

Climate-related extreme weather events and COVID-19

**A first look at the number of people
affected by intersecting disasters**

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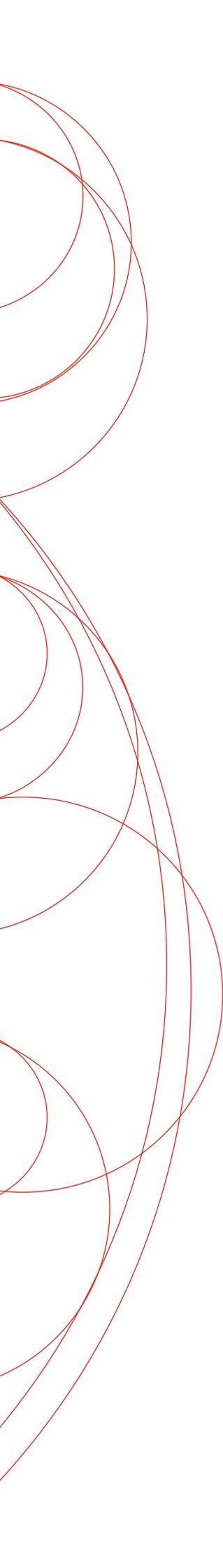


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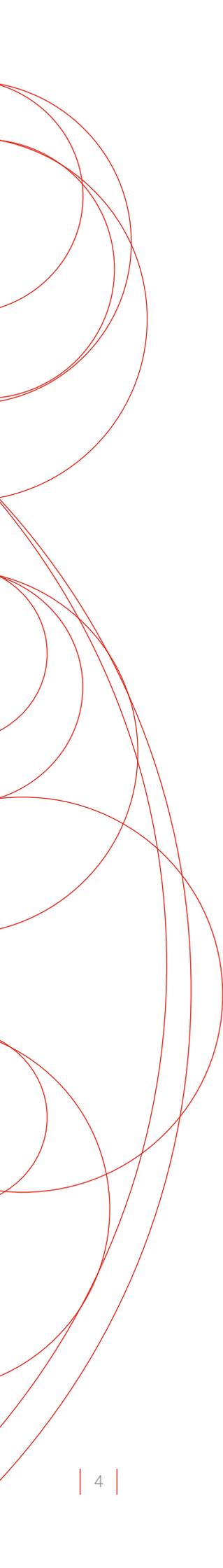
Acknowledgements

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It is clearly a preliminary analysis of an unfolding 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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Further analysis on links between climate and disasters, including compound impacts with other drivers of vulnerability, will be available in the upcoming World Disasters Report 2020 that will appear in October 2020.



Summary

The ongoing COVID-19 pandemic is an unprecedented humanitarian crisis which intersects with the global climate emergency. Climate change has not stopped in the midst of the pandemic's global spread. In fact, COVID-19 is directly affecting and increasing the needs of persons affected by climate-related disasters. People in the path of extreme weather events are currently faced with overlapping disasters with compounding effects.

Of course not all climate-related disasters have a direct link with climate change. However, it is unequivocal that due to global warming we are facing a more volatile climate with more weather extremes. In recent years, according to the World Meteorological Organization “a clear fingerprint of human-induced climate change has been identified on many of these extreme events”.¹ Scientists have already shown that some of the extremes we faced in 2020, such as the Siberian heatwave, would have been virtually impossible without climate change.²

This paper aims to provide a preliminary analysis of the number of people jointly affected by COVID-19 and climate-related disasters – demonstrating the multi-layered nature of these crises and highlighting the compounded vulnerability faced by communities.

Based on data from EM-DAT, the main global disaster database, supplemented and cross-checked by an analysis of the International Federation of Red Cross and Red Crescent Societies (IFRC) GO platform and the United Nations Office for the Coordination of Humanitarian Affairs (UNOCHA) ReliefWeb, we demonstrate that

- Of the 132 identified unique extreme weather related disasters occurring in 2020 so far, 92 have overlapped with the COVID-19 pandemic.
- As of 15 September 2020, 51.6 million people globally have been recorded as directly affected by an overlap of floods, droughts, or storms and the COVID-19 pandemic. Over 3,000 people have been killed in these events.
- In addition, we estimate that major wildfires, which were not yet fully captured in EM-DAT, have affected an estimated 2.3 million people (mostly in the United States), killing at least 53 people.

1 WMO, 2020. Press release United in Science report: Climate Change has not stopped for COVID19. <https://public.wmo.int/en/media/press-release/united-science-report-climate-change-has-not-stopped-covid19>

2 World Weather Attribution Consortium, 2020. Siberian heatwave of 2020 almost impossible without climate change. <https://www.worldweatherattribution.org/siberian-heatwave-of-2020-almost-impossible-without-climate-change/>

- Heatwaves are underreported in disaster databases, but are among the most deadly and rapidly rising climate-related extremes, with significant overlapping risks with COVID-19.³ Our rough estimates indicate that 431.7 million people in vulnerable populations across the world have been exposed to extreme heat during the COVID-19 pandemic (although we note that these numbers strongly depend on the definition used). Notably, the European heatwave affected 75.5 million people in vulnerable populations, and our initial estimates suggest that the heat resulted in excess mortality of over 9000 people over July-August.

We note that our analysis is preliminary, based on a first look at the available data. However, we also note that the figures presented here of the number of people affected and killed by climate-related disasters are almost certainly a significant underestimate. These estimates are based on preliminary data in currently available sources. Furthermore, recording of the effects of extreme weather events during the COVID-19 pandemic, particularly in developing countries, is not comprehensive, further contributing to the extent of the underestimate.⁴ Furthermore, our analysis does not include the aggravated impacts of COVID-19 on food security, which often also has at least partly climate-related drivers. We note that WFP estimates that the effects of the pandemic will likely increase the number of people suffering from acute food insecurity to almost double from 135 million to 270 million people.⁵ We have also not looked at overlaps with conflict conditions and displacement – clearly yet another category of compound impacts, with vulnerable populations facing the triple risks of conflict, COVID-19 and climate. More generally, we of course acknowledge that not everyone counted as “affected” is affected similarly, with poor and marginalized groups hit especially hard.⁶ Further work is clearly needed to better understand, and hopefully address, the rising compound risks facing vulnerable groups.

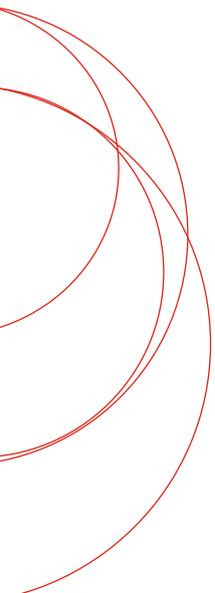


3 Global Heat Health Information Network, 2020 <https://www.ghhin.org/news/global-partnership-urges-stronger-preparation-for-hot-weather-during-covid-19>

4 World Meteorological Organization. 2020. United in Science 2020. https://public.wmo.int/en/resources/united_in_science

5 WFP. 2020. Responding to the development emergency caused by COVID-19 WFP’s medium-term programme framework. <https://docs.wfp.org/api/documents/WFP-0000117125/download/?ga=2.62248556.1110410529.1600683117-551083947.1600683117>

6 The 2020 World Disasters Report, which focuses on climate change, will take a closer look at these drivers of risk.



1. Introduction

Around the world, billions of people are directly or indirectly affected by the COVID-19 pandemic. Among the most affected are the people suffering its direct health impacts, but also those especially vulnerable to the compound impacts of the effects of COVID-19, including effects of lockdowns and other restrictions to reduce the spread of the pandemic, and their economic implications. These compound impacts are particularly severe for people hit by extreme weather events, which always hit the most vulnerable groups hardest, and are now significantly exacerbated by the impacts of the pandemic.

The pandemic is also placing strain on national and international emergency relief systems. For instance, evacuations for storms are more difficult during a lockdown, requiring people to be spread over a larger number of shelters and ensure provision of protection to avoid unintentionally aggravating the pandemic by protecting people from a natural hazard. Relief agencies are facing a double threat of responding to COVID-19 outbreaks and a simultaneous reduction in mobilisable front-line workforce and resources.⁷ Global supply chains have experienced severe disruption due to reduced logistics capacity, slowing the supply of relief aid and recovery equipment.⁸ Furthermore, the pandemic has vastly extended the need for financial humanitarian assistance at a time of deep global economic downturn.⁹

This paper aims to provide a preliminary analysis of the number of people jointly affected by COVID-19 and climate-related disasters – demonstrating the multi-layered nature of these crises and highlighting the compounded vulnerability faced by communities.

7 International Federation of Red Cross and Red Crescent Societies, 2020. COVID-19 OUTBREAK OPERATIONAL UPDATE #18. <https://media.ifrc.org/ifrc/emergency/global-covid-19/>

8 United Nations, 2020. An urgent call to fund the global emergency supply system to fight COVID-19. <https://medium.com/humanitarian-dispatches/an-urgent-call-to-fund-the-global-emergency-supply-system-to-fight-covid-19-ea063658f7d9>

9 Development Initiatives, 2020. How are aid budgets changing due to the Covid-19 crisis? <https://devinit.org/resources/how-are-aid-budgets-changing-due-covid-19-crisis/>

2. Methods

This section contains the methodology and definitions used for our estimates of people affected by extreme weather events compounded by the COVID-19 pandemic based on their overlapping occurrence period and geography.

2.1. Climate-related disasters and extreme weather events

Our analysis is mainly based on the Emergency Events Database (EM-DAT). In the EM-DAT categorization, the following event types are considered as climate-related disasters, or ‘extreme weather events’, inside the scope of this analysis: droughts, floods, storms, extreme temperature (heatwaves) and wildfires.

Several other types of disasters classified by EM-DAT have links to climate, but are not clearly defined as extreme weather events (epidemics and insect infestations, for example). Given the interest in the impacts of climate change, we have also excluded those weather-related disasters that are diminishing due to climate change (cold waves and severe winter conditions, for example). As noted below, we have complemented the EM-DAT database with data from IFRC GO and UN OCHA’s ReliefWeb, and included our own separate analysis for wildfires and extreme heat.

We want to be clear that not all “climate-related” disasters in this analysis reflect a clear trend in risk due to climate change. For some extremes, such as extreme heat, this link is pretty straightforward almost everywhere. For others, such as extreme rainfall, globally the link can clearly be made, but in individual places, the trends can go either way, and may be difficult to distinguish from the high year-to-year variability. However, it is unequivocal that globally we are facing a more volatile climate with more weather extremes. In particular, the World Meteorological Organization notes that “a clear fingerprint of human-induced climate change has been identified on many of these extreme events”.¹⁰ Scientists have already shown that some of the extremes we faced in 2020, such as the Siberian heatwave, would have been virtually impossible without climate change.¹¹

Our analysis does not include the aggravated impacts of COVID-19 on food security, although we recognise that food insecurity can often also have climate-related drivers.¹²

10 WMO, 2020. Press release United in Science report: Climate Change has not stopped for COVID19. <https://public.wmo.int/en/media/press-release/united-science-report-climate-change-has-not-stopped-covid19>

11 World Weather Attribution Consortium, 2020. Siberian heatwave of 2020 almost impossible without climate change. <https://www.worldweatherattribution.org/siberian-heatwave-of-2020-almost-impossible-without-climate-change/>

12 WFP estimates that the effects of the pandemic will likely increase the number of people suffering from acute food insecurity to almost double from 135 million to 270 million people. See WFP 2020. Responding to the development emergency caused by COVID-19. WFP’s medium-term programme framework. https://docs.wfp.org/api/documents/WFP-0000117125/download/?_ga=2.62248556.1110410529.1600683117-551083947.1600683117

2.2. Defining the overlap of COVID-19

In this analysis, a country (or locality in China, United States and India – see below) is considered to be affected by the COVID-19 pandemic if at least one of the following criteria is true: 1) there is or has been a legally enforced closure of non-essential business premises, schools, and/or other isolation orders (i.e. a ‘lockdown’); 2) WHO-recorded cumulative cases exceed 1,000 or 0.01% of the population, whichever is lower; 3) the date is after 11 March 2020, when a global pandemic was declared by the WHO.

This three-criteria definition aims to capture a broad definition of pandemic overlap: as the impact and compounding effect of COVID-19 is demonstrated through direct presence of the disease, measures instituted to control its spread, and its wider economic ramifications. Locality-based analysis for large countries (China, India and United States) is done to account for local differences in presence and measures which may have occurred before the global pandemic declaration. In practice, however, no recorded disasters are identified in localities which met these criteria before the 11 March 2020 date.

Identifying which disasters are overlapped by the COVID-19 pandemic is established by an examination of infection rates obtained from the World Health Organization (WHO)¹³ and lockdown dates obtained from collated international media sources.¹⁴



13 World Health Organization, 2020. WHO Coronavirus Disease (COVID-19) Dashboard. <https://covid19.who.int/table>. Accessed 15/09/2020.

14 Wikipedia contributors, 2020. Wikipedia. https://en.wikipedia.org/wiki/Template:COVID-19_pandemic_lockdowns. Accessed 15/09/2020.

Considerations and caveats

The date of 11 March 2020 represents a global threshold for the pandemic whereby its effects were clearly present and pervasive in many countries, and international concerted action to control the spread was deemed necessary.¹⁵ However, timelines of individual country rates of infection and measures of control have differed significantly and the point at which a country (or locality) can be considered totally 'affected' by the pandemic is not universally defined. As such, the choice of a secondary threshold requiring the infection rate to exceed 0.01% or 1,000 cases – whichever is lower – aims to capture cases where the COVID-19 pandemic was present – and prevalent in effect – prior to 11 March 2020, but no or limited restrictive measures had been taken against it. In practice, only one disaster event meets this criterion of inclusion and no others.

It is acknowledged that WHO-recorded cumulative cases, particularly in the early stages of COVID-19's spread, may be inaccurate due to differences in national reporting. The cumulative case-load is retrospectively updated by the WHO as and when data emerges on the historical prevalence of COVID-19.

2.3 Methods of analysis for floods, droughts and storms

Data on droughts, floods, storms and wildfires is primarily obtained from EM-DAT.¹⁶ The database version used is from 15 September 2020.

The EM-DAT repository contains records for disasters at a country level. These records include the type, location (national and subnational), dates of disaster, the number of people affected, and number of people killed. Based on the dates of each disaster, and where the disaster occurred, events which overlap with the COVID-19 pandemic criteria (above) are entirely counted as overlapping. The full sum of people affected and/or killed by these disasters are included in the global total.

Data from EM-DAT is supplemented and cross-checked by an analysis of the International Federation of Red Cross and Red Crescent Societies (IFRC) GO platform¹⁷ and the United Nations Office for the Coordination of Humanitarian Affairs (UNOCHA) ReliefWeb.¹⁸ GO is a Red Cross Red Crescent platform containing data on emergencies and disasters responded to by national societies; ReliefWeb is a humanitarian information service containing collated information and status reports on humanitarian disasters. Notably, information on the number of people affected by ongoing droughts is limited in EM-DAT – subsequently data for one major drought event (Southern Africa) is obtained from these supplementary sources based on the reported number of people experiencing high food insecurity due to drought during the pandemic.¹⁹

15 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-media-briefing-on-covid-19---11-march-2020>

16 Université catholique de Louvain (UCL) - CRED, D. Guha-Sapir, 2020. EM-DAT: The Emergency Events Database. Brussels, Belgium. www.emdat.be. Accessed 15/09/2020.

17 International Federation of Red Cross and Red Crescent Societies. 2020. IFRC GO. <https://go.ifrc.org/>. Accessed 15/09/2020.

18 United Nations Office for the Coordination of Humanitarian Affairs. 2020. ReliefWeb. <https://reliefweb.int/disasters>. Accessed 15/09/2020.

19 <https://reliefweb.int/disaster/dr-2018-000429-zwe>

Data for the number of people killed by droughts is very limited – with data available for less than 10% of affected population-weighted drought events – and hence is discounted from the analysis.

Considerations and caveats

The most recent available data from EM-DAT for this paper was published 15 September 2020; data on the number of people affected and killed for ongoing disasters and those occurring in recent months is preliminary and is subject to revision with new releases of data. Furthermore, EM-DAT does not contain complete data for all recorded disasters on the number of people affected or killed.²⁰ Of the 83 events identified within EM-DAT in this analysis of these disaster types, 10 are missing data on the number of people affected, and 24 are missing data on the number of people killed. In reality, therefore, the estimated number of people affected by both extreme weather events and the pandemic is likely to be higher than that found here.

EM-DAT documentation defines persons ‘affected’ by a disaster as those “requiring immediate assistance during a period of emergency situation”. However, the documentation further notes that differences in exact definitions and methodologies used in reporting the number of people affected by each disaster make these numbers difficult to directly compare, and they are rarely precise.²¹ This paper uses figures presented as-is by EM-DAT as its common definition of ‘affected’ is considered appropriate to the analysis, and the drawbacks of imprecise figures are outweighed by the value of reporting a meaningful scale of the impact of disasters.

Supplementary data sourced from IFRC GO and ReliefWeb is based on individual organisation reporting to the platforms for specific disaster instances. The data on the number of people affected is not directly comparable with those found in EM-DAT.



20 <https://emdat.be/frequently-asked-questions>

21 <https://www.emdat.be/guidelines>

2.4 Method of analysis for extreme heat

2.4.1 Number of people exposed to extreme heat

Estimates for the number of people exposed to extreme heat are derived from a simple geospatial analysis of spatial temperature data from the Copernicus Climate Change Service (3CS)²² and spatial population data from the Socioeconomic Data and Application Center (SEDAC) by the Center for International Earth Science Information Network.²³ The temperature data used is fifth generation ECMWF atmospheric reanalyses (ERA5) of the hourly 2m maximum temperatures at a 0.5 degree resolution grid.

Everyone in the path of extreme heat experiences the same high temperatures, but the varied impact on different groups is significant. People who are most vulnerable to the effects of prolonged extreme heat – notably the elderly, babies, and young children²⁴ – are more aptly considered to be ‘affected’ by the detrimental effects of extreme heat than others.²⁵ In this analysis, an estimate for the number of people exposed to extreme heat is based on these vulnerable populations (those under five years and those over 65 years old).

There is no universally accepted measurable threshold of a heatwave; the World Meteorological Organization (WMO) defines a heatwave as a period of hot weather persisting at least three consecutive days during the warm period of the year.²⁶ Many different working definitions of heatwaves are used by climate researchers: six or more consecutive days exceeding their respective calendar-day 90th percentile of daily maximum temperature;²⁷ three or more consecutive days with minimum and maximum daily temperatures over the 95th percentile;²⁸ three or more consecutive days over the 98th percentile of maximum temperature;²⁹ two or more consecutive days over the 99th percentile maximum temperature.³⁰ Despite differences in exact definitions, heatwaves are commonly characterised by two factors: magnitude and duration.

For the purpose of this analysis, an extreme heat event in any single grid square is defined as a period of three or more consecutive days with a maximum daily temperatures over the 98th percentile for their respective calendar-days based on 1979-2019, where the temperature is also in the yearly 90th percentile. This definition serves to meet the criteria of a persistent period of hot weather during the warm period of the year. The resulting extreme heat occurrences are checked against national meteorological forecasts and heatwave warnings for the same period to ensure a good alignment with national definitions.

22 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 15/09/2020.

23 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 15/09/2020.

24 Other groups particularly vulnerable to ill-effects from heatwaves include those with chronic health conditions and those working outside in the sun, but are not considered in this analysis.

25 Watts, N., et al., 2019. The 2019 report of The Lancet Countdown on health and climate change: ensuring that the health of a child born today is not defined by a changing climate.

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

27 Fischer, E. M. & Schär, C., 2010. Consistent geographical patterns of changes in high-impact European heatwaves. *Nature Geoscience* 3, 398–403.

28 Nissan, H., Burkart, K., Coughlan de Perez, E., Van Aalst, M., Mason, & S., 2017. Defining and Predicting Heat Waves in Bangladesh. *Journal of Applied Meteorology and Climatology*, 56, 2653–2670.

29 Schoetter, R., Cattiaux, J. & Douville, H., 2015. Changes of western European heat wave characteristics projected by the CMIP5 ensemble. *Climate dynamics*, 45, 1601–1616.

30 Robinson, P. J., 2001. On the Definition of a Heat Wave. *Journal of Applied Meteorology and Climatology*, 40, 762–7

Spatial population is sourced from the Socioeconomic Data and Application Center (SEDAC) by the Center for International Earth Science Information Network, which provides 2020 population counts, and 2010 age demographic information at a 0.5 degree resolution grid globally. For each grid, the number of people aged under five years and over 65 years is calculated as a share of total grid population in 2010. This share is then applied to each grid's population count for 2020, producing an estimate of the total vulnerable population in each grid. Where an extreme heat event occurs at a grid location also experiencing the COVID-19 pandemic (based on the above approach), the whole vulnerable population count for that grid is counted as affected.

Considerations and caveats

The approach utilised in this paper for defining extreme heat is one of many possible methods. We recognise the importance of more locally appropriate heatwave definitions to guide public health interventions in specific contexts, and note that for instance night-time temperature may be an important indicator.

The selected approach of 98th percentile over three consecutive days provides the narrowest definition of surveyed research based on the resulting total of the number of people affected globally (431.7m). Sensitivity analysis performed using alternatives of 90th percentile over six days (725.6m), 95th percentile over three days (629.2m), and 99th percentile over two days (438.4m) all showed an increase in the global outcome estimate.

Producing an estimate for the number of people exposed utilises spatial population distributions estimates sourced from SEDAC. These 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.



Age is not the only major risk factor associated with extreme heat (e.g. several diseases are also known to make people more vulnerable); however, due to data availability and estimation issues, only age is considered for defining populations vulnerable to heatwaves. This may lead to an underestimation of the size of vulnerable population exposed. In addition, protective measures, such as air-conditioning access, has not been factored into this analysis.

2.4.2 Number of people killed by heatwaves

Estimates for the number of people killed by heatwaves are derived from national statistics offices³¹ and the European Centre for Disease Prevention and Control (CDC),³² based on recorded excess mortality rates which coincide with the heatwave.

This task is made difficult by the excess mortality associated with the COVID-19 pandemic; to date, few national statistics offices have made public official figures for people killed by heatwaves in 2020. Given the inherent difficulty of separating the cause of excess mortality between heatwaves and COVID-19 and lack of data availability for many countries, this paper only produces an estimated death toll for a limited number of countries during the European heatwave.

Overall mortality data from eight national statistics offices are examined: Belgium, France, Germany, Netherlands, Portugal, Spain, Switzerland and United Kingdom. These countries are chosen due to generally good matches between reported deaths attributed to COVID-19 and excess deaths in March-April, and their exposure to heatwave events. COVID-19 death data is sourced from the European CDC. Utilising the approach described by European Mortality Monitoring,³³ a weekly expected mortality rate is generated for all countries based on historical data. The weekly difference between observed total deaths and COVID-19 deaths plus expected deaths is then calculated for the European heatwave period (27 July - 31 August). Negative excess death values are discounted.

31 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/>)

Italy – ISTAT (<https://avvisi.istat.it/>)

Netherlands – Centraal Bureau voor de Statistiek (<https://www.cbs.nl/>)

Portugal – SNS (<https://www.sns.gov.pt/>)

Spain – Instituto de Salud Carlos III (<https://www.isciii.es/>)

Switzerland – Federal Statistical Office (<https://www.bfs.admin.ch/>)

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

32 European Centre for Disease prevention and Control, 2020. COVID-19 situation update for the EU/EEA and the UK, as of 12 September 2020. <https://www.ecdc.europa.eu/en/cases-2019-ncov-eueea>

33 EUROMOMO, 2020. <https://www.euromomo.eu/how-it-works/methods/>

Considerations and caveats

It is impossible to entirely separate heatwave-related deaths from other causes in this analysis. This is particularly difficult in the current scenario, as the COVID-19 pandemic has coincided with an increase in deaths which are not officially attributed to the disease.³⁴

Furthermore, the pandemic has prompted many national statistics offices to publish frequent updates on death rates and causes. While allowing for a timely analysis, this data is frequently revised retrospectively as death records are processed with a time delay. Finally, excess mortality may also be attributable to non-heat causes not including COVID-19. These issues lend themselves to an imprecise estimation of the number of deaths associated with heatwaves.

2.5 Methods of analysis for wildfires

Unified data for the estimated number of people affected by wildfires is limited; the 15 September release of EM-DAT records just one instance of a wildfire event during the pandemic – that in Liangshan Prefecture, China. In order to supplement this data to capture the effects of other major wildfires, this paper uses a spatial approach utilising fire detection data from the Visible Infrared Imaging Radiometer Suite (VIIRS)³⁵ and spatial population data from SEDAC.

VIIRS contains daily satellite-based fire detection data. Detection is based on individual pixels of data, with a nominal resolution of 375m – observed pixels containing potential fire events are ascribed a confidence rating – low, nominal or high – for the likelihood based on observation conditions. For this analysis, low-confidence detections are removed.



34 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>

35 NRT VIIRS 375 m Active Fire product VNP14IMGT, 2020. <https://earthdata.nasa.gov/firms>. Accessed 15/09/2020.

As with extreme heat, spatial population data for 2020 is sourced from SEDAC at a 0.5 degree global resolution grid. Each of these grid squares is divided into 100 (approximately 5.5km²) subcells, which are individually analysed for the presence of fire based on the reported sizes and locations of fires from VIIRS. The maximum weekly share of subcells with fire presence is then calculated to be the total area of the grid square affected by fire.

The affected population is calculated as the maximum fire presence grid share observed during the pandemic multiplied by the grid's population. This provides an estimate, scaled by fire size and movement, of the number of people affected by fires within an approximate 50km distance threshold.

The results of this analysis is applied to the location of several major concurrent wildfires on the US West Coast, which have been grouped into a single event in the output of analysis.

Considerations and caveats

The approach used in this paper is a simple analysis utilising raw satellite data and geographical population counts. The approach is not intended to provide a precise figure, but rather an accurate measure of the scale of impact caused by major wildfires. Analysis is limited to a single geographical region due to data quality and availability limitations.

The effects of sustained wildfires can far exceed their geographical boundaries; however this paper's calculations for the number of people affected by wildfires is limited to the immediate locality of a fire (approximately 50km), and does not consider the effects of far-drifting air pollution caused by substantial fires (which can extend hundreds of kilometres), nor wider areas of pre-emptive evacuation which may occur.

The identification of fires by VIIRS does not assign cause, meaning that technological fires may be included in the analysis where nearby pre-identified natural wildfire events.

Furthermore, as with extreme heat, the underlying population count utilises spatial population distributions; this data is based on modelled analysis conducted by SEDAC which is limited by the quality and granularity of national population census reporting.

3. Results

This section presents our findings for people killed and affected simultaneously by climate-related disasters and COVID-19. As noted above, droughts, floods and storms are grouped together as they are mainly based on EM-DAT (& IFRC GO & ReliefWeb) data, whereas heatwaves and wildfires are based on a novel spatial analysis.

3.1 Droughts, floods and storms

Droughts, floods and storms are significant climate disasters which require emergency relief such as evacuation, disbursement of food aid and temporary shelter. When overlapped with the COVID-19 pandemic, relief measures are more difficult to enact safely and quickly, placing those affected at even greater risk.

Based on figures reported to emergency and disaster databases, during the COVID-19 pandemic droughts, floods and storms have affected 51.6 million people across 84 unique events, with over 3,400 people recorded as killed (Table 1).³⁶

Table 1: Number of people affected and killed by droughts, floods and storms overlapping with the COVID-19 pandemic

Disaster Type	Total Affected	Total Deaths	Number of events
Drought	4,977,123	Unknown	3
Flood	30,095,959	3,134	65
Storm	16,513,326	342	16
Total	51,586,408	3,476	84

Source: EM-DAT, IFRC GO, ReliefWeb.

Notes: Due to very limited data on deaths due to drought events, a total estimate is not known.

The largest impact disasters of this type have occurred in India and Bangladesh: almost 40 million people across the two countries have been affected by both the pandemic and floods or storms. Notably, Cyclone Amphan – the region’s strongest tropical storm for over a decade³⁷ – affected 15 million people in May, killing 129.

³⁶ These totals are likely underestimates due to limited and incomplete reporting. See methodology for more details.

³⁷ BBC, 20 May 2020. <https://www.bbc.co.uk/news/world-asia-52734259>

Table 2: Top ten droughts, floods and storms overlapping with the COVID-19 pandemic by number of people affected

Type	Countries affected	Event month (2020)	Total Affected
Flood	India	June-August	17,000,000
Storm	Bangladesh, India, Sri Lanka	May	15,101,100
Flood	Bangladesh	June-August	5,000,000
Drought	Lesotho, Zimbabwe	March-August	4,720,000*
Flood	Bangladesh	July	1,500,000
Flood	India	June	1,400,010
Flood	China	June	1,400,000
Flood	Ethiopia, Somalia	April	1,219,020
Flood	Kenya, Uganda	March-April	810,855
Storm	China	May	600,000

Source: EM-DAT, IFRC GO, ReliefWeb.

Notes: *Figure is based on the number of people in high food insecurity due to this drought in two countries.

Monsoon flooding across India from June to September was the largest singular disaster: the nationwide event has affected 17 million people, and killed over 1,000. Associated secondary disasters, particularly land and mudslides, have contributed to the significant size of the overall disaster.³⁸ Severe flooding as a result of monsoon rains has also occurred in Bangladesh, affecting five million people as of September 2020; an estimated 24% to 37% of the country was submerged in this event.³⁹



38 CNN, 10 August 2020. <https://edition.cnn.com/2020/08/10/asia/kerala-landslide-deaths-intl-hnk/index.html>

39 New York Times, 30 July 2020. <https://www.nytimes.com/2020/07/30/climate/bangladesh-floods.html>

3.2 Extreme heat

Heatwaves are extreme weather events which see a sustained raised temperature across a wide geographical area. Heatwaves occurring in locations also affected by the COVID-19 pandemic present compounded risks to vulnerable populations in their path: extreme temperatures place at greatest risk people already most vulnerable to COVID-19, notably older adults.^{40, 41}

Furthermore, the overlapping difficulties of extreme heat and the pandemic extend into a conflict of safe practices: for example, whereas the advice for people enduring heatwave events is to wear light clothing and remove restrictive coverings, many governments currently require the wearing of masks in public spaces. In some cases, people may be advised to go to dedicated public cooling centres or air-conditioned buildings for relief from extreme heat. However, during the pandemic such utilities may be limited or unavailable.

As noted above, the following numbers were generated by simple geospatial analysis of the the vulnerable population living in areas which have recorded a heatwave during the pandemic. The number of people killed is estimated based on observed excess mortality rates while controlling for COVID-19-associated deaths.

Table 3: Regional extreme heat events overlapping with the COVID-19 pandemic

Region	Event month(s) 2020	Total Affected	Total Killed
East Asia and Pacific	July-September	145,667,190	Unknown
Europe and Central Asia	July-September	75,539,826	9,334*
Sub-Saharan Africa	July-September	73,016,939	Unknown
Latin America and Caribbean	July-September	42,289,847	Unknown
Middle East and North Africa	July-August	35,455,319	Unknown
South Asia	July-August	33,603,380	Unknown
North America	July-September	23,005,486	Unknown
Other regions	Various	3,168,355	Unknown
Total		431,746,342	9,334*

Source: Analysis based on 3CS, SEDAC, European CDC and various national statistics offices.

Notes: *Figure is only for Belgium, France, Germany, Netherlands, Portugal, Spain, Switzerland and United Kingdom.

40 GHINN, 2020. Heat and COVID19 information series, <http://www.ghinn.org/heat-and-covid-19>. <https://www.gov.uk/government/publications/heatwave-plan-for-england/heat-health-risks-and-covid-19-actions-to-prevent-harm>

41 Public Health England, 2020. Heat-health risks and COVID-19.

In total, an estimated 431.7 million people worldwide have experienced extreme heat while also affected by the COVID-19 pandemic. Due to the nature of the analysis (and heatwaves themselves), it is practical to group extreme heat into geographical regions (Table 3).

The region with the largest number of people exposed to extreme heat is East Asia and Pacific – with over 145 million people in vulnerable populations exposed to extended periods of extreme heat. However, notably in Europe and Central Asia, 75.5 million people in vulnerable populations experienced at least one extreme heat period since July. Our initial estimates based on excess mortality data (comparing actual mortality to expected mortality and subtracting reported COVID-19 mortality) suggest that the heat resulted in excess mortality of about 9,300 people.

Countries in sub-Saharan Africa have also been affected by extreme high temperatures during the pandemic – exposing 73 million people in vulnerable populations. However, due to limited data availability and difficulties in calculating deaths associated with extreme heat, the total number of people killed in this region, like most, is unknown.



3.3 Wildfires

Wildfires, or bushfires, present a compounded threat to regions experiencing the COVID-19 pandemic. Beyond the clear risk of property damage and injury by fire, smoke from burning fires is a significant health hazard that may increase the likelihood of lung infections – including COVID-19.⁴²

Based on a geospatial analysis of the wildfire extent and local populations, and records from EM-DAT, it is estimated that close to 2.3 million people have been affected. This figure is limited to those in close proximity to wildfires (within approximately 50km), and does not directly consider the wider effects of air pollution which can extend for hundreds of kilometres from substantial fires.⁴³

Table 4: Major wildfires overlapping with the COVID-19 pandemic

Wildfire region	Event month(s) (2020)	Total Affected	Total Killed
West Coast, United States	June-September	2,260,000	34
Liangshan Prefecture, China	March-April	1,200	19
Total		2,261,200	53

Source: EM-DAT, and analysis based on VIIRS and SEDAC.

Throughout June to September, the West Coast of the United States has experienced unprecedented wildfires. To date, these fires are estimated to have burned at least 19,000km² during the pandemic – the largest ever recorded in a single fire season – and are not yet under control.⁴⁴ These fires have killed at least 34 people,⁴⁵ while affecting over 2.2 million.

We also note that this excludes several other extensive wildfires, such as the Siberia wildfires which had massive impacts (and have been shown to be at least 600 times more likely due to climate change)⁴⁶ but for which we could not generate reliable numbers of people affected.

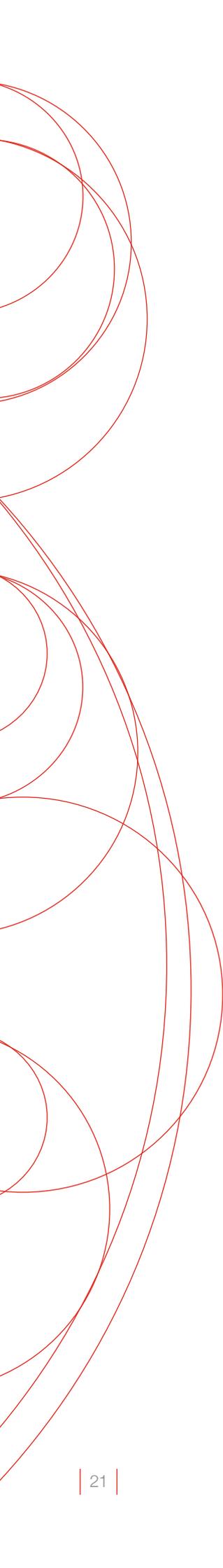
42 Centers for Disease Control and Prevention, 2020. Wildfire Smoke and COVID-19. https://www.cdc.gov/disasters/covid-19/wildfire_smoke_covid-19.html.

43 Rogers, H., Ditto, J., Gentner, D., 2020. Evidence for impacts on surface-level air quality in the northeastern US from long-distance transport of smoke from North American fires during the Long Island Sound Tropospheric Ozone Study (LISTOS) 2018. Atmospheric Chemistry and Physics 20 (2): 671. <https://acp.copernicus.org/articles/20/671/2020/>

44 The Guardian, 14 September 2020. <https://www.theguardian.com/us-news/ng-interactive/2020/sep/14/how-big-are-us-wildfires-visualized-california-oregon-washington-fires>

45 BBC News, 13 September 2020. <https://www.bbc.co.uk/news/world-us-canada-54130785>

46 World Weather Attribution Consortium, 2020. <https://www.worldweatherattribution.org/siberian-heatwave-of-2020-almost-impossible-without-climate-change/>



4. Discussion and conclusions

Our preliminary analysis demonstrates the huge scale of combined impacts of climate-related disasters and COVID-19:

- At least 92 disasters and at least 51.6 million people globally affected by an overlap of floods, droughts, or storms and the COVID-19 pandemic. Over 3,000 people have been killed in these events.
- At least an estimated 2.3 million people affected by wildfires, killing at least 53 people.
- An estimated 431.7 million people in vulnerable populations exposed to extreme heat during the COVID-19 pandemic, including a European heatwave affecting 75.5 million people in vulnerable populations. Our initial estimates suggest that this has resulted in excess mortality due to the heat of over 9,000 people in July and August.

Clearly, the pandemic is unfolding and climate-related extremes do not stop, so we hope to repeat this analysis in due course.

In addition, our numbers only scratch the surface of the complex interactions between the various drivers of risk and vulnerability. Further work on the compound risks posed by the COVID-19 pandemic and climate change is urgently needed. This may include generating better insight on the drivers of risk, but also the complexities of managing risk, such as evacuations during lockdowns.

Most importantly, our analysis points to the strong overlaps between various risks the world is facing. We cannot deal with the pandemic and its economic impacts in isolation from the climate crisis and wider development objectives such as poverty reduction. As the world is investing unprecedented amounts of international finance to help economies recover from the massive economic damage of the pandemic, we should consider how to not just recreate our old vulnerabilities, but invest in greener, more resilient and inclusive societies.⁴⁷

47 See also Meige, Blewitt and Van Aalst, 2020. A humanitarian recipe for a green, resilient and inclusive recovery from Covid-19. <https://future-rrc.com/2020/07/03/a-humanitarian-recipe-for-a-green-resilient-and-inclusive-recovery-from-covid-19/>