information/high-risk-groups

31 WHO, June 2018. https://www.who.int/news-room/fact-sheets/detail/climate-change-heat-and-health

32 ibid. Singh, R., Arrighi, J., Jjemba, E., Strachan, K., Spires, M., Kadihasanoglu, A., Heatwave Guide for Cities. 2019. Red Cross Red Crescent Climate Centre.

33 GHHIN, May 2020. https://ghhin.org/heat-and-covid-19/

34 CDC, June 2018. https://www.cdc.gov/niosh/topics/heatstress/heatrelillness.html

Similarly, in an early pandemic effort to control the spread of COVID-19, many municipalities closed public drinking fountains – an action that can have an acute, negative impact on people who are homeless during an extreme heat event. Some illustrative examples include: Windsor, Tampa, Lansing, Chicago, and London. Other cities instituted large-scale disinfection protocols.

Cooling centres were operating at reduced capacity, with strict health protocols and physical-distancing measures.[35, 36, 37] Supplementary cool spaces such as cinemas and shopping centres were frequently closed, but outdoor features such as beaches, spray parks and greenspaces were frequently accessible.[38, 39, 40] Furthermore, hospitals at capacity with COVID-19 cases experienced heat-related demand surges, for instance in Oregon and Louisiana.

Innovative adaptations to manage the combined risk of COVID-19 and extreme heat also emerged. New York City scaled up its social protection system and installed 40,000 air conditioners in the homes of at-risk elderly people. In Rome, health authorities repurposed COVID-19 telemonitoring systems to remotely check people at high risk of heat-related illnesses.

Many of the challenges described above are more acutely felt in conflict settings. For example, in Syria, extreme temperatures were particularly hard-hitting in Al-Hol camp, where indoor air-temperatures routinely exceeded 50°C, making physical isolation in tents untenable.[41] In Iraq and Syria, frequent power cuts during excess temperatures due to a strained electric grid means that only wealthier individuals can afford to stay cool by running at-home generators.

The compound risks associated with extreme heat and the COVID-19 pandemic further underlines the urgent need to strengthen public awareness and individual perception of the risks from extreme heat events, to invest in urban planning to reduce the urban heat-island effect, to ensure the most vulnerable have access to at-home cooling methods, to develop heat action plans and warning systems, to ensure social service systems are partners in outreach to the most vulnerable when a heatwave strikes and ensure the protection of displaced people.

35 NYC, July 2020. https://www1.nyc.gov/site/em/about/press-releases/20200718_pr_nycem_advises-new-yorkers-to-prepare-for-extreme-heat.page

36 The Seattle Times, June 2021. https://www.seattletimes.com/seattle-news/politics/where-are-cooling-spaces-in-seattle-city-announces-options-limited-by-covid-19/

37 Seven News Boston, July 2020. https://whdh.com/news/cooling-centers-open-as-boston-records-first-heat-wave-of-2020/

38 ibid. NYC, July 2020. https://www1.nyc.gov/site/em/about/press-releases/20200718_pr_nycem_advises-new-yorkers-to-prepare-for-extreme-heat.page

39 Euronews, Sept 2020. https://www.euronews.com/2020/09/16/heatwave-shatters-september-records-in-western-europe

40 France 24, Aug 2020. https://www.france24.com/en/20200809-europe-swelters-under-a-heatwave-complicated-by-covid-19-restrictions

41 Red Cross Red Crescent Magazine, Oct 2020. https://www.rcrcmagazine.org/2020/10/covid-19-syria-summer-heat/

5. Discussion and conclusions

The challenge: compound shocks, more complicated preparedness and response

The large numbers of people affected by climate-related disasters during the COVID-19 pandemic clearly signal the immense toll the two crises have already had on people's lives. As demonstrated by the case studies, preparedness and response for extreme weather events were hampered by the pandemic, and recovery was more challenging due to the impacts of the pandemic and the measures taken to contain it on economic activity.

We have also seen that no one was immune: compound impacts play out even in the richest countries, such as the US or Canada in the case of the unprecedented 2021 heatwave. Elderly people, at highest risk of extreme heat, would face increased risk of COVID-19 infection if they sought shelter in cooling centres.

But it is clear that some of the most devastating impacts have occurred in the places where both health and climate risks were already high before the pandemic hit: the most vulnerable people in the most vulnerable countries. This particularly includes countries facing compound crises not only of climate and covid, but with a third "c" into the deadly mix: conflict – such as in Afghanistan.

The result: a long-term reduction in resilience and increase in climate risk

One of the key implications of the past year is also a long-term increase in climate risk, mainly caused by the impact of COVID-19 on livelihoods and poverty.

Climate risks are partly determined by extreme weather and climate events, which are on the rise in a warming climate. The recent IPCC report[42] clearly outlines what's in store: an overall increase in the frequency and intensity of extreme conditions in a changing climate, but also a rising risk of unprecedented conditions and surprises, complicating preparedness and risk reduction (as demonstrated, for instance by the unprecedented US/Canada heatwave).

42 IPCC, 2021: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S. L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M. I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J. B. R. Matthews, T. K. Maycock, T. Waterfield, O. Yelekçi, R. Yu and B. Zhou (eds.)]. Cambridge University Press. In Press.

But the risks are also determined by exposure and vulnerability. We can save lives by moving people out of harm's way in time, as demonstrated by the relatively low death toll of Amphan in Bangladesh – the disaster that affected the most people in 2020. However, climate impacts are also determined by vulnerability. . This is where poorer people generally suffer the biggest blows. Livelihoods have been hit by COVID-19 and the measures to contain it, and sometimes by the additional impact of climate-related disasters in the very same period. Recovery will take longer, and more people will be more vulnerable to future shocks of any kind, including the rising risk posed by climate-related extremes.

Two years ago, our Cost of Doing Nothing report projected the potential increase in the need for international humanitarian assistance in 2030 and 2050, based on climate scenarios and development projections. In a worst case scenario, double the number of people could be in humanitarian need by mid-century. Besides the climate scenarios, a key driver for those numbers was development. In particular, extreme poverty leaves people much more vulnerable to many types of shocks and stresses, including climate change. The impact of COVID-19 has been an increase in extreme poverty by about 100 million people.[43] This increase in poverty and vulnerability will also result in a lasting increase in humanitarian needs in the face of the climate crisis.

The need: investing in a green, resilient and inclusive future as we recover from COVID-19

As the world looks ahead to a COVID-19 recovery, a few priority investment areas emerge at the nexus of COVID-19 and climate change, from the perspective of a green, resilient and inclusive recovery effort.

The compound effects of climate change and COVID-19 demonstrate the critical need to get the pandemic under control. Equitable access to vaccines around the world will be an essential element.[44]

Equally, we need to tackle the root causes of climate change and reduce emissions to prevent the increasing climate extremes from getting further out of hand.

But there is also a range of investments that will help us to adapt to the rising risks that can no longer be avoided and increase resilience in the face of a range of shocks.[45]

43 World Bank. 2021. Global Economic Prospects, June 2021. Washington, DC: World Bank. doi:10.1596/978-1-4648-1665-9.

44 Red Cross Red Crescent (May 2021): We need new extraordinary steps to increase access to COVID-19 vaccines and we need them now

45 See also Pelling et al. (2021) Synergies Between COVID-19 and Climate Change Impacts and Responses, *Journal of Extreme Events* (in press). This paper highlights how recovery investments can be used to specifically promote and invest in sustainable measures that increase climate resilience, including strategies that address root causes of vulnerability and the fundamental interlinkages between ecosystem health and human health. Degraded ecosystems and illegal wildlife trade, for example, become breeding grounds for diseases through increasing animal-human contact and increasing invasive species. Protecting, restoring and sustainably managing ecosystems can increase resilience of local communities, whilst reducing emissions, providing health benefits and supporting economic recovery.

Firstly is the need to invest in **anticipatory action** ahead of climate-related disasters as a key component of climate change adaptation, disaster risk reduction and humanitarian work. Anticipatory action is centered on the idea of establishing systems that ensure acting before a disaster, based on a forecast of impending risk. They are crucial to minimize lives and livelihoods lost when a hazard strikes. Once established, anticipatory action systems and structures can also provide dual benefits with emerging health crises, such as future pandemics. In addition, their risk analysis directly informs long-term priorities, especially also for climate change adaptation.

Second is to invest in robust, **adaptive social protection** systems which can not only help people recover from COVID-19, but when well designed can help to lessen the impact of climate shocks and build resilience to long-term risks. Key aspects to consider in strengthening social protection systems in the wake of COVID-19 are: ensuring up-to-date databases and data sharing protocols for quick scale ups; allocating additional funding to respond to climate-related disasters, in addition to poverty and livelihood related risks; and coordination to standardize targeting, transfer values and payment mechanisms to enhance cost-efficiency and returns. Investing in additional social protection options could include green energy subsidies and climate resilient infrastructure through cash for work programs. Conditionalities associated with social protection programs can also be modified to include social services check-ins before, during and after shocks. Anticipatory action mechanisms layered into social protection systems can further strengthen their ability to protect the most vulnerable at scale.

A third priority area is **cash as humanitarian aid**, Cash as humanitarian aid is not only an effective and dignified support mechanism to people affected by a wide range of shocks, it also provides a unique opportunity when coupled with anticipatory action mechanisms or layered to work hand-in-hand with social protection systems. Key priorities to consider in strengthening cash as a humanitarian response mechanism in this context include strengthening of preparedness activities including pre-contracting and ensuring agreements and protocols are in place for the transfer of funds. A clear understanding of the affected population to ensure strong targeting and the identification of cash focal points to support effective implementation. As always, it is necessary to work closely with governments and financial service providers to streamline regulations, such as identity requirements, for rapid cash flows at scale and often across borders in the context of humanitarian situations.

A fourth is to accelerate and double down on the global commitment to **invest in local capacity** to act ahead of climate risks and respond to emergencies. The COVID-19 pandemic has shown us something that the Red Cross and Red Crescent has always known: the future of humanitarian action is local. Work to reduce the impact and needs stemming from disasters and health crises must be funded and implemented at the community level, where it is needed most, by strong and empowered local actors. When travel restrictions grounded the international humanitarian community, it was local actors, such as Red Cross Red Crescent volunteers and staff, who remained on the frontlines to respond to this global crisis. In the context of the climate crisis, the same is true. Local actors – including the volunteers of National Red Cross and Red Crescent Societies around the world – are uniquely placed to provide urgent assistance tailored to people's needs and to save lives. Investment in the localization of aid must remain a dual priority, mirrored between the "localization" commitments made by the humanitarian community, and the "principles for locally led action" adopted in the context of climate change. The Bangladesh case study, of 2.4 million people being evacuated by 70,000 volunteers as Cyclone Amphan approached, is a shining example of the power of localization at scale to save lives. Similarly, the role Cyclone Preparedness Programme volunteers are currently playing in disseminating information about COVID-19 as part of Bangladesh's vaccination efforts shows the dual benefits of ensuring strong, localized systems in advance of seemingly unrelated crises.

A fifth priority is to invest in **urban climate resilience**. Many of the risks associated with COVID-19 and climate change are amplified in urban settings. The rapid urban growth happening in many countries on the one hand creates an enhanced risk profile, but it also creates incredible opportunities to adapt and build resilience. This is further underscored by global demographic trends that point to an increasingly urban future. Priorities include: ensuring equitable, inclusive urban planning processes; investing in urban coalitions; strengthening resilience and business continuity skills of small and medium enterprises; investing in nature for its dual benefits of increasing a city's livability and acting as a buffer against climate-shocks, and investing across timescales - from early warning systems for immediate risk, to forward-looking investments to mitigate risks decades into the future.

Finally, a cross-cutting foundation to all of the preceding priorities, is to invest in approaches that jointly recognise the **differentiated needs and capacities of all people impacted by crisis or shocks**. This begins with understanding how power relations and structures hinder access to basic resources, creating an uneven playing field. This whole-society approach bolsters our understanding of how seemingly disconnected groups, such as pastoralists and the urban poor in Kenya, can be impacted in unique ways by the same drought. It recognizes that violence, discrimination and exclusion are interconnected and that tailored support is necessary to meet the unique needs of people living with disabilities, feeling the impacts of extreme heat in northwestern Syria, or children preparing for a cyclone in Cox's Bazar. And it embeds dignity, access, participation and safety as a framework for ensuring even the most vulnerable in the richest societies – such as undocumented migrants losing their livelihoods during the pandemic are included in vital processes and help mitigate further consequences.

Red Cross teams worked around the clock to help people and their pets affected by floods in Valkenburg, Netherlands. Volunteers helped with evacuations, set up camp beds at emergency shelters, and provided psychosocial support. (Photo: Netherlands Red Cross via IFRC)

Annex A: Methodology

A.1 Which disasters and disaster data?

Our main analysis utilises the Centre for Research on the Epidemiology of Disasters (CRED) Emergency Events Database (EM-DAT).[46] We examined disasters recorded as occurring up to 15 August 2021.

The following event types are considered as extreme weather events within this analysis: droughts, floods, storms, extreme temperatures (heatwaves), and wildfires. Disasters not clearly defined as extreme weather events (for example, insect infestation and epidemics), and weather-related disasters that are diminishing due to climate change (for example, cold waves) are excluded.

We have also included a separate analysis for wildfires and extreme temperatures, the methodologies for which are described in the following sections.

A.2 When does a disaster overlap with COVID-19?

In this analysis, a disaster was considered to overlap with the COVID-19 pandemic if it was ongoing or occurred after 11 March 2020, when a global pandemic was declared by the World Health Organization.[47] We consider the date of 11 March 2020 as the threshold at which the effects of COVID-19 became global.

Prior to this date, individual countries and localities experienced prevalent infection and/or measures of control which would be appropriate to consider 'affected' by COVID-19. As such, we also implemented a secondary threshold of cumulative infection rate exceeding 0.01% or 1,000 cases, whichever is lower, or legally enforced closures and/or isolation orders (i.e. a 'lockdown') occurring before 11 March 2020. For these data, COVID-19 infection rates were retrieved from the World Health Organization (WHO)[48] and lockdown dates obtained from collated international media sources.[49]

46 Université catholique de Louvain (UCL) - CRED, D. Guha-Sapir, 2021. EM-DAT: The Emergency Events Database. Brussels, Belgium. www.emdat.be. Accessed 13/09/2020.

47 World Health Organization, 2020. WHO Director-General's opening remarks at the media briefing on COVID-19 - 11 March 2020. https://www.who.int/dg/speeches/detail/who-director-general-s-opening-remarks-at-the-mediabriefing-on-covid-19---11-march-2020

48 World Health Organization, 2020. WHO Coronavirus Disease (COVID-19) Dashboard. https://covid19.who.int/table. Accessed 28/08/2020.

49 Wikipedia contributors, 2020. Wikipedia. https://en.wikipedia.org/wiki/Template:COVID-19_pandemic_lockdowns. Accessed 28/08/2020.

We also conducted a locality-based analysis for large countries (China, India, and United States) to account for local differences in the overlap of COVID-19 and disasters which occurred before 11 March 2020. No disasters were identified in localities which met the infection or lockdown criteria before this date.

Considerations

We acknowledge that WHO-recorded cases, particularly in early 2020, may bear inaccuracies and likely underestimate the prevalence of infection due to a lack of testing. We also acknowledge that definitions of a 'lockdown' differ widely between authorities. However, in practice only one disaster event meets the of secondary criteria for COVID-19 overlap prior to the global pandemic declaration on 11 March 2020.

A.3 EM-DAT analysis

Data for the number of people affected and killed by extreme weather events is sourced from CRED's Emergency Events Database. The EM-DAT repository compiles data on natural and technological disasters globally, sourcing information from governments, IFRC, UN agencies, NGOs, insurance companies, research institutions, and press agencies. These disaster records include the type, location, dates of disaster, the number of people affected, and number of people killed. EM-DAT records disaster data at a country-level, with events which impact several countries containing an entry for each individual country, while retaining the same unique disaster identifier.[50]

The version of the EM-DAT database used in this analysis was published on 13 September 2021.

Based on the dates of each event, and where the event occurred, event entries which meet the COVID-19 overlap criteria – given above – are included in the analysis. For the global totals, we analysed included extreme weather events based on their location and, to avoid double-counting people who may have been affected by more than one event, determined the largest event in terms of number of people affected for each location. These figures of people affected and the total sum killed by all included events contribute to the global totals. For event type totals, we summed the number affected and killed for all included extreme weather events, without a correction for potential double-counting. No supplementary additions are made to the main results tables.

50 Université catholique de Louvain (UCL) - CRED, D. Guha-Sapir, 2021. EM-DAT: The Emergency Events Database. Glossary. Brussels, Belgium. www.emdat.be/Glossary. Accessed 28/08/2020.

Considerations

EM-DAT does not always contain complete data for all recorded disasters on the number of people affected or killed.[51] Of the 433 events identified within this analysis, 44 are currently missing data on the number of people affected. In reality, therefore, the total number of people affected is likely to be higher than that found here.

EM-DAT is also subject to retrospective additions and revisions—sometimes significant—even months after disaster events have occurred. We highlight this with our comparative analysis conducted using a version of the EM-DAT repository published in September 2020 and one published a year later in September 2021 (as discussed in Annex 2). We therefore acknowledge that the figures presented for events occurring in recent months are preliminary, and subject to increase.

A.4 Supplementary analysis: extreme temperatures

We performed a separate complementary analysis estimating the number of vulnerable people experiencing extreme heat, and deaths associated with extreme temperature events overlapping with COVID-19.

Number of people in vulnerable age groups that experienced extreme heat during COVID-19

Our analysis of the number of people in vulnerable age groups who experienced extreme temperatures follows the same approach as that derived in our seminal paper: the number of people exposed to extreme temperatures globally are calculated through an analysis of spatial temperature data from the Copernicus Climate Change Service (3CS),[52] and spatial population data from the Socioeconomic Data and Application Center (SEDAC) by the Center for International Earth Science Information Network,[53] at a 0.5' resolution grid. In this study, an extreme temperature event (heatwave) is defined as a period of 3 or more consecutive calendar days each with a maximum daily temperature which exceeds the 98th percentile of maximum daily temperatures for the period 1979-2019, where the temperature is also above the annual 90th percentile of maximum daily temperatures for any individual grid square.

We define the demographic groups most vulnerable to the effects of exposure to high temperatures as children and elderly. In this analysis, we include populations under five years and those over 65 years old who are exposed to an extreme temperature event.

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51 Université catholique de Louvain (UCL) - CRED, D. Guha-Sapir, 2021. EM-DAT: The Emergency Events Database. Frequently asked questions. Brussels, Belgium. www.emdat.be/frequently-asked-questions. Accessed 28/08/2020.

52 Copernicus Climate Change Service (C3S), 2017. ERA5: Fifth generation of ECMWF atmospheric reanalyses of the global climate. https://cds.climate.copernicus.eu/cdsapp#!/home. Accessed 28/08/2021.

53 Center for International Earth Science Information Network - CIESIN - Columbia University, 2018. Gridded Population of the World, Version 4 (GPWv4): Population Count, Revision 11. Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC). https://doi.org/10.7927/H4JW8BX5. Accessed 28/08/2021.

Spatial population data is limited to availability of 2020 population counts, and 2010 age demographic information at a 0.5' resolution grid globally. For each grid square, the number of people aged under five years and over 65 years is calculated as a share of total grid square population in 2010. This share is then applied to each grid square population count for 2020, producing an estimate of the total vulnerable population in each grid square.

Considerations

There is no universally accepted definition of a heatwave: the World Meteorological Organization (WMO) defines a heatwave simply as a period of hot weather persisting at least three consecutive days during the warm period of the year.[54] We note that our selected approach of 98th percentile over three consecutive days provides the narrowest definition compared to that of other approaches found in surveyed research: sensitivity analysis performed using alternatives of 90th percentile over six days, 95th percentile over three days, and 99th percentile over two days all showed a higher estimate for the global number of vulnerable people experiencing extreme heat.

We also acknowledge the importance of more locally appropriate heatwave definitions, given differing contexts, and note that for instance humidity and night-time temperature may be an important factor in extreme temperature events.

Our approach does not directly account for different magnitudes of extreme temperature events, as an event which exceeds the temperature threshold by less than a degree is counted the same as one that exceeds it by ten. Further revisions of this analysis may extend the approach to consider how greater magnitude events affect larger population groups.

We note that spatial population distributions are based on modelled analysis conducted by SEDAC which is limited by the quality and granularity of national population census reporting. Furthermore, while total population estimates are available for 2020, the latest available demographic breakdowns by geography are for 2010.

Excess mortality

We estimate the number of deaths associated with extreme temperature events through an analysis of excess mortality over extreme temperature periods. This approach is complicated by excess mortality associated with the COVID-19 pandemic. We therefore selected two major extreme temperature events for which both consistent and high-quality total mortality and COVID-19 deaths data were available: the Western Europe heatwave in 2020, and the Western North America heatwave in 2021. For the Western Europe heatwave in 2020, total mortality data for Belgium, France, Germany, Netherlands, Switzerland, and the United Kingdom were sourced from their respective national statistics offices.[55]

54 World Meteorological Organization, 2018. Guidelines on the definition and monitoring of extreme weather and climate events.

55 These national statistics sources are as follows:
Belgium – Statbel (https://statbel.fgov.be/)
France – Insee (https://www.insee.fr/)
Germany – Destatis (https://www.destatis.de/)
Netherlands – Centraal Bureau voor de Statistiek (https://www.cbs.nl/)
Switzerland – Federal Statistical Office (https://www.bfs.admin.ch/)

COVID-19 death data was sourced from the European Centre for Disease Prevention and Control (ECDC).[56] These countries were chosen due to good matching figures of total excess mortality and COVID-19 deaths outside of the heatwave period, and their exposure to the extreme temperature event. Utilising the approach described by European Mortality Monitoring,[57] weekly expected mortality rates were produced for all countries based on historical data. Weekly expected deaths plus COVID-19 deaths were then subtracted from the total observed number of deaths over the period 27 July – 31 August 2020.

For the Western North America heatwave in 2021, total mortality data and COVID-19 death data for the US states of Oregon and Washington was sourced from the US Centers for Disease Control and Prevention (US CDC).[58] The same approach as described above was used to produce excess mortality figures exclusive of COVID-19 deaths in these two states over the period 26 June – 17 July. For the Canadian provinces of British Columbia and Alberta, preliminary estimates of heat-related excess mortality over the period were publicly provided by authorities.[59, 60]

In neither case do we make adjustments for the so-called harvesting effect – otherwise known as mortality displacement – which is where a period of excess mortality is typically followed by a dip in overall mortality. Therefore, negative excess mortality figures, where they occur in the weeks following an extreme temperature event, are not included in the sum totals.

Considerations

We note that it is not possible to entirely separate extreme temperature-related deaths from other causes captured by excess mortality, particularly as the COVID-19 pandemic has coincided with an increase in deaths which are not officially attributed to the disease.[61]

Furthermore, while the pandemic has prompted many national statistics offices to publish frequent data on mortality rates and causes, such figures are frequently revised retrospectively as death records are processed with a time delay. These issues lend themselves to an imprecise estimation of the number of deaths associated with recent extreme temperature events – in particular the western North America heatwave across June-July 2021.

United Kingdom – ONS (https://www.ons.gov.uk/)

56 European Centre for Disease prevention and Control, 2021. COVID-19 situation update for the EU/EEA and the UK, as of 27 August 2021. https://www.ecdc.europa.eu/en/cases-2019-ncov-eueea. Accessed 28/08/21.

57 EUROMOMO, 2021. https://www.euromomo.eu/how-it-works/methods/. Accessed 28/08/21.

58 U.S. Department of Health & Human Services Centers for Disease Control and Prevention, 2021. Excess Deaths Associated with COVID-19. https://www.cdc.gov/nchs/nvss/vsrr/covid19/excess_deaths.htm. Accessed 28/08/21.

59 British Columbia Coroners Service, 2021. Heat-Related Deaths in B.C. https://www2.gov.bc.ca/gov/content/life-events/death/coroners-service/news-and-updates/heat-related. Accessed 28/08/21.

60 Edmonton Journal, 2021. Alberta saw spike in reported deaths during heatwave, causes still under investigation. https://edmontonjournal.com/news/local-news/alberta-saw-spike-in-reported-deaths-during-heatwave-causes-still-under-investigation. Accessed 28/08/21.

61 The Economist, 2020. Tracking covid-19 excess deaths across countries. https://www.economist.com/graphic-detail/2020/07/15/tracking-covid-19-excess-deaths-across-countries

A.5 Supplementary analysis: wildfires

Supplementary figures for numbers of people affected and killed by wildfires were sourced from The International Federation of Red Cross and Red Crescent Societies (IFRC) disaster response platform IFRC GO,[62] and the United States Forest Service web information system InciWeb.[63] Four wildfire events were selected for supplementary analysis due to the currently limited data available in the EM-DAT repository: Northern Algeria 2021, Syria and Lebanon 2020-2021, and both the 2020 and 2021 wildfire seasons in United States.

For the two wildfire events outside of United States, we examined field reports and appeals data from IFRC GO. The maximum of people affected or number of targeted beneficiaries of IFRC assistance was taken as the number affected for each event. Deaths were taken as recorded by the most recent IFRC field report.

For the two wildfire seasons in United States, we examined information and reports collated by InciWeb on the number of people evacuated or under evacuation orders during both wildfire seasons. We took the maximum number people under evacuation order at any one time on a state basis, as announced by the respective state fire authorities as the total number of people affected over the period 1 July – 31 December 2020, and 1 July – 15 August 2021. Deaths were taken as reported by relevant state authorities during the same periods.

Multiple wildfires broke out on Turkey's Mediterranean coast this summer, killing at least eight people. Hundreds of animals also died in the blazes and countless homes were lost. More than 2,000 Turkish Red Crescent staff and volunteers were on the ground, providing mobile kitchens, water, hygiene kits and emergency shelter. (Photo: Turkish Red Crescent via IFRC)

62 The International Federation of Red Cross and Red Crescent Societies, 2021. IFRC GO. https://go.ifrc.org/. Accessed: 28/08/21.

63 United States Forest Service, 2021. InciWeb – Incident Information System. https://inciweb.nwcg.gov/. Accessed: 28/08/21.

Considerations

IFRC field reports contain information from IFRC or national society personnel about disasters as they occur and reflect the best knowledge of these personnel at the time. Numbers of people affected or killed are subject to revision in further field reports or are superseded by data recorded by IFRC appeals. IFRC appeals have a targeted number of beneficiaries, but this figure may be lower than the number of people actually affected by a disaster, furthermore this figure is subject to revision as the scale of needs and availability resources changes.

Figures for the number of people affected in United States wildfires derive from state-level announcements and reports of the number of people covered by evacuation zones during the wildfire seasons. These totals therefore exclude people outside evacuation zones, but otherwise affected by poor air quality, good shortages, or other effects. Furthermore, we were unable to account for changing evacuation zones affecting varying populations across the wildfire season, and hence identified the maximum number of people covered at any time on a state basis; these figures are therefore likely underestimate the total number of people who faced evacuation or evacuation orders at any point during the wildfire season.

Annex B: Comparison of updated results with our initial estimates from September 2020

In September 2020, we presented an initial analysis of the first 6 months of the COVID-19 pandemic[64], based on data available at that time. The current figures from March 2020 to August 2021 of course include that same period. This Annex compares the initial analysis from last year with the updated numbers available now.

The 15 September 2020 version of EM-DAT's repository recorded 84 extreme weather events in this period. Without supplementary figures from IFRC and ReliefWeb, these events accounted for 46.8 million people affected, and 4,676 deaths.

The new data, utilising the 13 September 2021 version of the repository, reveals a significant increase, based on updated reporting of events that had happened only recently when we presented our initial analysis. It now displays almost 100 more unique events over the same period — a total of 181. Up to 15 September 2020, over 80 million people were affected, and more than 12,000 killed in extreme weather events overlapping with the COVID-19 pandemic.

The largest difference in the updated data is that it includes more than 25 million people affected by drought events. We excluded droughts in our analysis last year based on very limited reporting in EM-DAT. The updated numbers reflect the difficult but improving process of accurately recording the effects of slow-onset disasters, although mortality data is still extremely limited. Also notable in the updated EM-DAT results are additions to extreme temperature and wildfire events (which we complemented with additional analysis ourselves last year). The former now presenting data for the Western Europe heatwave representing over 6,000 deaths, and the latter including some data from the Western United States wildfires.

We note that the results presented in this updated analysis for the total number of extreme weather events overlapping with COVID-19 to date (August 2021) should therefore also be considered with this understanding, that the estimates of numbers of people affected and killed by extreme weather events are subject to upward revision — sometimes significantly — as time-delayed data becomes available. This implies that the numbers presented are an underestimate.

64 Walton, D. and M.K. van Aalst, 2020. *Climate-related extreme weather events and COVID-19. A first look at the number of people affected by intersecting disasters*. IFRC, Geneva.

Table B.1: Extreme weather events overlapping with COVID-19 up to 15 September 2020

Disaster Type	Total Affected	Total Deaths	Number of events
Drought	25,528,303	*Unknown*	14
Flood	32,008,015	5,456	126
Storm	22,798,585	479	36
Extreme temperature*	*Unknown*	6,340	1
Wildfire	141,579	59	4
Total	**80,476,482**	**12,387**	**181**

Source: EM-DAT.

Notes: Due to very limited data on deaths due to drought events and people affected by extreme temperatures, estimates are not given for these totals.

* EM-DAT figures limited to Belgium, France, Netherlands, UK in 2020.