Estimating needs in disasters

Anneli Eriksson

Thesis for the degree of Doctor Philosphiae (dr. philos.)
University of Bergen, Norway
2020

UNIVERSITY OF BERGEN

Estimating needs in disasters

Anneli Eriksson

Thesis for the degree of Doctor Philosphiae (dr. philos.)
at the University of Bergen

Date of defense: 09.06.2020

Year: 2020

Title: Estimating needs in disasters

Name: Anneli Eriksson

Print: Skipnes Kommunikasjon / University of Bergen

Scientific environment

This thesis is the result of a collaboration between Centre for International Health, Department of Global Public Health and Primary Care, UiB and Centre for Research on Health Care in Disasters (KcKM) at KI.

Centre for International Health undertakes research, education and leadership development aimed at improving the health situation in low- and middle-income countries. CIH initiates, coordinates and conducts research and capacity building in collaboration with partners from other departments and faculties at UiB, as well as other national and international partners.

Centre for Research on Health Care in Disasters (KcKM) Health Systems and Policy research group, Department of Global Public Health Sciences at Karolinska Institute, Stockholm, Sweden.

The centre's aim is to contribute to a strengthened and improved Swedish and global health response to major disasters through research, education and policy development. The centre critically explores the role of health care in disasters, defines the dominant type of needs and considers how to respond to those needs.

The studies in this thesis were funded by the Swedish International Development Cooperation Agency, Sida (I and II) and by the Swedish National Board of Health and Welfare (I, II and III).

Acknowledgements

They say that: *It is all about the journey*!

Mine has been somewhat long. I think my colleagues and advisors have had some doubts, whether I actually were heading towards a doctoral degree, at all.

I have nevertheless enjoyed the road and I am immensely grateful to so many colleagues and friends who have guided and supported me in different ways. In particular I would like to thank:

My co-authors:

Thorkild Tylleskär, who I first met at IMCH, in Uppsala, all those years ago, when I was preparing for my first mission with MSF. Thank you for taking me along, on this somewhat untraditional road to a doctoral degree. I am truly impressed with your calm support, kindness and patience and I must say that your "allergic reactions" to double spaces and ugly tables has taught me to shape up.

Johan von Schreeb, friend and colleague since decades and in this process, my closest supervisor. Much can be said about your comments on my manuscripts and the way you tend to discuss your own suggestions with yourself in the following drafts. I would like to acknowledge your admirable enthusiasm. You always strive for the best, even when I, at times, may have suggested that good enough could do. I am grateful for the trust and space you have given me to develop and to learn. To go off on field missions and other non-research activities that all in all have kept me sound.

Tina Ohlsén, you were the first who jumped into "the indicator-swamp". I came to your rescue, and you left me there! Still, thanks for your encouragement, support and all the talks and laughs during our joint course-coordination ventures and outside.

Martin Wärnberg Gerdin, thank you so much for the all the statistical help and for listening to my, often desperate, questions and worries. Thanks for keeping me focused on the possible when I wanted to go out and measure the world. Thank you, for taking the time in the midst of your own research, specialisation and family responsibilities.

Richard Garfield, thanks for the always interesting discussions, over email, at meetings or on your visits. Thank you for sharing your experience and knowledge generously.

Thank you also to he Centre for Research on the Epidemiology of Disasters at the Université Catholique de Louvain (*CRED*), for letting me access your data base on disasters (EM-DAT).

A big thank you to the **Centre for International Health at Bergen University:** Thank you for welcoming me to present my thesis for a Doctor Philos degree. Thank you, for inviting me to conferences and to your department. Special thanks to *Bente, Ingunn* and *Catherine* for discussions and for your interest in my research and also to *Daniel* for your administrative support.

To my everyday workplace: the department of **Global Public Health at Karolinska Institutet.**

My roommates: *Dell,* thanks for some truly interesting and fun years of sharing office, frustrations and fun. You have always been there to listen to my worries (as well as never-ending stories about whatever might have come to my mind). It is possible that your work would have been more efficient without me in the same room, but I'm sure, not as much fun! *Martina,* I'm so happy to have someone with whom I share a "cow-milking background", nursing profession and västgötska (at times). I am very impressed by your calm. You certainly walk into the PhD process open-eyed. All the best of luck! I will try to support in whatever way I can.

The KcKM team: *Andreas, Titti, Max* and former great colleagues: *Jhon, Kim, Primus, Roy*. Special thanks to *Moa,* for all your work with the course preparations. It would all be chaos if it wasn't for you. *Sid,* thanks for your enthusiasm, dinner company and for believing in me to the extent that you gave a graduation gift even before I finalised the thesis.

The HSP-group: especially to *Cecilia* for your "matter of fact" encouragement and support, to *Tobias, Claudia, Anna, Carina, Nada, Oliver, Frida, Erika, Dorcus, Ulrika, Tim, Gaetano, Birger* and everyone else. A special thanks to our former research group leader: *Göran* who told me that "my kind" makes the worst PhD students: too much experience, too opinionated, too busy with other stuff, but who also encouraged me whole-heartedly to persue my research.

All other great colleagues at the GPH-department, especially *Marie, Per, Helle, Asli Bo and Lucie*. Thank you for your encouragements. To *Anders* for your practical advice and support, while defending your own PhD- thesis. *Hannele,* I am so grateful for your patience and all the help to organize our courses.

Thank you to MSF, and all MSF-friends, giving me the opportunity to go on field-assignments, giving me a seat at the board, ensuring that I have kept in touch with the harsh reality and all the "non-measurable". A particular thanks to LAM, especially to the very core: *Anna-Karin* and *Anna,* for uplifting and inspiring discussions as well as quality time with Eskil, Hansi, Erling, Tor and the others.

To my friends, no one forgotten. A special thanks to *Zara,* for your "sisterhood", encouragement and support. *Anette, Lise-Lotte* and *Johanna* for walks and talks. Thank you *Matthew* for reading, commenting and removing all those « s» and «is».

Thanks to my family, to my brothers, with whom I share the universe of childhood and to our whole extended family.

To my closest ones, my sons: *Edvin, Linus* and *Axel,* always and every day. For being there, for helping me to keep a perspective on things and for your support. Special thanks to Axel who read and commented on my writing.

And finally to *Mats*, my partner, companion and best friend, who encourage me in my research and push me to focus. Thanks for always being there.

Preamble

September 1999, Darwin, Australia and Baucau, East Timor. After the UN-supported independence referendum in East Timor was held on August 30, organised violence and destruction of infrastructure took place on a wide scale, leading to suffering and mass displacement. As a registered nurse working for Médecins Sans Frontières, I was part of an immediate and massive international response, where donations were fast and generous. This was in stark contrast to Sierra Leone, where I had worked some months before, in early 1999. In the 'everlasting' armed conflict, the rebel group RUF invaded Freetown, the capital and was then chased out again, leaving over 100 000 people displaced and hundreds killed. The hospital where I worked was packed with patients who had been severely mutilated. Internally displaced people were lodging in closed factories and the football stadium. With the rainy season approaching, the risk of cholera and other outbreaks was increasing. While security concerns hindered access and assistance in large parts of the country, Freetown was, if not safe, at least accessible. However, in my view, the assistance that arrived was far from sufficient. Why? Why was the funding of humanitarian assistance in East Timor so much higher? If assistance is not divided on the basis of need, is it instead linked to geopolitics, security or other agendas?

Some years later, in Niger, in 2005 and 2007, I was tasked with providing care for children with severe acute malnutrition. On both occasions, our centres were full, and the needs were obvious. In 2005, the response was to a serious nutrition and food crisis, considered even a famine by some. Resources, organisations and nutritional treatment were rolling in. The response was late but impressive. Two years later, in 2007, we were struggling to meet needs. It was not an exceptionally bad year, just a "usual" hunger gap before the harvest, but many organisations that had entered in 2005 had run out of funds and closed their projects. The children we treated were not displaced or affected by conflict or other disasters. The major cause was poverty and a lack of development. However, in a context where the "normal" rate of malnutrition surpasses the agreed emergency threshold, should the needs not trigger a stronger and more sustained response? If the needs remain, but the response declines is the funding of assistance linked to media coverage, novelty or political flavour-of-the-month?

The list goes on: working in the initial phase of the large Ebola outbreak in West Africa, we were overwhelmed with people infected by the deadly disease. Only when colleagues from the rich part of the world were being infected and evacuated for care in their home countries did the world seem to wake up, and a massive response was rolled out.

I am well aware that the resources and the size of the response do not guarantee its “success” as this is dependent on WHAT is being done and HOW it is done. However, regardless of its efficiency, a response will not be sufficient if the resources to meet the needs are lacking. While responding organisations and funding agencies claim that needs are the driving force and that assistance is being provided according to needs, the lack of comparison of needs between contexts or over time is striking to me in the examples above. Is there not a way to compare suffering and needs in an objective manner to ensure assistance according to the scale of needs?

Abstract

Introduction: In 2019, more than 130 million people were affected by disasters caused by natural, man-made or mixed hazardous events that overwhelmed local capacity, necessitating international humanitarian assistance. Such assistance is predominantly funded by governmental agencies and should, according to international agreements, be based on needs. However, as needs are greater than available funding, donors must rationalise funding in proportion to the scale of needs. To date, there is no commonly accepted tool to guide needs-based funding of humanitarian assistance.

The aim: of this thesis was therefore to increase the understanding of what factors contribute to disaster severity and how they can be measured in order to estimate the scale of needs in disasters.

Methods: The three thesis papers build on the assumption that a limited number of readily available indicators of vulnerability, exposure and magnitude of the hazardous event can be included in a composite index that indicates or predicts the severity and the scale of needs in disasters. Papers I and II explore and define estimates of the scale of needs in conflicts and other types of complex emergencies. Paper III explores estimates that can predict the scale of needs after earthquakes. In the first paper (I), a model to distinguish the severity and the scale of needs was developed through a two-step literature and Internet search that identified more than 100 indicators. A core set of six indicators was selected through ranking. A basic model, based on the Utstein style framework for disaster research and evaluations was developed. In the second paper (II), the usefulness of the developed model was assessed through application to 25 countries affected by complex emergencies, using data from 2013 to 2015. The validity was assessed by applying it to 11 complex emergencies, and the results were plotted against excess mortality. In the third paper (III), the predictive performance of the indicators from four commonly used disaster indexes, in total 26 variables, was assessed through data from earthquakes for the period 2007 – 2016. The assessment was performed using linear regression with root mean square error (RMSE) as the performance measure.

Main results: Data for vulnerability and exposure was identified to indicate severity and in turn the scale of needs in disasters. The vulnerability indicators were as follows: 1) GNI per capita, PPP, 2) under-five mortality rate per 1 000 live births, 3) adult literacy rate: proportion among people aged 15 and older, and 4) underweight: proportion of the population under 5 years. The two exposure indicators were as follows: 1) number of persons and proportion of population affected and 2) number of uprooted persons and proportion of the population uprooted. The required data were largely available for all countries. With these indicators a model was developed, that was able to discriminate between levels of severity and needs among countries and to correlate with excess mortality. The assessed variables did not predict the scale of needs after earthquakes, individually or in multivariable models.

Conclusions: Data on vulnerability and exposure can be used to estimate severity and the scale of needs in conflicts and other types of complex emergencies. Out of the selection of indicators from commonly used disaster indexes, none are able to predict the scale of needs after earthquakes.

List of Publications

Paper I: Eriksson A, Ohlsén YK, Garfield R, von Schreeb J. **Who is worst off? Developing a severity-scoring model of complex emergency affected countries in order to ensure needs-based funding**. PLOS Currents Disasters. 2015;7. Edition 1. doi: 10.1371/currents.dis.8e7fb95c7df19c5a9ba56584d6aa2c59.

Paper II: Eriksson A, Gerdin M, Garfield R, Tylleskär T, von Schreeb J. **How Bad Is It? Usefulness of the "7eed Model" for Scoring Severity and Level of Need in Complex Emergencies**. PLOS Currents Disasters. 2016;8. Edition 1. doi:10.1371/currents.dis.d59e0fa39887031e1c3763851a6e5c2a.

Paper III: Eriksson A, Wärnberg M G, Tylleskär T, von Schreeb J. **Predicting the unpredictable – Harder than expected.** Prehospital and Disaster Medicine. 2020;1–10. doi:10.1017/S1049023X20000217

Paper 1 and paper II were published in open access.

Contents

List of abbreviations

CAP	Consolidated Appeal Process, a UNOCHA lead process conducted at the country level for complex emergencies and other complex and protracted disasters
CE	Complex Emergency
CI	Confidence Interval
CMR	Crude Mortality Rate
CRED	The Centre for Research on the Epidemiology of Disasters at the Université Catholique de Louvain
ECHO	European Civil protection and Humanitarian aid Operations
GHD	The Good Humanitarian Donorship initiative and principles
GINI index	A measure of statistical dispersion intended to represent the income or wealth distribution of a nation's residents, developed by Corrado Gini
HDI	The Human Development Index, developed by the United Nations' Development Program (UNDP)
HNO	Humanitarian Needs Overviews (replacing the CAPs in 2014)
HRP	Humanitarian Response Plan (replacing the CAPs in 2014)
KI	Karolinska Institutet
RMSE	Root mean square error
Sida	Swedish International Development Cooperation Agency
UN	United Nations
UNDRR/UNISDR	United Nations' Office for Disaster Risk Reduction – formerly known as United Nations International Strategy for Disaster Reduction (UNISDR)
UNOCHA/OCHA	United Nations' Office for Coordination of Humanitarian Assistance

Key definitions

Affected	Refers to the number or proportion of persons who are directly or indirectly affected by a hazardous event [1, 2].
Complex Emergency (CE)	A situation where the mortality among the civilian population has increased significantly compared to baseline, due to direct or indirect causes of conflict, such as malnutrition and/or spread of communicable diseases [3]. Or where governmental policies contribute to the development of a disastrous situation, such as food insecurity and high rates of malnutrition [3, 4].
Coping capacity	People's or a society's ability to manage the negative consequences of hazards and hazardous events by using their skills and resources, the opposite of vulnerability [1].
Damage	The harm or injury that reduces the value or usefulness of something. Damage can be divided in structural and functional [5].
Disaster	"A serious disruption of the functioning of a community or a society at any scale due to hazardous events interacting with conditions of exposure, vulnerability and capacity, leading to one or more of the following: human, material, economic and environmental losses and impacts", UNDRR terminology 2017 [1]. Disasters further overwhelms local capacity and necessitates national or international assistance [2, 4, 6].
Exposure	The people, property, systems, or other elements present in hazard zones that are subject to potential losses [1]. Exposure determines the damage a hazardous event can cause.
Hazard	A phenomenon or process that may lead to loss of lives and injuries or other damages. Hazards can be man-made or natural with a slow or sudden onset in time. When referring to a specific hazard that has occurred, the term **hazardous event** is used [1, 7].
Magnitude	The total energy released, the duration and intensity of a hazardous event. Magnitude is defined by different factors for different disasters [5].
Prediction	A statement of what is foreseen to happen [8], a forecast, based on experience or statistical modelling.

Resilience	The capacity to timely and efficiently “resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard” [1]. This includes the maintenances and rebuilding of essential structures and functions.
Risk	The combination of the probability of an event and its negative consequences [1].
Severity	Disaster severity is a manifestation of the impact of a hazardous event in combination with the vulnerability, coping capacity and resilience of the affected society [7]. Severity refers to the conditions and status of the people affected by a disaster. It can also include the complexity of the situation and factors that affect mitigation [9]
Threshold	The level or point at which you start experience something or where something starts to happen, for instance a disaster [8]
Vulnerability	The characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard [1, 7].

Databases and indexes

Databases from which indicator information has been extracted in the thesis

EM-DAT	Emergency Events Database: an International Disaster Database provided by CRED that contains information on different natural hazardous events and their effects, from 1900 to present. Web: https://www.emdat.be/database
GDACS	The Global Disaster Alert and Coordination System, created in 2004. A cooperation between the United Nations and the European Commission, with the aim to provide information and analysis in the early phase of major sudden-onset disasters. The GDACS is used as a source of information and is one of the assessed indexes in the thesis. Web: https://www.gdacs.org
HNO, CAP, HRP	The United Nations' Office for Coordination of Humanitarian Assistance UNOCHA: collects, analyses and consolidates information on needs and response plans in the form of Humanitarian Needs Overviews, Humanitarian Response Plans - previously Consolidated Appeals, for approximately 25 countries that requires substantial humanitarian assistance. Information on the present situation has been extracted from these documents. Web: https://www.unocha.org/
World Bank Open Data	An analysis and visualisation tool that comprises a vast number of time series data presented at the country level. Web: https://data.worldbank.org

The main indexes referred to and assessed in the thesis

7-eed	Severity-Scoring Model developed by KI in papers I and II. Assessed in paper III
GDACS	see databases
GNA	The Global humanitarian Needs Assessment developed and used by ECHO from 2004 – 2013
INFORM	The Index for risk management, produced since 2014 through a collaboration of the Inter-Agency Standing Committee Reference Group on Risk, Early Warning and Preparedness and the European Commission

1. Introduction

Throughout the history of mankind, we have been accompanied by disasters [10]. While we may think of epidemics, floods, earthquakes and wars as unusual or rare events, they are in fact common and affect more than 200 million people every year [10-12]. Disasters cause damage, suffering and death and leave people in need of life-saving assistance [6].

1.1 Disasters – concepts

A disaster disrupts the functioning of a society, leading to human, material, economic and environmental losses that overwhelm local capacity and necessitate national or international assistance [1, 2, 6, 13]. Disasters are caused by hazards, but all hazardous events that occur do not become disasters. Several factors contribute to whether a hazard progresses to a disaster or not.

The terms crisis, emergency and disaster all capture the context studied in this thesis, as definitions often overlap. These terms will therefore be used interchangeably.

1.1.1 From hazard to disaster

A hazard is phenomenon that may lead to loss of life, injury and have other health impacts, as well as cause damage, social disruption and environmental destruction [1, 6, 7]. Hazards may be classified as either natural, man-made or mixed (Table 1) [2, 7].

The term hazardous event is used to describe the occurrence of a specific hazard, in time and place. In everyday language disasters often refers to a sudden hazardous events, such as an earthquake or flood. However, it is not the event in itself that constitutes a disaster, it is the situation that follows.

Table 1: Classification of hazards after Sundnes and Birnbaum's hazard classification [7]

Type	Subtype	Manifestation
Natural hazard	Seismic	Earthquake, tsunami, volcanic eruption, celestial collision
	Climatic, meteorological	High winds, precipitation, lightning – fire, extreme temperatures, flood, drought, avalanches, etc.
Mixed: natural and man-made		Drought, desertification, flood, erosion, landslide, fire, health-related, such as epidemic outbreaks
Man-made	Technological	Release of: chemical, biological or nuclear substances, structural failure, explosions, etc.
	Conflict	Armed conflict: war, complex emergencies, terrorism, etc.
		Non-armed conflict: sanctions, embargo

Whether a hazardous event develops into a disaster or not, depends on several interlinked factors. Sundnes and Birnbaum developed a model to illustrate the progress from hazard to disaster in order to better understand, evaluate and research the development of disasters (Utstein style) [7]. A modified version (the disaster framework) of the Utstein style model is presented in Figure 1. It combines structural and functional damage and includes exposure as a central factor (Figure 1 and Figure 2) [5]. For detailed description of the components of the framework, see Key definitions.

In the disaster framework, hazard refers to the threat of a hazardous event to occur. [13-16]. The magnitude of a hazardous event will influence the damages it causes and the impact it has on a society's' functioning [7]. The larger the magnitude of the hazardous event, the more likely that the damage will be severe, which increases the risk that a disaster develops. This development may be positively or negatively modified depending on factors in green (positivly) and red (negativly) in the framework (Figure 1).

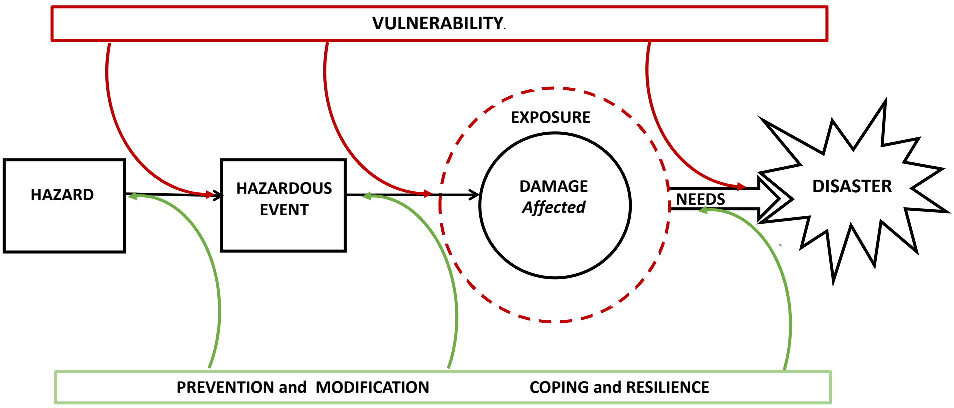


Figure 1: Disaster framework, that conceptualises factors affecting the development from a hazard to a disaster. Adapted from Sundnes' and Birnbaum 2003 and Birnbaum, et al. 2015 [5, 7, 17].

In the framework, I added the term affected, as part of damage, to emphasise the thesis' focus on the effects of hazardous events on people's lives, rather than potential structural damage. In line with this logic, I also added exposure as a prerequisite for damage. The extent of exposure of the people present in hazard zones will affect the damage of a hazardous event and thereby the risk of a disaster to develop [1, 7]. In the literature and United Nations' Sendai framework, exposure is highlighted as a key risk factor for disasters to develop [1, 16, 18-22].

The hazard can be prevented from occurring or the damage of a hazardous event can be reduced through modification. This is widely acknowledged and serves as a basis for initiatives aiming at disaster risk reduction [16]. Efforts to reduce the damage and progress to a disaster, strive to build resilient societies with sufficient coping capacity [7, 14]. Coping involves risk-awareness, sufficient resources and a functioning management, both in normal times, as well as during disasters, thus, response capacity and response [1, 6]. Resilience is linked to absorption capacity and recovery from the effects of a hazardous event [1].

Vulnerability is related to individual characteristics or geophysical or societal circumstances[1, 6, 7]. What constitutes vulnerability varies, depending on the type of hazard and the damage it may cause. Socio-economic vulnerability is a key factor that determines whether a hazardous event develops into a disaster or not [21, 23, 24]. The risk that hazards lead to disasters are, thus, higher in low-income countries compared to high-income countries [25].

1.1.2 Categorisation of disasters

Disasters are mainly categorised in three different ways, a) type of hazard causing them, b) speed of onset and duration, as well as c) their social or health impact. [5, 26]. Table 1 lists types of hazards (natural, man-made and mixed) [27]. The speed of onset categorisations include sudden-onset disasters that occur within a short time span, leaving destruction and urgent needs behind. Among sudden-onset natural disasters, earthquakes tend to cause the highest number of injured and most urgent needs [26, 28]. Slow-onset disasters, such as droughts and desertification, may take years or even decades to develop [29]. A protracted disaster is a disaster that due to complicating factors, such as conflict or political turmoil, has long duration, often years [30].

A disaster can also be categorised based on its impact [31]. A complex emergency is classified as man-made (Table 1), but it is also defined based on the impact it has on people's life and livelihood [3, 13]. A complex emergency develop through the interaction between different hazardous events [32]. In an armed conflict, a drought that affects an agriculture-dependent population may lead to prolonged violence and a worsening of the situation [33]. The long duration and extent of the Ebola outbreak in eastern Democratic Republic of Congo (DRC), detected in August 2018, is to a large extent explained by the ongoing armed conflict in the same region [34]. Conflicts and other types of man-made complex emergencies receive the absolute majority of international assistance, (see further in 1.3.3) [35].

1.1.3 Disaster thresholds

Disasters are situations where damage of the hazardous events has caused human needs that exceed existing resources, requiring outside assistance [2, 6, 13]. In reality, the progress from damage to disaster is dynamic and dependent on several factors, that in combination will interact [5, 36]. A disaster is defined by severity and needs. Coping capacity and resilience are factors that can mitigate the needs and hinder a disaster to develop, or lessen the severity and the scale of needs in a disaster. Vulnerability, on the other hand, will 1) increase the (unmet) needs and 2) contribute to the development of a disaster, by increasing the severity and the scale of needs in a disaster (Figure 2)

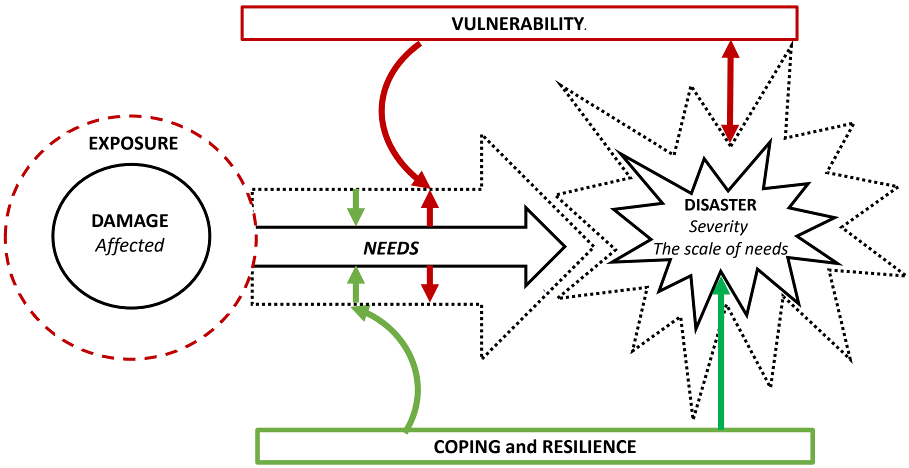


Figure 2: Detail from the disaster framework presented in Figure 1 [5, 7, 17],

Disaster severity is, thus, a manifestation of the damage of a hazardous event in combination with the vulnerability, coping capacity and resilience of the affected society [7]. Severity refers to the conditions and status of the affected people and the urgency of life threatening needs. Severity is also influenced by the complexity of the situation and other factors that affect mitigation [9]. In the thesis, the scale of needs refers to the estimated or predicted magnitude of needs for humanitarian assistance in disasters. It is, thus, a quantifiable measurement that allows comparison between disasters, in terms of proportion of needs.

For the theoretical understanding, the development of a disaster is described as linear (Figure 1and 2). In reality the severity and the scale of needs often fluctuates. The descriptions of a steadily worsening human situation with defined disaster thresholds may, therefore, have problems to adequately capture the dynamic reality [37]. Nevertheless thresholds are important, as they signal the severity of the situation and the scale of needs and consequently the needs for assistance [38]. Several measurements and indicators to monitor the progress as well as set disaster thresholds have been suggested.

Excess mortality rate is an established public health indicator that describes the increased death rate in a population due to the exposure to a hazardous event. Excess mortality rates equivalent to the doubling of baseline crude mortality has since the 1990s been a recognised threshold for disaster [3, 26, 37, 39-41]. This indicates a worsening situation with unmet need for life-saving assistance [3, 28, 37, 42, 43]. However, excess mortality rate can be difficult to monitor in a timely manner and can in addition be a late sign of a deteriorating situation [39]. Moreover, excess mortality rate does not necessarily capture disaster severity following sudden onset hazardous events such as tsunamis that momentarily kill many and leave fewer injured. In these situations excess mortality does not indicate the scale of needs for assistance of those remaining [28]. In contrast, the usefulness of excess mortality rates as a disaster threshold for earthquakes could be more appropriate as it leaves significantly more people in need of life-saving assistance, than dead, compared to tsunamis[28, 44]. Moreover, reported excess mortality must be interpreted with caution as it is a politically sensitive indicator that can be both under- or over-reported [45-48].

The UN system and several organisations have developed staged emergency and disaster thresholds. The UN system uses a three tiered scale where emergency level 3 is the worst, but with variations of what this entails between UN agencies [13, 49]. The Integrated Food Security Phase Classification (IPC) for malnutrition and food insecurity uses thresholds based on the level of food insecurity in emergencies and disasters [50]. The IPC classifies a situation from normal to famine based on various information and expert judgement [50].

The Centre for Research on the Epidemiology of Disasters (CRED) maintains the Emergency Event Database (EM-DAT), that includes natural hazard disaster data since 1900. The thresholds for inclusion in the disaster database is that the hazardous event has led to: ten or more people dead, 100 or more affected, the declaration of the state of emergency or call for international assistance. [26, 41].

1.2 How many people are affected by disasters?

The number of people who are affected by a hazardous event is often referred to as a way to measure or quantify disaster severity [12, 26, 38]. The number of affected does not on its own provide information about overstretched resources or the need for assistance, but it gives an indication of the magnitude of a hazardous event and the damage it has caused [2, 17, 38]. This information can, in turn, indicate the severity and the scale of needs [12, 26, 38].

The term affected is not well defined, its definition varies between agencies and it remains unclear who to label as affected. In general, affected people are described as those who are directly or indirectly affected by a disaster [38]. Directly affected are those with injuries or health effects caused by the hazardous events, and also includes displaced or evacuated [2, 6]. Indirectly affected are more loosely described as those affected by increased poverty, vulnerability, or loss of social services in the aftermath of hazardous events [37, 38]. The United Nations' Office for Coordination of Humanitarian Assistance (UNOCHA) mainly keeps data on complex emergencies and counts the affected as those who are either directly or indirectly affected to the extent that they are in need of international humanitarian assistance [12]. CRED, on the other hand, categorises the affected as those directly affected in their database (EM-DAT) [2].

CRED states that an average of 200 million people have annually been affected by disasters caused by natural hazardous events [11, 51-53]. The number fluctuates yearly, but there is a decreasing trend. In 2018 a total of 70 million people were reportedly affected [11, 51-53]. With the tendency towards more severe hazardous events, including tropical storms, floods, heat waves and droughts, the trend may turn [54-57].

In 2019, UNOCHA estimated that more than 130 million people were affected by complex emergencies [58]. This is an increase compared to the previous five years in terms of both the number of people and the number of disasters, explained by an increase in protracted man-made complex emergencies [12, 35].

1.3 Disaster assistance and needs

When national capacity is insufficient or unavailable, international assistance to people affected by disasters is needed [38]. This type of assistance is characterised as international humanitarian assistance. It should be guided by humanitarian principles and provided according to needs [59, 60].

1.3.1 Humanitarian principles and ethics

Humanity, impartiality, neutrality and independence are core humanitarian principles (Textbox 1) [61, 62]. The principles have ancient origin but are in modern times associated with the creation of the International Committee of the Red Cross (ICRC) and its founder, Henry Dunant, in the second part of the 19th century [63]. The principles are signed on to by 500 organisations, as part of "the code of conduct for the International Red Cross and Red Crescent movement and non-governmental organisations in disaster relief" [60]. The UN General Assembly has since 1991 endorsed them as core principles [60, 64].

Humanity and impartiality are sometimes referred to as fundamental humanitarian principles while neutrality and independence are tools to implement the fundamental principles [61].

***Textbox 1. The core humanitarian principles** [61, 62]*

- **Humanity** postulates that suffering must be addressed wherever it is found with the purpose to protect life and health and ensure respect for human beings.
- **Impartiality** implies that assistance should be provided on the basis of needs alone.
- **Independence** refers to humanitarian action as autonomous from political, economic, military or other agendas and objectives.
- **Neutrality** refers to the necessity for a humanitarian actor to not take side in armed conflicts.

From an ethical perspective, the provision of humanitarian assistance can be understood as deontological: People suffer, therefore, we – the bystanders – have an obligation or a duty to help. The intention to do something is most important. However, the dutiful attitude needs to be interlinked with an ethics based on virtue: Assistance should be provided in a way that protects people's humanity and dignity [65-67]. The moral obligations to assist also relates to the universal ethics of humans as equal in value and rights (the basis for human rights), where duties and rights are two sides of the same coin [65, 66, 68, 69].

Humanitarian principles may seem unambiguous on paper, but the harsh reality makes upholding them far less simple [65, 70]. Implementers and funders of humanitarian assistance often find themselves in situations where the principles collide [69-73]. The fundamental idea that all assistance to disaster-affected people should be needs-based unifies funding agencies, organisations and actors, regardless of other motivations [70, 71, 74].

A needs-based approach is challenged by the fact that resources in disasters are insufficient to meet even the most basic needs of all affected in the world [35, 75]. Therefore, in contrast to the deontological and universal ethics above, consequential considerations are inevitable [38, 65], and a utilitarian approach is required. Help should be provided where it is most needed or where it will create most benefit [67].

It is accepted that humanitarian assistance should be provided based on the scale of needs [71, 72].

1.3.2 Components of needs-based humanitarian assistance

There is no commonly accepted definition for "needs" following disasters. Maslow's pyramid categorises human needs in a hierarchy where physical needs for survival are at the base, followed by safety, social needs, esteem and finally, self-actualization [76]. It is beyond the scope of humanitarian assistance to meet all human needs. Instead, such assistance is focused on a narrow range of basic needs of services for a community [38, 77].

The assistance aims to ensure that people affected by disasters have access to assets necessary for their survival and for a healthy life such as food, water, sanitation, shelter, access to health-care services and prevention of diseases, school services for children as well as protection from violence and other hazards [77]. Humanitarian assistance can also include efforts for early recovery, risk management and the building of resilience and risk reduction [71, 73, 74, 78].

1.3.3 Defining needs

Needs-based assistance entails addressing the specific needs in each disaster. It is therefore necessary to assess the needs, in order to plan and implement assistance in accordance with the needs [79, 80]. Humanitarian responders have heavily invested in needs-assessments, to ensure a needs-based focus of all humanitarian assistance [74, 79-84]. The amount of data on needs produced in disasters is increasing, but despite the many reports systematic comparison between disasters is lacking [85]. Variation in the scale of needs in different disasters as well as how responses are matched to needs is largely overlooked [70, 73].

Critics highlight that needs in disasters are defined, based on the response that international actors are able to provide [71, 74]. In disasters where few or no international actors are present - be it due to lack of funding, security or other reasons - needs risk being overlooked and thereby not responded to [70, 71, 73, 74, 84].

In addition, timeliness of assistance is in addition important, especially in sudden-onset disasters, as needs often are urgent [86]. The delay or even non-existent availability of real-time data, particularly in the first phase of sudden-onset disasters risks delaying funding decisions and response [86, 87]

There is, therefore, a inconcistency between the accepted needs-based approach, the principle of impartiality that also requires proportional assistance between disasters. Responders and funding agencies are criticised for not sufficiently taking the scale of needs into account [72, 88, 89].

1.4 Funding of humanitarian assistance

1.4.1 Appeals for and allocation of humanitarian assistance

The UN-system consolidates appeals for funding response plans of UN-organisations and other organisations in disasters. The appeals are divided in a humanitarian needs-overview (HNO) and a humanitarian response plan (HRP) [12]. In addition consolidated flash appeals are assembled for major natural disasters and the UN Central Emergency Fund (CERF) channels funds for smaller emergencies [90].

In 2018, an estimated 29 billion USD was allocated to international humanitarian assistance. This is an increase of 30 percent over the previous six-year period [91-94]. 80 percent of the funding was allocated from governmental funding agencies, predominantly through the UN consolidated appeals [35] and mainly to complex emergencies (Figure 3) [12]. Considerably lower amounts were allocated through UN flash appeals for sudden-onset disasters and through CERF [35, 90, 93, 94].

Both the request for, and funding of humanitarian assistance have increased. For the UN consolidated appeals this has lead to constant underfunding. During the last five years, only 60 percent of funding requests were covered, with considerable variations (Figure 3) [35, 94].

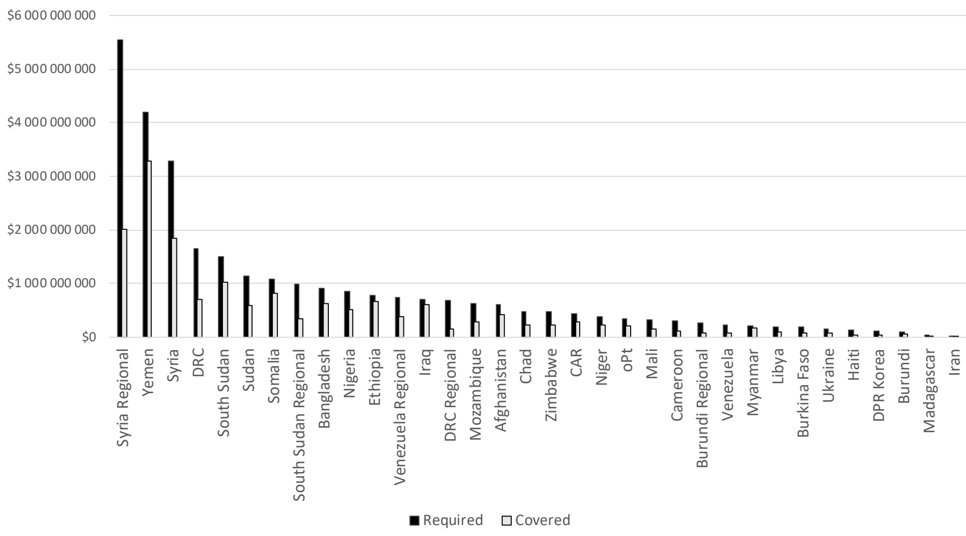


Figure 3: UN appeals and donor coverage for 2019 as of December 2019.Source: Global humanitarian overview 2020, funding update by 4 December [95]

1.4.2 Funding according to the scale of needs

Governmental funding agencies of humanitarian assistance (donors) has long been criticised for not funding according to needs [38, 96-98]. In an effort to adress this critique a group of donors convened in 2003 to formulate "The good humanitarian donorship principles" (GHD principles), to ensure more needs-based and transparent funding for humanitarian assistance [59, 96]. Since then, a majority of governmental donors have signed on to the principles [99]. The GHD emphasise the importance of needs assessments as a tool to ensure needs-based funding. The principles further states that funding should be proportional and, thus, be allocated in accordance with the scale of needs [59].

Despite the GHD initiative efforts, criticism of donors remains for not allocating funds according to the scale of need [70, 75, 86]. Some disasters receive less funding compared to disasters of seemingly more strategic interest, regardless of size of appeals and unmet needs (Figure 3) [71, 73, 97, 100].

On the other hand there is no recognised mechanism to validate that the required amounts requested in UN-appeals reflect the scale of needs in the different disasters, nor to validate that the funding of assistance is provided according to the scale of needs [97, 101]. Moreover, studies have documented the absence of a systematic approach in defining and quantifying the scale of needs between disasters [97, 98]. And, to add to the problem of needs based funding, there are no commonly accepted indicators to define and quantify the scale of needs nor a lack of standardised methods to collect and compare such data [97].

1.4.3 Quantifying the scale of needs?

Needs-based funding require clearly defined and quantifiable indicators that capture the scale of needs. Such indicators could, if populated with numerical data, form the basis for needs-based decision of funding and thereby contribute to alignment to the principle defined in the GHD initiative.

To be useful for needs-based funding, an indicator should be sensitive to changes over time, easy to measure on a routine basis, as well as be easy to interpret and have a baseline [38, 102]. Several indicators could be combined into a model or index that captures measurements of the different factors contributing to the scale of needs in disasters [103]. Such a model could be useful to understand the bigger picture and allow comparison of the scale of needs between disasters [104].

There are several indexes that assess vulnerability, risk or crisis severity [105-109]. However, these indexes often fall short of differentiating the scale of needs in complex emergencies. They don’t provide enough granularity on the scale of needs to guide needs-based funding, as many complex emergencies fall into a worst off category, without any distinction between them [105-109]. Moreover, the components and indicators in the indexes tend to change frequently, as do the logic they are based on. This makes them difficult to use systematically [110]. Finally, there are, to my knowledge, no studies that validate the indicators or the index results against the actual, the scale of needs in disasters.

2. Rationale

The need for humanitarian assistance is increasing, while international funding is insufficient. At the World Humanitarian Summit in 2016, the world's leader stated that no one should be left behind, that vulnerability should guide assistance [70, 71, 73, 74, 84]. To ensure that limited funding is allocated in accordance to the scale of needs should therefore be high on the agenda.

While the efforts to improve and increase information sharing in disasters are growing: For instance, through joint needs assessments, the establishment of new information sharing- and coordination platforms [85, 111]. The amount of information collected and number of reports produced in disasters increases steadily, but despite this, the scale of needs in different disasters remains largely overlooked and severe needs are unmet [35, 70, 73, 75, 85, 112].

Donors have agreed to fund according to needs, yet other considerations such as geopolitical interest, media attention, principles of proximity, complexity and donor fatigue in protracted disasters compete with the principle to let the scale of needs guide funding decisions [70, 75].

To improve needs-based allocations and ensure alignment with the GHD, governmental donors must be able to conduct independent and objective analyses of the scale of needs in disasters. There is a need for practical analytical tools, to that based on best possible indicators that make use of available information to systematically estimate the scale of needs in disasters.

To allow this, better understanding of the factors to a disaster and that influence disaster severity is needed. It is moreover important to understand how they can be measured.

This thesis applies a systematic approach combining theoretical research with an understanding of the practical challenges of defining needs of disaster affected populations and rapidly taking decision to fund needs based humanitarian assistance.

The thesis focuses on man-made complex emergencies that renders most people in need of assistance [12, 35], but it also attempts to develop tools to rapidly predict needs following earthquakes, that are the deadliest natural disasters that also generate a significant number of people in urgent need of life saving humanitarian assistance [11, 28, 86, 87].

3. Aims and objectives

The aim of this thesis was to increase the understanding of what factors contribute to disaster severity and how they can be measured in order to estimate the scale of needs in disasters.

The specific objectives were:

For complex emergencies:

1. to define indicators that approximate severity and the scale of needs (Paper I)
2. to develop a severity- and needs-scoring model (Paper I)
3. to test the usefulness of the developed model based on a) the availability of the indicator data and b) variations between countries and over time (Paper II)
4. to assess the validity of the developed model (Paper II)

For earthquakes:

5. to define predictors for the scale of needs (Paper III)

4. Material and methods

4.1 Overview of the thesis

In Table 2, we have summarised the work in the three papers in an overview format.

4.2 The research framework

All three papers included in my thesis build on the disaster framework (Figur 1). I chose the Utstein style disaster framework, as a starting point, as it is comprehensive, peer reviewed and updated. The Utstein style was invented for reporting on out-of-hospital cardiac arrests, which of course isn't found in the presented theoretical frame. Here, Utstein style refers to uniform definitions or agreements on what data to report, thus, a recognised research framework. The Sendai Framework for instance, refers to many of the same components and suggested relationships between the different factors in the global framework that aims at disaster risk reduction [16]. In the disaster framework, risk, as such was not included but it can be understood as an underlying factor, throughout the development of disasters [113]. I did not focus on the overall risk perspective. In paper III, my focus was prediction, which has a more narrow meaning than risk.

Figure 4 specifies how I have applied different parts of the framework in the papers (I-III).

In papers I and II, I focused on factors that negatively influence the severity and the scale of needs in disasters: vulnerability and exposure. In exposure, I concentrated on damage. In the papers, I used severity and the scale of needs as disaster outcomes (Figure 4).

In paper III, I set out to identify predictors for the scale of needs after earthquakes. I assumed a situation where the prediction of the scale of needs would be based on the magnitude of the hazardous event, vulnerability and exposure. In this paper I used the broader term of exposure, in red (Figure 4), the people living in the area exposed to the earthquake.

Table 2: Overview of the thesis, Papers I – III.

Paper	Objective	Design	Setting	Data source	Main analysis
I	To identify indicators that approximate, the severity and the scale of needs To develop a severity scoring model	Literature review, internet search Adjustment and application of published theoretical framework, through expert judgemen	Complex emergencies	EBSCO database, which includes preMEDLINE, MEDLINE and Google Scholar. UN consolidated appeals 2010 and 2012	A two-step Internet and document search, extracting, listing and ranking of indicators The model was adjusted to fit the preconditions: easy to use, readily available information, using expert judgement
II	To test the usefulness and assess the validity of the developed model	Application of the model and regression against excess mortality	Complex emergencies	The World Bank's online database, if unavailable: Multiple Indicator Cluster Surveys by UNICEF. UN consolidated appeals (CAPs and HNOs/HRPs) 2013 – 2015. UNHCR's website. *The Global Burden of Armed Violence* 2008 (the Geneva Declaration Organization)	The model was applied to 25 countries with ongoing complex emergencies, over three consecutive years. The severity score calculated and plotted against outcome (excess mortality) in 11 complex emergencies
III	To identufy predictors of the scale of disaster needs	Testing of hypothesis through linear regression analysis	Earthquakes	The World Bank's online database. The CRED/EM-DAT databases. UN's Global Disaster Alert and Coordination System (GDAC). The Index for Risk Management (INFORM) The Global Humanitarian Needs Assessment (GNA). KI's Severity- and Needs-Scoring Model (7-eed), papers I and II.	The predictive performance of the indicators from four commonly used disaster indexes was assessed through data from earthquakes for the period 2007 – 2016. The assessment was performed using linear regression with root mean square error (RMSE) as the performance measure.

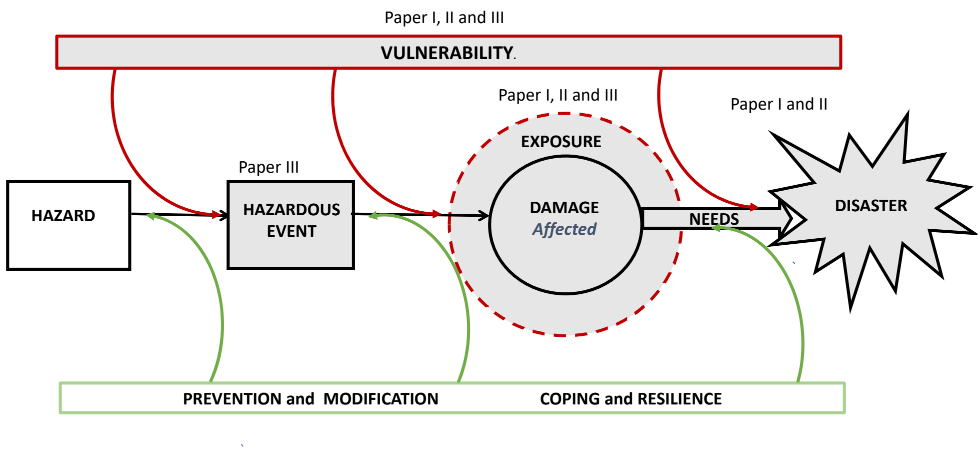


Figure 4: The Research framework and its use in Papers I, II and III.

Further, I assumed that the damage could indicate the scale of needs. I used the number and proportion of people who died in the earthquake or who were directly affected by the earthquake as indicators for damage (Figure 4).

4.3 Study settings

All three papers build on secondary data published on open websites or in UN reports.

Paper I

I collected data on the indicator values from the 50 least developed countries in the world according to the Humanitarian Development Index (HDI) [103], as well as from the UN Consolidated Appeals. The data were used to set thresholds in the developed model.

Paper II

I tested the model by using data from 16 disaster countries for three years. In addition, data from 9 supplementary countries were assessed for two years (Table 3). All countries went through complex emergencies during the study.

In paper II, I used data from 11 complex emergencies that occurred partly or completely before 2005. The numbers in parentheses indicates between what years the complex emergency lasted (Table 3).

Table 3: Countries assessed in Paper II.

Countries in usefulness test		Countries in validity test
Afghanistan	Myanmar	Angola (1975–2002)
Burkina Faso	Niger	Burundi (1993–2003)
Cameroon	Nigeria	Congo (DRC) (1998–2002)
Central African Republic (CAR)	occupied Palestinian Territories	East Timor (1974–1999)
		Iraq (2003–2007)
Chad	Senegal	Kosovo (1998–1999)
Congo (DRC)	Somalia	Liberia (1989–1996)
Djibouti	South Sudan	Sierra Leone (1991–2002)
Gambia	Sudan	Darfur, Sudan (2003–2005)
Haiti	Syrian Republic	South Sudan (1999–2005)
Iraq	Ukraine	Northern Uganda (2005)
Kenya	Zimbabwe	
Mali	Yemen	
Mauritania		

The vast majority of countries in paper II are, according to the World bank classification, low-income and lower-middle-income countries. Iraq is considered an upper-middle income country, and Kosovo, as an underserved part of Serbia, also an upper-middle income country [114].

Paper III

All earthquake events recorded in both the CRED/EM-DAT and GDAC earthquakes between 2007 and 2016 were selected for the analysis. In total, 226 events in 55 countries were included, of which 2/3 were upper-middle income countries or high-income countries. Country characteristics are available in Table 4. The numbers in parentheses refer to the number of earthquakes that were included from the country, if more than one. The world bank classification 2019, was used as source for the country income levels [114].

Table 4: Countries included in paper III

Low-income countries	**Lower-middle-income countries**	**Upper-middle- income countries**		**High-income countries**
Afghanistan (6)	Bhutan	Albania	Iran (17)	Chile (6)
Congo (DRC) (2)	Comoros	Algeria	North Macedonia	Greece (3)
Haiti	Honduras (2)	American Samoa	Malaysia	Hungary
Malawi (2)	India (3)	Azerbaijan (2)	Mexico (5)	Italy (7)
Nepal (3)	Indonesia (24)	Brazil	Peru (5)	Japan (13)
Rwanda	Kyrgyzstan (3)	Bulgaria	Russia (2)	Republic of Korea
Tajikistan (6)	Myanmar (3)	China (44)	Samoa	Martinique-France
Tanzania	Nicaragua	Colombia (4)	Serbia	New Zealand (5)
Timor-Este	Pakistan (4)	Costa Rica (2)	South Africa	Spain
	Philippines (5)	Ecuador (3)	Thailand	Taiwan (4)
	Solomon Islands (4)	Georgia	Tonga	United Kingdom
		Guatemala (4)	Turkey (4)	USA (4)

4.4 Source of data

For all papers, vulnerability indicator data were extracted at the country level from the World Bank's online database. Where information was unavailable in the database, other sources were systematically searched, such as Multiple Indicator Cluster Surveys (MICSs) published by UNICEF and other credible surveys referred to in the UN appeals. If no indicator value was found, the indicator was marked as not available. When composite indexes were used as vulnerability indicators, these were obtained from the index website, for instance, the Human Development Index and the gender inequality index.

Paper I

The first literature search was performed in the EBSCO database, which includes preMEDLINE, MEDLINE and Google Scholar, without any time limit. Searches were limited to English using the search words Disaster(s), Emergency(ies), Vulnerability, Index, and Indicator(s) in combinations. To assess their use, a mapping of the indicators presented in UN Consolidated Appeals, documents from 2010 and 2012 was performed [82, 115].

Paper II

Values for exposure indicators were derived from the UN Consolidated Appeals. Data for 2013 and 2014 were obtained from Consolidated Appeal Documents, CAP documents and for 2015 from the UN's Humanitarian Response Plans [83]. Values for the "number of uprooted" were obtained from the UNHCR's website. Information on excess mortality in complex emergencies was taken from a publication by the Geneva Declaration Organization, Global Burden of Armed Violence from 2008 [116].

Paper III

Data on earthquakes and outcomes were obtained from both the CRED/EM-DAT databases [26] and the GDAC alert archive [107]. Data on the country, date, number of deaths, and total number affected were extracted from CRED/EM-DAT. GDAC alert data were matched with the list of earthquake events from CRED/EM-DAT. The earthquake magnitude, depth and number of people living within 100 kilometres of the epicentre were extracted for the earthquakes listed in both EM-DAT and GDACs.

4.5 Study designs, analysis and statistical methods

All three papers are based on quantitative methods. In addition, in paper I, an expert panel was used for final selection of indicators and development of the model.

Paper I

A literature and Internet search of indicators rendered more than 100 indicators that characterize vulnerability and exposure to complex emergencies. In the two-step search, the indicators were compiled according to a) relevance and relation to best practices or evidence, b) timeliness and c) availability. Each indicator was then ranked per criterion using a scale of 1–3. The ranked indicators received a score ranging from 3–9, with a higher number representing higher relevance, timeliness and availability.

A core set of six indicators was selected by an expert panel. The selection was made based on an indicator's availability and ability to characterise pre-existing or underlying vulnerabilities (four indicators) or to quantify exposure to a complex emergency (two indicators).

A model, that builds on the selected factors in the research framework was developed (Figure 4) and populated with the selected indicators. A three-tiered scoring system was set for the value of each individual indicator to allow comparison and distinguish severity between complex emergencies (Low-Moderate, High, and Critical). The scoring of the vulnerability indicators builds on values from approximately 50 countries with low development index, <0.5 (UNDP), while exposure values use data from the 15 UN Consolidated appeals for 2012.

Paper II

In this paper, I applied the model developed in paper I to 25 countries affected by complex emergencies between 2013 and 2015. Based on the results, heat maps were developed and tested for indicator availability, variations over time, and variations between countries.

In a second step, standardised mathematical equations to calculate severity and the scale of needs was established. The formula built on the research framework logic (Figure 4). Each indicator was given a numeric value based on its score (Low-Moderate, High, and Critical). Vulnerability scores and exposure scores were added, and then, the total vulnerability score was multiplied by the total exposure score.

To obtain a score for the scale of needs, the number of people in need of assistance was added to the equation.

I tested the validity of the model by applying it to a number of complex emergencies with a “known” outcome. In complex emergencies, excess mortality is a late sign of a deteriorating situation, and data on mortality are difficult and complex to collect [39, 117]. However, the link with disaster severity is broadly recognised. I therefor used excess mortality as outcome variable, to validate my studies on complex emergencies The severity scores of the countries were plotted against the excess mortality rates to test whether there was any correlation. For the earthquakes assessed in the study, paper III, the EM-DAT threshold was applied, as I assessed earthquakes that had been entered into this database.

Paper III

In paper III, I assessed the predictive performance of the vulnerability indicators and outcome indicators of four commonly used disaster risk and severity indexes, first individually and then in different combinations using linear regression. The number of people who reportedly died or who were affected was used as an outcome variable for the scale of needs.

I selected three indexes that assess risks, vulnerabilities, severity or needs in relation to disasters on a global scale; have a published methods section; and are published or sponsored by a United Nation (UN) branch as well as governmental funding agencies for humanitarian assistance. In addition, I included the model I developed in paper I.

The disaster indexes used were as follows:

- the Global Humanitarian Needs Assessment (GNA) produced by the European Civil Protection and Humanitarian Aid Operations (ECHO) between 2004 and 2015 [105].
- the Index for Risk Management (INFORM), which replaced the GNA and is the result of a collaboration between the Inter-Agency Standing Committee Task

Team for Preparedness and Resilience and the European Commission, with close to 20 UN and governmental partners [109].

- the UN's Global Disaster Alert and Coordination System (GDAC) earthquake alerts [107].
- the model developed by Karolinska Institute's (KI's) Severity- and Needs-Scoring Model (7-eed), in papers I and II.

The indicators from the selected indexes were tested on 55 countries that experienced 226 earthquakes between 2007 and 2016. The number of deaths was recorded for 153 events, while the number of affected persons was recorded for 222 events. In total, data for 26 variables were extracted. The results were then compared to outcome (expressed as the number of deaths), the total number of people affected (number affected), and the proportion of deaths and people affected among the total number of people exposed to the hazardous events.

To ensure a valid analysis, we removed indicators with more than 10 percent missing data. For the remaining indicators, missing data were imputed using median imputation. Winsorizing was used to replace extreme outliers with the values observed at the 2.5^{th} and 97.5^{th} percentiles. The data were split into a training and a validation set using a temporal split based on the date of an event. Two-thirds of the observations were assigned to the training set, and the remaining one-third were assigned to the validation set.

The predictive performance of the indicators was estimated for each indicator individually and in different combinations. The root mean square error (RMSE) was used as the measure of predictive performance. Linear regression models were built first for individual indicators and as a second step for different combinations of indicators. To estimate 95% confidence intervals (CI) around the RMSE point estimates, a bootstrap procedure was used, with 1000 resamples drawn with replacement.

4.6 Ethical considerations

The three papers in this thesis all build on public secondary data, collected and published on web-based databases and in public UN reports. As no primary data collection has been conducted, I have not sought ethical permission for the studies leading up to the three papers.

I searched for and suggested the use of indicators that can be measured numerically. The exclusion of aspects that lack numerical values deserves ethical attention, as does the macro-level approach that hides details and inequalities within contexts. In chapter 6.4 in the discussion, I will discuss these aspects further, along with other ethical implications.

On a more important note, the distribution of resources in proportion to needs contains ethical challenges when the needs exceed the available resources. Ethical questions arise as to what principle should be used when distributing insufficient funds to the expressed needs [118].

4.7 The role of the funding source

The work behind the thesis was funded by two Swedish governmental agencies:

- The Swedish International Development Cooperation Agency (Sida) - papers I and II
- The Swedish National Board of Health and Welfare – papers I, II and III and the writing up of the thesis.

Sida took an active part in the initiation of the first study, and a group of programme officers with humanitarian funding responsibility gave input on the overall aim and expressed their specific needs in relation to the assessment of the scale of needs.

The funders did not have any involvement in the design of the studies, the conclusions derived from the studies or the presentation of the conclusions in the three papers.

5. Main results

5.1 Indicators that approximate severity and needs

A total of 19 single indicators were identified as valid in capturing vulnerability or exposure in complex emergencies. A total of 17 out of 19 indicators were found in the available vulnerability and development indexes. I found 14 indicators and one index (HDI) that were used for at least 9 countries in the 2010 and 2012 UN Consolidated Appeals.

Table 5: Single indicators identified to approximate mortality, vulnerability and exposure in disasters. Adapted from paper I.

Category	Indicator	Ranking
Economic	**Gross National Income (GNI) per capita at PPP**	**7**
Education	**Literacy rate (>14yrs) F/M**	**6**
Environmental	Arable land	5
Political	Voice and accountability	3
Population	Rural population growth rate	5
	Urban population growth rate	5
	Population density	5
	Uprooted people (Internally Displaced – IDP + refugees)	**8**
Public Health	Life expectancy at birth	5
	Improved water source, Access to improved Water	6
	Access to improved sanitation	6
	Child mortality rate, U-5	**7**
	Crude mortality per 10 000/day	5
	Excess mortality	5
	Vaccination coverage (measles)	7
	Maternal mortality per 100 000	5
	Prevalence of HIV/AIDS, TB, malaria	6
	Malnutrition weight for age	**7**
	Calorie intake per capita	5
Added from CAPs search, indicators used $\leq$ 9 CAPS	**Number of affected people**	**7**
	Health work force per 10 000	6
	Global Acute Malnutrition/Severe Acute Malnutrition	6/5

The indicators in bold were selected for the model (Table 5). They were selected based on the ranking and with the intention of including proximations from the public health area and other areas of vulnerability that were suggested to be relevant in the preceding review.

5.2 The developed model

The developed severity scoring model for conflicts and other types of complex emergencies builds on the conceptual framework presented for papers I and II. Of the top ranked indicators, six were selected for the severity- and needs-scoring model:

To define and quantify vulnerability:

- GNI per capita, PPP
- Under-five mortality rate, per 1000 live births
- Adult literacy rate, % of people aged 15 and older
- Underweight: % of population under 5 years

To define and quantify exposure , the following two indicators were selected:

- Affected in total number and as a proportion of the total population.
- Uprooted people in number and as a proportion of the total population

The model, from now on: the 7-eed model

To illustrate how the developed model estimates severity and needs, I named it: the 7-eed model (seve(rity)need). From now on I will use 7-eed when I refer to the developed model.

In the following equations, I explain how the vulnerability score, exposure score, severity score and needs score are calculated.

In the first step, the value of each indicator is scored, as described in the method, Study designs, analysis and statistical methods.

The vulnerability score is then defined as the sum of these scores (Equation 1). Exposure is defined as the sum of the scores for the number of affected and uprooted and the proportion of affected and uprooted (Equation 2)

Equation 1

$$\begin{aligned} Vulnerability \\ &= GNI_{score} + Literacy_{score} + Undernutrition_{score} \\ &+ Child\ mortality_{score} \end{aligned}$$

Equation 2

$$\begin{aligned} Exposure \ &= Number\ of\ affected_{score} + Proportion\ of\ affected_{score} \\ &+ Number\ of\ uprooted_{score} + Proportion\ of\ uprooted_{score} \end{aligned}$$

To obtain the severity score, the vulnerability score and the exposure score are multiplied (Equation 3).

Equation 3

$$Severity = Vulnerability \times Exposure$$

In the 7-eed model, the severity score can vary from 4 to 36. To obtain the scale of needs in disasters, the number of people in need is multiplied by the severity score (Equation 4).

Equation 4

$$The\ scale\ of\ needs\ = Severity\ x\ Million\ people\ in\ need$$

5.3 The usefulness of the 7-eed model

5.3.1 Indicator availability and variation

The vulnerability indicator data was to a large extent available and the availability also increased over time. In 2015, only one country (Somalia) had missing data for one single indicator. A drawback was that the values for two of the indicators (adult literacy and underweight) were not updated yearly. Undernutrition is no longer one of the WHO core health indicators. It is therefore not collected broadly [119]. The indicator was replaced with the "prevalence of stunting", in paper III.

Information on the number of people affected was not consistently presented; it was presented as per the intervention sector, such as health or food security, and in other cases as an overall number. The number of people in need was available for all assessed countries in the 2015 UN appeals. It was therefore included in the 7-eed model instead of the number and proportion of affected people (paper II).

5.3.2 Variations between countries and over time

The vulnerability scoring (Equation 1), showed variations among countries and over time. Exposure varied significantly (Equation 2), as did the severity score (Equation 3). The needs score (Equation 4), showed a larger variation, as the number of people in need varied between 300 000 and 21 million people (Figure 5).

The severity score for the countries assessed in 2015 is presented as bars, while the needs score is presented as a curve (Figure 5). For a country with a high severity score, the needs score can still be low. A high severity score in a context with few people in need will yield a lower needs score and vice versa; see, for instance, CAR. The 7-eed model takes both the severity and the scale of needs into account.

5.4 Is the 7-eed model valid?

When the 7-eed model was applied to the eleven previous complex emergencies, the severity score follows the estimated excess mortality in ten of the eleven countries. The exception is DRC, where the estimated excess mortality suggests a more severe situation than what we found when we applied the severity scoring model to the same context (Figure 6). Conflict mortality rate refers to the deaths directly attributed to a conflict (killing, warfare) and the indirect deaths attributed to the conflict, when compared to the expected crude mortality baseline in the specific setting. Conflict mortality is, thus, equal to excess mortality.

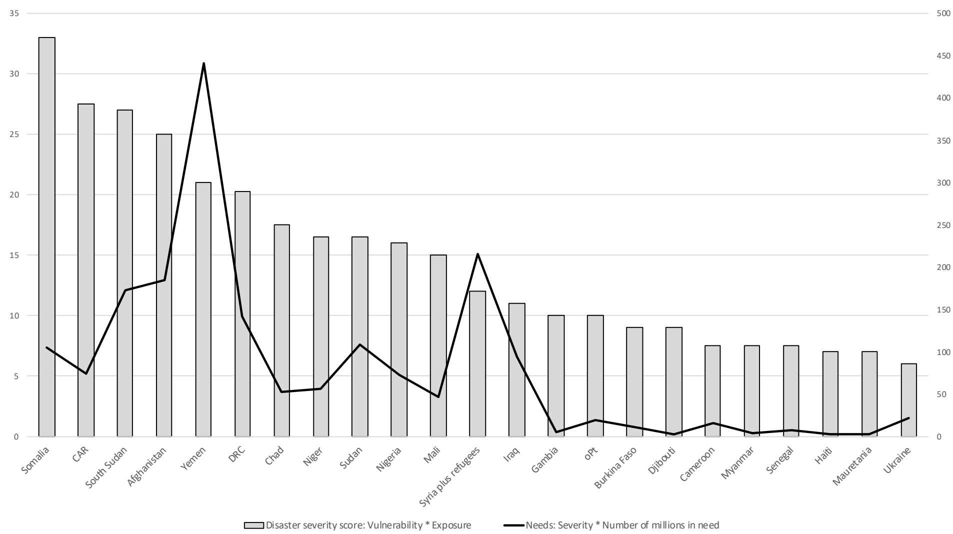


Figure 5: Severity and needs score for assessed countries in 2015, based on data from paper II.

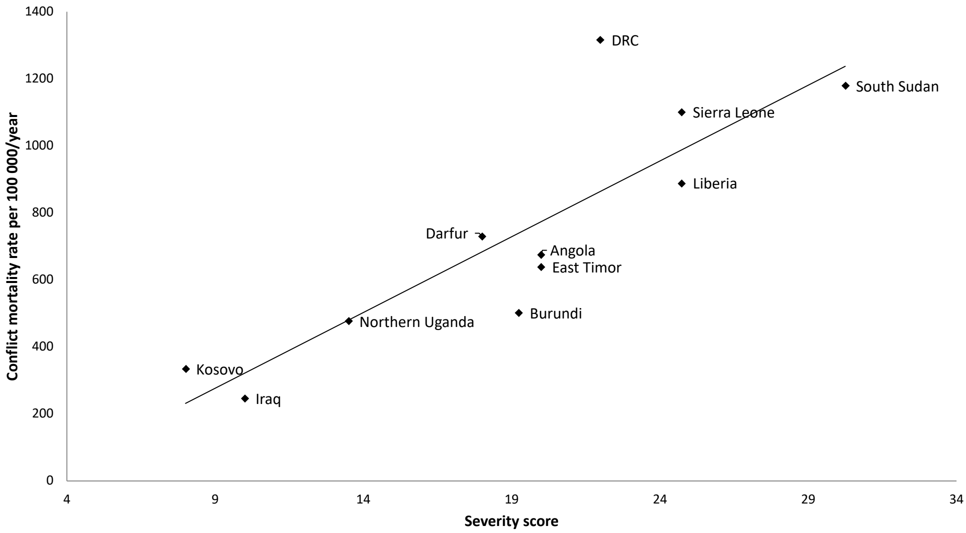


Figure 6: Calculated severity score plotted against average excess mortality, Source: Paper II, modified to include the names of the countries in the chart.

5.5 Predictors for the scale of needs after earthquakes

No obvious correlation between the standardised index scores and the number of deaths, number of affected, proportion of deaths and proportion of affected among exposed individuals were visually observed in the initial analysis. I could, in addition, not identify a correlation between any of the individual indicators tested through cross-validated RMSE across predictors for each outcome (Table 3 in paper III). In the last step of the study, the created multivariable models did not result in any substantially improved performance. I was not able to identify any predictors for the scale of disaster needs after earthquakes.

Table 6, shows models for the number of deaths and number of affected, using the 7-eed vulnerability indicators. In addition, the magnitude and depth of the earthquake was added, as well the number of people exposed.

The RMSE (95% CI) of the prespecified 7-eed for the number of deaths was 712 (392 - 1091). The RMSE (95% CI) of the prespecified 7-eed model for the number affected was 595 932 (252 828 - 840 877). This makes the models incapable of predicting the number of deaths as well as the number of affected with any precision and in turn even broadly predict the scale of needs.

Table 6:The models with the 7-eed indicators and in addition magnitude and depth

	Prespecified 7-eed model of number of deaths			Pre-specified 7-eed model of number of affected		
Predictor	*Coefficient*	*95% CI*	*95% CI*	*coefficient*	*95% CI*	*95% CI*
(Intercept)	-3 572	-5 968	-1 175	-1 217 964	-3 010 729	574 801
GNI	0.01	-0.01	0.03	-9	-24	5
Under-five mortality	14	-0.02	29	51 36	-5 698	15 970
Adult literacy rate	9	-11	29	4 642	-10 306	19 590
Stunting	-16	-34	2	-9 839	-23 096	3 418
Magnitude-earthquake	436	236	635	174 322	24 996	323 648
Depth	-7	-16	1	-2 072	-8 335	4 191
Exposed-earthquake	0.000	0.000	0.000	0.03	0.000	0.07

6. Discussion

My research in this thesis aimed to increase the understanding of what factors that contributes to disaster severity and if and how they can be measured in order to estimate the scale of needs in disasters. In the discussion, I first, consider methodological aspects of my research and then discuss the main findings. In the methodological consideration section, strengths and weaknesses are discussed under each heading.

6.1 Methodological considerations

It is a methodological challenge to ensure that theory and practice align, especially in disaster research. How to converge them has been a main challenge during my research training. Disasters are not static events but dynamic processes that develop as a consequence of several interlinked factors that complexly interact.

For this thesis I applied a deductive approach, where I built and tested hypotheses based on established knowledge and practice [120]. I based my studies on a recognised theoretical disaster framework to build and test my hypothesis. In addition, I tested the hypothesis with established variables (indicators). The alternative would have been to use an inductive approach and observe the outcome in different disasters and to have searched for associations with a greater variety of possible determinants. This may have led to different results [120]. For the last study (III), where I did not find an association between tested predictors and the scale of needs after an earthquake, an inductive approach may be tested, as an alternative scientific approach in a new study, to further explore prediction.

I chose to search for the measurable or quantifiable, while “the truth” is always more complex, with many non-measurable aspects. One might question whether it is relevant to only measure what is measurable. To get a wider and richer perspective while addressing the research objectives, I could have included qualitative methods, but it was beyond the scope of this thesis.

6.1.1 Study designs

An overall challenge has been to systematically apply robust scientific methods on secondary data that often have missing values or are fragmented, in addition to the uncertainty of their reliability with regards to timeliness of data capture. I have adhered to best possible practice in the application of the methods.

In the development of the 7-eed model, I used a step-wise approach, building on published literature, extraction of indicators used on existing indexes and UN-reports as well as assessments of the availability of information on indicator-values. Further, the selection of indicators and the development of the 7-eed model largely builds on ranking and in addition selection by experts. The objective was to develop a model with a small number of relevant indicators that would be easy to find and easy to interpret. This was a prerequisite to allow ensure the pragmatism of the model. However, from a statistical rigour point of view, a multivariable regression modelling might seem more reliable.

In paper III, the mapping of indicators that are used in four well-known indexes was validated against the outcome in over 200 earthquakes through linear regression. The method ensured improved scientific rigour, in comparison to the study design in paper I.

6.1.2 Reliability and availability of data

Disaster data is often patchy and incomplete [45]**.** To ensure that my work could be of practical use, the starting point of the thesis was to make use of readily available and easy to find data, that in addition is published by credible sources.

Vulnerability indicators

The use of databases that present aggregated country data on a regular basis was a deliberate choice as they are easily accessible and regularly updated. However, to use vulnerability indicators on country level, rather than on local level, has limitations. Variations in vulnerability between different groups or regions within a country will not necessarily be identified. A high vulnerability in one area of a country, can be hidden by a low vulnerability in another area.

Time is another aspect that influences the reliability of the vulnerability indicators. There is often a timespan between data collection and publication in the databases. Data from countries in a disaster situation, such as a protracted complex emergency, may be even more outdated. In paper II, data was not available for some countries. How to interpret absence of data remains an unsolved problem. Conversely, precise point estimate data from a country with a complex emergency may bring into question data reliability [121]. A lack of robustness in data collection and data analysis in the countries with the highest vulnerability may also raise questions about the data reliability [121].

Exposure indicators

Exposure data was primarily extracted from UN reports and in turn collected by the UN and partner organisations in the field, which should indicate high reliability. However, access problems, willingness to inflate data due to fundraising concerns as well as varying or unclear methodologies for data collection could affect data reliability [122]. A concern noted during the studies, was the change from year to year regarding the type of data and measurements used in the UN reports, which made it difficult to compare data over time.

Indicators for severity and the scale of needs

In paper II, I opted to use data on excess mortality in complex emergencies published by the Geneva Declaration Organization as outcome data [116] . This referenced publication systematically collates and compares secondary data on excess mortality, based on compilations of surveys found in a number of peer reviewed publications.

The reliability of the outcome data in paper III, number of deaths and number of people affected is somewhat questionable, as described in the thesis introduction. The number of deaths has been shown to be both over- and underestimated after natural disasters. For instance, the number of people who died in the 2010 earthquake in Haiti is believed to be highly overestimated [123]. A more recent examples is the Hurricane Maria in the Caribbean's where the mortality is suggested to be higher than reported [124]. Moreover, the term affected is ill-defined and has several meanings, as described in the introduction [6]. The number of people reported to be affected in the same disaster can therefore vary widely, depending on the definition.

I used one source for the outcome data, the EM-DAT database. While the EM-DAT is well established and systematic in its data collection [2],differential reporting may have affected the data reliability.

6.1.3 Internal validity of data and of the 7-eed model

The internal validity of a study refers to the ability of a study to provide an unbiased estimate of what it sets out to measure [125]. In this section, I will discuss to what extent the selected data captures the level of vulnerability, exposure, magnitude, severity and the scale of needs.

Vulnerability indicators

The vulnerability indicators I used and assessed in the three papers are recognised as indicators of a society's vulnerability and are used in several of the examined indexes [6, 117, 126-130]. However, in paper III, I did not find that the assessed vulnerability correlated with the selected outcome indicators. While the vulnerability indicators still point to a general vulnerability and a lack of capacity to cope with a disaster, my study did not show that they are valid as predictive indicators for the scale of needs after the studied earthquakes.

Exposure indicators

In the disaster framework, exposure is a prerequisite for damage. Damage is presented as the inner core of exposure (Figure 1.)

In paper I and II, I selected indicators that approximate the human damage, the number and proportion of affected people and uprooted people. While the absolute numbers reflect the extent of damage, the proportion of the total population gives indication on the remaining capacity to cope in a country and in this sense they are valid indicators for the severity and the scale of needs [38, 117, 127, 130].

The number and proportion of uprooted people was selected as displacement is known to increase needs [75, 131, 132]. However, among groups of uprooted individuals, it is generally recognised that internally displaced individuals are among the most exposed to complex emergencies, while refugee populations have been shown to be better off , as the ability to reach a country of refuge may correlate to avilability of resourses as well as the access to safety and assistance [132]. The selected indicator: uprooted, does not consider these variations, nor does it differ between recent or long-term displacement. This may affect the validity of uprooted as an exposure indicator in a disaster.

In paper III, I instead opted for the outer frame of exposure, "the people living in the affected area" (Figure 4). The choice is based on the circumstances under which the model is meant to be applied and on what information is likely to be available at the moment of application. The people living in the affected area is presented by GDACS-alerts, in the immediate aftermath of an earthquake.

Magnitude of the event

In paper III,earthquake magnitude and earthquake depth were selected as quantifyable indicators for the hazardous events. This information is available immediately after the event in the GDAC-database. In recent years, GDAC has started to include shake, that possibly approximates both exposure and magnitude of the event. However, for the years assessed in paper III, information on shake-maps was missing and could therefore not be assessed [107].

Severity and the scale of needs

The validity of excess mortality as a measurement of severity, paper II, is emphasised by numerous publications [3, 37, 39, 117, 133]. In turn, the plotting of severity scores against excess mortality showed an almost perfect correlation for the 11 assessed complex emergencies (Figure 6). This points to the internal validity of the 7-eed model, to estimate severity in these specific complex emergencies.

By the same logic, a high number of immediate direct deaths after an earthquake points to a severe situation. However, the number of deaths only captures the direct and immediate effects. The data in the EM-DAT does not capture the excess mortality that may be present over longer periods of time [134]. The validity in relation to the scale of needs could therefore be questioned. A typology of time to mortality after earthquakes could allow more accurate, comparable measurements.

The number of deaths and the number of affected primarily indicates the damage that the earthquake has caused and therefore indicates the needs that follow (Figure 2). However, the indicators fall short of approximating the coping capacity and resilience that could mitigate the situation as well as the vulnerability that threaten to exacerbate the scale of needs, (Figure 2). The validity of the number of deaths and the number of affected as indicators for the scale of needs is therefore not certain.

In my studies I assumed that the severity and the scale of needs are closely interlinked and that the scale of needs is a product of the severity and the size of the population in need. I have however not sought to validate this assumption.

6.1.4 Generalisability – external validity

External validity refers to the degree to which the findings from a study may be generalised to populations or clusters, that did not participate in the study [125].

The 7-eed model

While the internal validity of the 7-eed model is promising, I cannot claim an external validity based on the regression against only 11 complex emergencies. I have therefore not been able to prove statistically that the 7-eed model can be applied to complex emergencies in general.

Prediction of the scale of needs after earthquakes

The external validity of the negative results found in paper III, must also be interpreted with caution. Even if the statistical basis and methods were more rigorous, questions on the reliability and validity of the chosen outcome indicators, make the results difficult to generalise.

6.2 Discussion on the main findings

In my thesis I have identified and used indicators that are recognised to approximate the vulnerability of countries and people. I have further identified additional indicators, recognised to estimate the exposure to hazardous events and the human damage of hazardous events, as well as indicators that point to the magnitude of earthquakes. Vulnerability, exposure, damage and event magnitude are in turn factors that contribute to the severity and the scale of needs in disasters, according to recognised theoretical frameworks for research in disasters [7, 17]. The factors are in addition recognised factors in the field of disaster risk reduction and include numerous disaster risk indexes [16, 110]. In the development of the 7-eed model, I endeavoured to put theory into practice, by putting numbers and measurements to a theoretical framework. I developed the model, as well as the model equations to allow the use by desk-officers at funding agencies, rather than statisticians. The few indicators and the absence of statistical algorithms, may put the validity of the model into question. However, my studies showed valid estimates of severity in the assessed complex emergencies, paper II. As stated in the methodological considerations, the results must be interpreted with caution.

In addition, quantitative measurements must always be interpreted in the specific disaster context. Additional qualitative information must be part of the narrative analysis, such as violations of human rights and other factors that our model does not capture, as well as important regional or local characteristics.

Yet, the 7-eed model could be a tool to make sense of, and allow comparison of data between disasters, an area reported to be overlooked, yet needed [70, 73, 85]. The model allows a systematic and transparent comparison of the scale of needs between countries affected by complex emergencies.

In my studies, I was not able to identify predictors that capture the scale of needs after earthquakes. In addition, I applied the same assessment to another type of hazard. I assessed the outcome in over 200 floods (unpublished data). None of the results that I obtained gave any indication that prediction of the scale of needs in floods could be made with the help of the assessed indicators. My hypothesis that approximations of vulnerability, the magnitude of a hazardous event and the size of the population exposed can give an early prediction of the scale of needs after earthquakes (and floods) was rejected since no correlation could be established. As the assessed indicators are used in many risk indexes, this is an important caveat [110, 135]. However, to better understand results, further research and analysis is needed. There may be more valid indicators found in the field of geophysical science and engineering, outside of the scope of this paper.

There are a number of limitations to my results, discussed under methodological considerations. One additional consideration relates to the factors in and logic of the disaster framework that I did not study. I did not assess the role of resilience, coping, prevention and modification as factors influencing disaster severity and the scale of needs.

6.2.1 Policy implications

The 2019 UN-appeals were briefly presented in the introduction. The appeals suggest that the needs per person substantially vary between contexts. In the Middle East and North Africa the UN appeals foresee an average need close to 500 USD per person, compared to just over 200 USD per person in the remaining 28 UN-appeals [12].

In the 7-eed model, most of these remaining UN appeals concern countries that present a substantially higher vulnerability and severity, compared to the Middle East

5). With the logic of the 7-eed model, the amount per person should have been the opposite. How to explain these significant differences remains difficult. My interpretation is that other considerations than the scale of needs are directing the amounts requested in the appeals.

6.2.2 Ethical implications

One must be aware of the ethical challenge of attributing estimates to human suffering and scoring the severity of distress in already poor and conflict-affected countries. Is it truly defendable to put “grades in hell”? Shouldn’t assistance be provided wherever possible without measurement?

Literature suggests, and my thesis highlights, that the attention and resources directed to disasters is unevenly distributed. Many international actors and massive attention in a given context leads to a situation where more needs are identified and addressed, compared to situations with little attention and few actors present. This, in turn leads to a situation where people affected by disasters and in need of life-saving humanitarian assistance do not receive it in proportion to the scale of their needs.

The deontological principle, the human urge to assist the people we “have in front of us”, overrides a global approach of impartiality.

While recognising that my studies are but one peace in a complex puzzle, the ethical implications, could be a more evenly distribution of assistance in accordance to the scale of needs.

6.2.3 Future developments

Needs-based funding and assistance remains high on the agenda for donor agencies, the UN and other humanitarian actors [74, 86, 136]. To my knowledge there is still no common understanding or analysis on how the scale of needs should be estimated or how estimates should guide needs-based funding decisions. My studies may provide some insight to address this.

During the time of my studies, I have been part of a network of UN staff, researchers, representatives from governmental funding agencies and others who have developed a crisis severity index that, based on approximately 30 indicators, rates the severity of different crisis situations in the world. In the development of the index, I have been able to contribute with my research results. In the network we have also tried to address how to capture variations within countries and between populations, which I raised earlier in the discussion [9].

In my own research, I also aimed for a model that would be practical to use and easy to understand, while building on a recognized theoretical framork and tested variables. While it is important to be cautious regarding errors and false conclusions stemming from the measurable, my thesis lays a foundation that could serve as a base for further analysis. My research raises a number of methodological, practical as well as ethical questions: Is it possible to validate a severity index against reality and what does the results actually tell us? How can the non-measurable aspects be taken into account? Can the model actually help to ensure needs-based funding or are there too many other factors that must be considered? From an ethical perspective, one also has to ask if impartiality really can be measured in amounts of money allocated, or if the living standards and receptivity should be taken into account.

These question require further research, but also policy discussions. For a donor agency, the 7-eed model could already now, provide a starting point for an independent analysis of the scale of needs and its results serve as a quantitative base for discussion on how to estimate needs in disasters.

7. Conclusions

At the start of my thesis, I set out to increase the understanding of what factors contribute to disaster severity and how they can be measured in order to estimate the scale of needs. Based on the study results I can conclude that:

- There are easy to find, available indicators that correlate with severity and the scale of needs in complex emergencies.
- The application of the 7-eed model is sensitive to changes over time and shows variations of severity between complex emergencies.
- Out of the selection of indicators from commonly used disaster indexes, none are able to predict the scale of needs after earthquakes

Source of data

1. United Nations Office for Disaster Risk Reduction (UNDRR formally UNISDR), *Terminology*, in *2017 UNISDR terminology on disaster risk reduction*. 2017, United Nations' Office for Disaster Risk Reduction (UNDRR), : https://www.unisdr.org/we/inform/terminology#letter-s.
2. Centre for Research on the Epidemiology of Disasters (CRED). *Glossary for the international disaster database -EM-DAT* 2018; Available from: http://www.emdat.be/glossary.
3. Salama, P., et al., *Lessons learned from complex emergencies over past decade.* The Lancet, 2004. 364(9447): p. 1801-1813.
4. World Health Organisation Humanitarian Health Action (WHO-HAC). *Humanitarian Health Action, Definitions: emergencies*. 2015; Available from: http://www.who.int/hac/about/definitions/en/.
5. Birnbaum, M.L., et al., *Research and Evaluations of the Health Aspects of Disasters, Part II: The Disaster Health Conceptual Framework Revisited.* Prehosp Disaster Med, 2015. 30(5): p. 523-38.
6. United Nations Office for Disaster Risk Reduction (UNDDR formally UNISDR), *Terminology*, in *2009 UNISDR terminology on disaster risk reduction*. 2009.
7. Sundnes, K.O. and M.L. Birnbaum, *Health disaster management: Guidelines for evaluation and research in the Utstein style*. 2003: Prehospital and Disaster Medicine.
8. Cambridge University Press, *Cambridge Dictionary* in *Cambridge Dictionary* 2020, Cambridge University Press: https://dictionary.cambridge.org.
9. Acaps, *Inform Global Crisis Severity Index, Guidance note , Beta version, .* 2019.
10. Anderson, M. and M. Gerber, *Introduction to Humanitarian Emergencies.* Health in Humanitarian Emergencies: Principles and Practice for Public Health and Healthcare Practitioners, 2018: p. 1.
11. Centre for Research on the Epidemiology of Disasters (CRED), *CRED. Natural Disasters 2018*. 2019, Centre for Research on the Epidemiology of Disasters (CRED) Institute Health and Society, Université Catholique de Louvain.
12. United Nations Office for Coordination of Humanitarian Assistance (UNOCHA), *Global humanitarian overview 2019*. 2019.
13. World Health Organisation (WHO). *Definitions: emergencies*. 2008 [cited 2014 12 17]; Glossary for terms used in relation to emergencies.]. Available from: http://www.who.int/hac/about/definitions/en/.

14. Birnbaum, M.L., et al., *Research and Evaluations of the Health Aspects of Disasters, Part IX: Risk-Reduction Framework.* Prehosp Disaster Med, 2016. 31(3): p. 309-25.

15. Birnbaum, M.L., et al., *Research and Evaluations of the Health Aspects of Disasters, Part VIII: Risk, Risk Reduction, Risk Management, and Capacity Building.* Prehosp Disaster Med, 2016. 31(3): p. 300-8.

16. United Nations' Office for Disaster Risk Rediction (UNDRR), *Sendai Framework for Disaster Reduction: 2015-2030.* 2015 United Nations: New York,New York, USA: United Nations; 2015: 1-37. p. 1-37.

17. Birnbaum, M.L., et al., *Disaster research/evaluation frameworks, part 1: an overview.* Prehospital and disaster medicine, 2014: p. 1-12.

18. Marulanda, M. and M. Salgado-Gálvez, *UNISDR's global exposure database and disaster risk: current developments and required improvements.* Natural Hazards, 2017. 86(1): p. 185-187.

19. Sena, A., et al., *Drought in the Semiarid Region of Brazil: Exposure, Vulnerabilities and Health Impacts from the Perspectives of Local Actors.* PLoS currents, 2018. 10.

20. Strader, S.M., et al., *Projected 21st century changes in tornado exposure, risk, and disaster potential.* Climatic Change, 2017. 141(2): p. 301-313.

21. Peduzzi, P., et al., *Assessing global exposure and vulnerability towards natural hazards: the Disaster Risk Index.* Natural Hazards and Earth System Science, 2009. 9(4): p. 1149-1159.

22. Banwell, N., et al., *Commonalities between disaster and climate change risks for health: A theoretical framework.* International journal of environmental research and public health, 2018. 15(3): p. 538.

23. Flanagan, B.E., et al., *A social vulnerability index for disaster management.* Journal of Homeland Security and Emergency Management, 2011. 8(1).

24. Hallisey, E.J., *Measuring Community Vulnerability to Natural and Anthropogenic Hazards: The Centers for Disease Control and Prevention's Social Vulnerability Index.* Journal of Environmental Health, 2018. 80(10): p. 34-36.

25. Kahn, M.E., *The death toll from natural disasters: the role of income, geography, and institutions.* Review of economics and statistics, 2005. 87(2): p. 271-284.

26. Centre for Research on the Epidemiology of Disasters (CRED). *EM-DAT, The international disaster database.* 2018; Available from: https://www.emdat.be/.

27. Al-Jazairi, A.F., *Disasters and Disaster Medicine*, in *Essentials of Accident and Emergency Medicine*. 2018, IntechOpen.

28. Pan American Health Organisation (PAO), *Vigilancia epidemiológica sanitaria en situaciones de desastre, Local, Guia Para El Nivel.* 2002.

29. Perry, R.W., *What is a disaster?*, in *Handbook of disaster research*. 2007, Springer. p. 1-15.

30. Food and Agriculture Organisation (FAO), *Countries in protracted crisis: what are they and why do they deserve special attention?*, in *The state of the food insecurity in the world 2010.* . 2011, FAO.

31. Perry, R.W., *Defining Disaster: An Evolving Concept*, in *Handbook of Disaster Research*. 2018, Springer. p. 3-22.

32. Spiegel, P.B., et al., *Occurrence and overlap of natural disasters, complex emergencies and epidemics during the past decade (1995-2004).* Confl Health, 2007. 1(2).

33. von Uexkull, N., et al., *Civil conflict sensitivity to growing-season drought.* Proceedings of the National Academy of Sciences, 2016. 113(44): p. 12391-12396.

34. Cohen, J., *Ebola outbreak continues despite powerful vaccine*. 2019, American Association for the Advancement of Science.

35. Development Initiatives (DI), *Global Humanitarian assistance report 2019 (GHA report 2019),* , Development Initiatives (DI), Editor. 2019. p. 90.

36. Gerdin, M., et al., *Does need matter? Needs assessments and decision-making among major humanitarian health agencies.* Disasters, 2014. 38(3): p. 451-464.

37. Checchi, F., et al., *Public health in crisis-affected populations. A practical guide for decision-makers.* 2007.

38. Darcy, J. and C. Hoffman, *According to need? Needs assessment and decision-making in the humanitarian sector.* HPG - Odi, 2003(15).

39. Checchi, F. and L. Roberts, *Documenting mortality in crises: what keeps us from doing better?* PLoS medicine, 2008. 5(7): p. e146.

40. Checchi, F., et al., *Health in humanitarian crises 2 Public health information in crisis-affected populations: a review of methods and their use for advocacy and action.* 2017.

41. Chan, J.L. and F.M. Burkle, Jr., *A framework and methodology for navigating disaster and global health in crisis literature.* PLoS Curr, 2013. 5.

42. Spiegel, P.B., *Differences in world responses to natural disasters and complex emergencies.* Jama, 2005. 293(15): p. 1915-1918.

43. The Geneva Declaration Secretariat, *Global Burden of Armed Violence*. 1st ed, ed. A. Potter. 2008, London: Geneva Declaration Secretariat. 161.

44. Keim, M.E., *Cyclones, tsunamis and human health.* Oceanography, 2006. 19(2): p. 40-49.

45. Guha-Sapir, D. and F. Checchi, *Science and politics of disaster death tolls*. 2018, British Medical Journal Publishing Group.

46. Wefer, A. and J. Von Schreeb, *Timing and type of disaster severity data available on internet following the 2010 Haiti Earthquake.* PLoS currents, 2012. 4.

47. Stephens, K., et al., *Excess mortality in the aftermath of Hurricane Katrina: a preliminary report.* Disaster Med Public Health Prep, 2007. 1(1): p. 15-20.

48. von Schreeb, J., H. Rosling, and R. Garfield, *Mortality in iraq.* Lancet, 2007. 369(9556): p. 101.

49. World Food Program (WFP). *Understandling Level 3 emergencies*. Blog&Stories 2018 [cited 2020 2020 02 04]; Available from: https://www.wfpusa.org/stories/understanding-l3-emergencies/.

50. Partners, I.G., *Integrated Food Security Phase Classification Technical Manual. Version 1.1. FAO*. 2008, Food and Agriculture Organisation FAO: Chief, Publishing Policy and Support Branch, Office of Knowledge Exchange, Research and Extension, FAO, Viale delle Terme di Caracalla, 00153 Rome, Italy.

51. Centre for Research on the Epidemiology of Disasters (CRED), *CRED. Natural Disasters 2017*. 2018, Centre for Research on the Epidemiology of Disasters (CRED) Institute Health and Society, Université Catholique de Louvain.

52. United Nations Office for Coordination of Humanitarian Assistance (UNOCHA), *World humanitarian data and trends 2018*. 2018.

53. Wallemacq, P., R. Below, and D. McLean, *UNISDR and CRED report: Economic Losses, Poverty & Disasters (1998 - 2017)*. 2018, CRED.

54. AghaKouchak, A., et al., *How do natural hazards cascade to cause disasters?* 2018, Nature Publishing Group.

55. Bakkensen, L.A. and R.O. Mendelsohn, *Global Tropical Cyclone Damages and Fatalities Under Climate Change: An Updated Assessment*, in *Hurricane Risk*. 2019, Springer. p. 179-197.

56. Dottori, F., et al., *Increased human and economic losses from river flooding with anthropogenic warming.* Nature Climate Change, 2018. 8(9): p. 781.

57. Stäubli, A., et al., *Analysis of weather-and climate-related disasters in mountain regions using different disaster databases*, in *Climate change, extreme events and disaster risk reduction*. 2018, Springer. p. 17-41.

58. United Nations Office for Coordination of Humanitarian Assistance (UNOCHA), *Global Humanitarian Overview 2019.*, in *Global Humanitarian Overview*. 2019, United Nations: Web based publication. p. 79.

59. The good humanitarian donorship initiative (GHD). *The good humanitarian donorship principles*. 2003 [cited 2013 07 01]; Available from: http://www.goodhumanitariandonorship.org/gns/principles-good-practice-ghd/overview.aspx.

60. International Committee of the Red Cross (ICRC) and the Federation of the Red Cross and Red Creschent Societie's (IFRC), *Code of Conduct for the International Red Cross and Red Crescent Movement and Non-Governmental Organizations (NGOs) in Disaster Relief*. 1994.

61. International Federation of Red Cross and Red Crescent Societies (IFRC) and International Committee of the Red Cross (ICRC), *The fundamental principles of the International Red Cross and Red Crescent movement. Ethics and tools for humanitarian action*. 2015. 96.

62. United Nations Office for the Coordination of Humanitarian Affairs (UNOCHA). *Humanitarian Principles*. OCHA on Message 2012 [cited 2019 2019 08 20]; Available from: https://www.unocha.org/sites/dms/Documents/OOM-humanitarianprinciples_eng_June12.pdf.

63. Finnemore, M., *Chapter six Rules of War and Wars of Rules: The International Red Cross and the Restraint of State Violence*. Constructing world culture: International nongovernmental organizations since. 1999: Stanford University Press. 154.

64. Rysaback-Smith, H., *History and principles of humanitarian action.* Turkish journal of emergency medicine, 2015. 15: p. 5-7.

65. Slim, H., *Humanitarian ethics.* A Guide to the Morality of Aid in War and Disaster. London: Hurst & Co, 2015: p. 25.

66. Gunner Göran, Namli E., *Allas värde och lika rätt, Perspektiv på mänskliga rättigheter*. 2005: Studentlitteratur.

67. Helgesson, G., *Forskningsetik (2. uppl.)*. Lund: Studentlitteratur. 2015.

68. Gibbons, P., et al., *Putting affected people at the centre of humanitarian action: an argument for the principle of Humanitarian Subsidiarity.* Disasters, 2019.

69. Donini, A., *Humanitarianism, perceptions, power.* In the Eyes of Others, 2012: p. 183.

70. Donini, A., *The end of impartiality? 2.1 The future of humanitarian action: Reflections on impartiality.* Maecenata Institut, 2018: p. 9.

71. Bennett, C., M. Foley, and S. Pantuliano, *Time to let go: Remaking humanitarian action for the modern era.* ODI, London, 2016.

72. Quack, M., *Based on need alone? Impartiality in humanitarian action.* 2018.

73. Spiegel, P.B., *The humanitarian system is not just broke, but broken: recommendations for future humanitarian action.* The Lancet, 2017.

74. United Nations Secretary General (UNSG), *One humanity- shared responsibility. Report of the United Nations Secretary General for the World Humanitarian Summit, 2016*. 2016.

75. Miliband, D. and M.T. Tessema, *The unmet needs of refugees and internally displaced people.* The Lancet, 2018. 392(10164): p. 2530-2532.

76. Maslow, A.H., *A theory of human motivation.* Psychological review, 1943. 50(4): p. 370.

77. Sphere Association, *Humanitarian Charter and Minimum Standards in Humanitarian Response*. Vol. 4ed. 2018: The Spehere Project. 418.

78. World Health Organisation (WHO), *Health emergency and disaster risk management framework*. 2019.

79. United Nations Office for Coordination of Humanitarian Assistance (UNOCHA). *Needs Assessment and Analysis*. 2019 2019 11 21]; Text on the importance of needs assessment and needs analysis and different efforts in this area]. Available from: https://www.unocha.org/es/themes/needs-assessment-and-analysis.

80. Inter Agency Standing Committee (IASC). *Task Force on Needs Assessment web text concerning needs assessments*. 2007; Available from: http://www.humanitarianinfo.org/iasc/pageloader.aspx?page=content-subsidi-common-default&sb=75.

81. The Inter Agency Standing Committee (IASC), *MIRA Multi Sector Initial Rapid Assessment guidance*. 2015, UNOCHA.

82. United Nations Office for Coordination of Humanitarian Assistance (UNOCHA). *Concolidated Appeal Process*. CAP appeals 2012 2012 [cited 2014 2014 11 25]; Available from: http://www.unocha.org/cap/appeals/by-year/results.

83. United Nations Office for Coordination of Humanitarian Assistance (UNOCHA), *Guidance: 2015 Humanitarian Needs Overview*. 2015.

84. United Nations Office for Coordination of Humanitarian Assistance (UNOCHA) and Inter Agency standing committee (IASC). *The Grand Bargain - Agenda for Humanity*. 2016; Available from: https://www.agendaforhumanity.org/initiatives/3861.

85. The Assessment Capacities Project (ACAPS). *Analytical thinking*. 2020 [cited 2020 2020 02 17]; Available from: https://www.acaps.org/methodology/analytical-thinking.

86. International Federation of the Red Cross and Red Crescent Societies (IFRC), *Leaving no one behind.* World Disaster Report. 2018, Geneva.

87. Stoddard, A., et al., *Efficiency and Inefficiency in Humanitarian Financing*, in *Humanitarian Outcomes*. 2017, Humanitarian Outcomes.

88. Narang, N., *Forgotten conflicts: need versus political priority in the allocation of humanitarian aid across conflict areas.* International interactions, 2016. 42(2): p. 189-216.

89. Vaux, T., *Proportion and distortion in humanitarian assistance.* Alnap Review at Humanitarian Action, 2005: p. 35-88.

90. United Nations (UN). *The United Nations' Central Emergency Fund (CERF),* 2005 - present [cited 2020 0110]; Available from: https://cerf.un.org/what-we-do/allocations-by-year.
91. Development Initiatives, *Global Humanitarian Assistance report (GHA) 2014*, S. Swithern, Editor. 2014, Development Studies - Global Humanitarian Assistance Programme. p. 140.
92. Development Initiatives, *Global Humanitarian Assistance report (GHA) 2015*, in *Development Studies - Global Humanitarian Assistance Programme*, S. Swithern, Editor. 2015. p. 158.
93. Development Initiatives (DI), *Global Humanitarian Assistance report (GHA) 2012,* Global Humanitarian Assistance - Development Initiatives.
94. Development Initiatives (DI), *Global Humanitarian assistance report 2018 (GHA report 2018),* . 2018, Development Initiatives. p. 66.
95. Humanitarian Insight, United Nations Office for Coordination of Humanitarian Assistance (UNOCHA). *Global Humanitarian Overview 2019 - needs and funding requirements*. 2019 [cited 2019 2019 12 15]; Web page where the humanitarian needs, funding requirements and funding allocations are presented on a regular and updated basis]. Available from: https://hum-insight.info.
96. Schaar, J., *The Birth of the Good Humanitarian Donorship Initiative*, in *The Humanitarian Response Index 2007*. 2008, Springer. p. 37-44.
97. Olin, E. and J. von Schreeb, *Funding Based on Needs? A Study on the Use of Needs Assessment Data by a Major Humanitarian Health Assistance Donor in its Decisions to Allocate Funds.* PLoS Curr, 2014. 6.
98. von Schreeb, J., et al., *Are donor allocations for humanitarian health assistance based on needs assessment data?* Global Public Health, 2008. 3(4): p. 440-447.
99. The good humanitarian donorship initiative (GHD). *The good humanitarian donorship initiative* 2003 [cited 2019 2019 06 30]; Available from: https://www.ghdinitiative.org/ghd/gns/about-us/our-members.html.
100. Clarke, M., et al., *What evidence is available and what is required, in humanitarian assistance.* International Initiative for Impact Evaluation, London, 2014.
101. EBA Sophia Swithern, *Underfunded appeals: Understanding the consequences, improving the system*, S.E. Expert Group for Aid Studies, Editor. 2018: http://eba.se.
102. Pelling, M., et al., *Reducing disaster risk: a challenge for development.* 2004.
103. United Nations Development Program (UNDP). *Human Development Index (HDI),* . Human Development Reports 2018 [cited 2019 2019 08 23]; Available from: http://hdr.undp.org/en/content/human-development-index-hdi.

104. Dervis, K. and J. Klugman, *Measuring human progress: the contribution of the Human Development Index and related indices.* Revue d'économie politique, 2011. 121(1): p. 73-92.

105. European Civil Protection and Humanitarian Aid Operations (ECHO). *Global Vulnerability and Crisis Assessment (GNA)*. 2014 [cited 2014; Available from: http://ec.europa.eu/echo/files/policies/strategy/gna_fca_2013_2014_map.pdf.

106. The Assessment Capacities Project (ACAPS). *The global emergency overview (GEO),* . 2019 [cited 2019; Launched 2012]. Available from: https://www.acaps.org/countries.

107. United Nations and European Commission. *The Global Disaster Alert and Coordination System (GDACS),* . [cited 2019; Available from: http://www.gdacs.org/alerts/.

108. United Nations Office for Coordination of Humanitarian Assistance (UNOCHA), *2013 Global Focus Model*. 2013.

109. Inter Agency Standing Committee, European Commission, and Joint Research Centre. *INFORM, index for risk management*. [cited 2019; Available from: http://www.inform-index.org.

110. Beccari, B., *A Comparative Analysis of Disaster Risk, Vulnerability and Resilience Composite Indicators.* PLoS Curr, 2016. 8.

111. Bjerge, B., et al., *Technology and information sharing in disaster relief.* PLoS one, 2016. 11(9): p. e0161783.

112. Poole, L., *Bridging the needs-based funding gap: NGO field perspectives.* Independent Study Commissioned by Norwegian Refugee Council (NRC Lebanon), 2014.

113. Aven, T., *Risk assessment and risk management: Review of recent advances on their foundation.* European Journal of Operational Research, 2016. 253(1): p. 1-13.

114. World Bank Group. *World Bank Open Data,*. 2020 [cited 2020 01 10].

115. United Nations Office for Coordination of Humanitarian Assistance (UNOCHA). *Consolidated Appeal Process*. 2010 [cited 2014 2014 11 25]; Available from: http://www.unocha.org/cap/appeals/by-year/results.

116. James, M. and A. Potter, *Global Burden of Armed Violence*. 2008, Geneva Declaration Secretariat.

117. Garfield, R., *Measuring humanitarian emergencies.* Disaster Med Public Health Prep, 2007. 1(2): p. 110.

118. Brock, D. and D. Wikler, *Ethical issues in resource allocation, research, and new product development.* Disease control priorities in developing countries, 2006. 2.

119. World Health Organization (WHO), *2018 Global reference list of 100 core health indicators (plus health-related SDGs)*. 2018, World Health Organization.

120. Johansson, I. and N. Lynøe, *Medicine & philosophy: A twenty-first century introduction*. 2013: Walter de Gruyter.

121. Hilbert, M., *Big data for development: A review of promises and challenges.* Development Policy Review, 2016. 34(1): p. 135-174.

122. Colombo, S. and E. Pavignani, *Recurrent failings of medical humanitarianism: intractable, ignored, or just exaggerated?* The Lancet, 2017. 390(10109): p. 2314-2324.

123. Daniell, J., B. Khazai, and F. Wenzel, *Uncovering the 2010 Haiti earthquake death toll.* Natural Hazards and Earth System Sciences Discussions, 2013. 1(3): p. 1913-1942.

124. Rivera, R. and W. Rolke, *Estimating the death toll of Hurricane Maria.* Significance, 2018. 15(1): p. 8-9.

125. Porta, M., *A dictionary of epidemiology*. 2014: Oxford university press.

126. Bremer, R., *Policy development in disaster preparedness and management: lessons learned from the January 2001 earthquake in Gujarat, India.* Prehospital and disaster medicine, 2003. 18(4): p. 372-384.

127. Brooks, N., W. Neil Adger, and P. Mick Kelly, *The determinants of vulnerability and adaptive capacity at the national level and the implications for adaptation.* Global environmental change, 2005. 15(2): p. 151-163.

128. Peduzzi, P., et al., *Global risk and vulnerability index trends per year (Gravity).* Phase II: Development, analysis and results, UNDP/BCPR, 2002.

129. Culver, A., R. Rochat, and S.T. Cookson, *Public health implications of complex emergencies and natural disasters.* Conflict and Health, 2017. 11(1): p. 32.

130. Cutter, S.L., *Vulnerability to environmental hazards.* Progress in human geography, 1996. 20: p. 529-539.

131. Médecins Sans Frontières (MSF), *Refugee health.* An Approach to emergency situations, 1997.

132. Heudtlass, P., E. Hosten, and E. Kayouli, *People affected by conflict 2013. Humanitarian needs in numbers.* 2014.

133. Sphere Association, *Humanitarian Charter and Minimum standards in Humanitarian Response*. 2011.

134. Green, H.K., et al., *Challenges with Disaster Mortality Data and Measuring Progress Towards the Implementation of the Sendai Framework.* International Journal of Disaster Risk Science, 2019. 10(4): p. 449-461.

135. Bakkensen, L.A., et al., *Validating resilience and vulnerability indices in the context of natural disasters.* Risk analysis, 2017. 37(5): p. 982-1004.

136. Sveriges Regering, *Strategi för Sveriges humanitära bistånd genom Styrelsen för internationellt utvecklingssamarbete (Sida) 2017-2020*, Utrikesdepartementet, Editor. 2017 - 2020: https://www.regeringen.se.

Errata

Page 34: Table 2: Objectives paper II: To test the usefulness **and assess** the validity… and assess included
Page 36: Paper III: **53** corrected to **55** countries were included
Page 41: **53** countries corrected to **55** countries
Page 67 Reference 95. **U.N.O.f.C.o.H.A.U** corrected to **United Nations Office for Coordination of Humanitarian Assistance (UNOCHA)**
Paper I, Table 1: References streamlined: **Bremer 2003 and UNEP/DEWA/GRID, 2009** referred to as **reference 33 and 27**, as in list of references. Reference numbers put in **numerical order**.

I

PLoS Currents
Rapid Sharing of Research in Progress

Version 1. PLoS Curr. 2015 November 3; 7: ecurrents.dis.8e7fb95c7df19c5a9ba56584d6aa2c59.
Published online 2015 November 3.
doi: 10.1371/currents.dis.8e7fb95c7df19c5a9ba56584d6aa2c59: 10.1371/currents.dis.8e7fb95c7df19c5a9ba56584d6aa2c
Research

PMCID: PMC4648580
PMID: 26635996

Who Is Worst Off? Developing a Severity-scoring Model of Complex Emergency Affected Countries in Order to Ensure Needs Based Funding

Anneli Eriksson,*
Ylva Kristina Ohlsén, Richard Garfield,*
and Johan von Schreeb*

Anneli Eriksson, Public Health Science, Centre for Research on HealthCare in Disasters, Health Systems and Policy Research Group, Karolinska Institutet, Stockholm, Sweden;
Contributor Information.

Abstract

Background: Disasters affect close to 400 million people each year. Complex Emergencies (CE) are a category of disaster that affects nearly half of the 400 million and often last for several years. To support the people affected by CE, humanitarian assistance is provided with the aim of saving lives and alleviating suffering. It is widely agreed that funding for this assistance should be needs-based. However, to date, there is no model or set of indicators that quantify and compare needs from one CE to another. In an effort to support needs-based and transparent funding of humanitarian assistance, the aim of this study is to develop a model that distinguishes between levels of severity among countries affected by CE.

Methods: In this study, severity serves as a predictor for level of need. The study focuses on two components of severity: vulnerability and exposure. In a literature and Internet search we identified indicators that characterize vulnerability and exposure to CE. Among the more than 100 indicators identified, a core set of six was selected in an expert ratings exercise. Selection was made based on indicator availability and their ability to characterize preexisting or underlying vulnerabilities (four indicators) or to quantify exposure to a CE (two indicators). CE from 50 countries were then scored using a 3-tiered score (Low-Moderate, High, Critical).

Results: The developed model builds on the logic of the Utstein template. It scores severity based on the readily available value of four vulnerability and four exposure indicators. These are 1) GNI per capita, PPP, 2) Under-five mortality rate, per 1 000 live births, 3) Adult literacy rate, % of people ages 15 and above, 4) Underweight, % of population under 5 years, and 5) number of persons and proportion of population affected, and 6) number of uprooted persons and proportion of population uprooted.

Conclusion: The model can be used to derive support for transparent, needs-based funding of humanitarian assistance. Further research is needed to determine its validity, the robustness of indicators and to what extent levels of scoring relate to CE outcome.

Background

A disaster is as an event that overwhelms local capacity, necessitating national or international assistance [1]. According to CRED, an estimated 400 million people annually are affected by disasters, of which over 170 million are affected by conflicts [2, 3, 4]. The Utstein template categorizes disasters based on the type of risk and hazard causing them [5]. There are natural, manmade and mixed disasters. Complex emergencies (CE) are a manmade disaster, defined as a situation where civilian mortality due to direct or indirect causes of conflict has increased significantly [6]. Disasters overwhelm existing capacities and require relief in the form of humanitarian assistance. The objective of humanitarian assistance is to save lives, alleviate suffering, and maintain human dignity [7]. In 2013, at least 22 billion USD worth of humanitarian assistance was globally made available to assist disaster affected populations [8]. Two thirds of this sum was from governmental donors and mainly allocated to CE [8]. Donors have long agreed that funding for humanitarian assistance should be allocated according to, and in proportion to, needs [7, 9].

However, there is no commonly accepted definition of "need". Maslow's pyramid categorizes human needs in a hierarchy, where the physical needs to achieve survival are the base, followed by safety, social needs, esteem and self-actualization at the top [10]. In development and humanitarian aid, the concept of *basic needs* has been developed, mainly referring to basic services required for a community, including food, shelter, and clothing for the individual. A donor often receives plentiful information on these aspects of need in requests for funding [9, 11]. Still, studies have documented the lack of a systematic approach to defining the relative importance and proportion of needs between disasters as a basis for funding [12, 13]. A main challenge for needs-based funding is the lack of commonly accepted indicators that define and quantify needs. A recent study highlighted the urgent need for defined, specific and well-accepted indicators and a system to determine the severity of crises and allow comparisons between disaster-affected countries [13].

Existing frameworks, such as ECHO's Global Needs Assessment (GNA), the Inform index for risk management, and ACAPs Global Emergency Overview (GEO), typically rate CE countries in the "worst off" category, underlining the need for humanitarian assistance in these countries [14, 15, 16]. However, while these initiatives allow for a broad comparison between the worst off countries, they do not distinguish between the levels, severity, and magnitude of need among the countries. UNOCHA's Global Focus Model (GFM) focuses on risk, but is not specifically designed to inform about the intensity or severity of an on-going CE [17]. Bayram et al. propose an assessment tool for CE, based on scoring of a limited number of indicators, but the tool is based on data from sudden onset disasters, not CE, and several of the indicators are not readily available. Thus the tool has limited value in supporting needs-based funding decisions [18].

Therefore, the basis of this study is the apparent need for a practical tool to assess severity and levels of need in CE affected countries. The aim is to develop a severity scoring model, built on well-defined and readily available indicators, that can facilitate decision making for needs-based allocation of humanitarian assistance funding.

Materials and Methods

Study assumptions and preconditions

Severity is a predictor of level of need. The level of severity is dependant on vulnerability and exposure [5]. A limited number of recognized and readily available indicators can be used to characterize and quantify vulnerability and exposure. Textbox 1 describes the Utstein template and defines the components and other terms that capture disaster severity.

A practical scoring model was defined as one that a) can be populated with data within a few hours, b) uses indicators that are readily available, and c) provides a numerical result.

Process

The following process was laid out: 1) a two-step Internet and document search, 2) the extraction, listing and ranking of indicators, 3) outlining a preliminary model based on the Utstein template logic, 4) modification in line with the model's precondition of easy to use, and population of the final model with the selected indicators, and 5) definition of cut-off levels for the indicators.

1) To generate a list of well defined, commonly used vulnerability indicators that were defined and assessed in the scientific literature, an Internet search was done using the EBSCO database, which includes preMEDLINE and MEDLINE and Google scholar, without any time limit. Searches were limited to English using the search words: Disaster(s), Emergency(ies), Vulnerability, Index, and Indicator(s) in different combinations.

To assess the use and availability of vulnerability and severity indicators in Consolidated Appeals (CAP) (United Nations proposals for humanitarian funding), documents from 2010 and 2012 [19, 20] were searched, using the same criteria as in the Internet search.

The first step of the Internet and document search was to identify vulnerability indicators that fit the search criteria and the purpose of the study. In the second step, 27 CAP documents were searched, and shortlist was made of the indicators that were used in more than one third of the documents.

2) The indicators from the two-step search were compiled and ranked according to: relevance and relation to best practices or evidence; timeliness; and availability.

The indicators were ranked from 1 – 3 for each area above, which gave a possible score range of 3 to 9 points for each indicator. To calculate the rank for best available practice, three points were given to indicators that were suggested in at least three individual articles from the literature search and used in at least three of the searched indexes (see table 1). Two points were scored to indicators suggested in at least two articles and used in two indexes while one point was given to indicators that were suggested in less than two articles. To calculate the rank for timeliness, three points were given to indicators likely to be updated when a context changes, or updated more frequently than annually. Two points were allocated to indicators that normally are updated annually and one point for less frequent updates. Ranking of availability or likelihood of availability was done by scoring three point for indicators found in more than one third of the CAP appeals searched and indicator and in World Bank statistics data base, two points if the indicator was found in one of two above and one point if the indicators were unavailable in both.

Vulnerability and exposure indicators were selected based on ranking. In our selection we also aimed for a variation between different fields (i.e. economics, health, education, and so on) rather than selecting indicators from the same field even if they ranked highly.

3) A preliminary model based on the Utstein template logic was outlined and populated with the indicators selected in step 2 (Textbox 1).

4) To adjust the model to its practical purpose, it was tested and modified so that it should be possible to assess and compare severity within a few hours, use readily available indicators, and provide a numerical result. The final model had two categories: vulnerability and exposure. Based on their relative importance, four indicators for vulnerability and four for exposure were selected.

5) Distinguishing levels of severity

To allow comparison and to distinguish the level of severity between CE countries, we set a three-tiered scoring system for the value of each indicator: Low-Moderate, High, and Critical. The scoring values of the vulnerability indicators were built on values from approximately 50 countries with a low development index (a value of less than 0,5 by the UNDP), while exposure values used data from the 15 CAPs for 2012.

Results

Part one of the results section shows the process leading up to the selection of indicators. Part two shows the completed model.

Part one

The results of the two-step Internet and document search are presented in Tables 1 and 2. A total of 19 single indicators were identified as valid in relation to vulnerability; 17 of them were used in vulnerability and development indexes. In addition, 3 of them also primarily indicated exposure. We found 14 indicators and one index (HDI) that were used for at least 9 countries in the 2010 and 2012 UN CAP documents. The tables display the indicators per sector. Eight indicators were the same or similar in the two searches. These are highlighted in bold, in Table 2.

Table 3 ranks the 25 indicators. While some ranked high as relevant in relation to best practices or recognized evidence, the timeliness and availability were rated low. For instance, this was the case for excess mortality and crude mortality rates per 10 000 people per day.

Part two

The final model consists of the formula Disaster severity = f (Vulnerability) (Exposure)

This is a simplification of the Utstein model. For a detailed description of how the model was simplified, see ANNEX I.

Of the top ranked indicators in Table 3, six were selected for the model. The selected vulnerability indicators were: 1) GNI per capita, 2) PPP Under-five mortality rate, per 1000 live births, 3) adult literacy rate, % of people ages 15 and above, and 4) underweight, % of population under 5 years.

The selected exposure indicators were: 5) total number of affected people, also as proportion of the total population, and 6) total number of uprooted people, also as proportion of the total population.

These indicators met the inclusion criteria and provide information on differing aspects of vulnerability and severity. ANNEX II has definitions of the indicators. Tables 4 and 5 illustrate the the scoring of the indicators. It should be noted that scoring Low-Medium does not indicate an acceptable situation, but that the country scored less poorly than those scoring High or Critical.

Finally, the model was populated with the proposed indicators an suggested scoring levels.

Discussion

To our knowledge, this is the first model that compares severity and needs between complex emergency affected countries in a systematic and transparent way. It provides an objective tool, based on accepted and available indicators, that can support needs-based funding decisions for humanitarian assistance. However, it should be noted that this type of support tool, based on quantitative indicators, cannot replace the analytical work being done by competent staff at humanitarian funding agencies. We are aware of the ethical challenge of putting numbers on human suffering and scoring the severity of already poor and conflict-affected countries. Nevertheless, a needs-based funding policy must be accompanied by a transparent account of the basis on which funding decisions are made.

This study has several limitations. It is based on the assumption that needs and level of severity are interchangeable. A small group of experts, who were also the authors, selected the indicators and developed the model. However, the experts, who all have experience with CE, needs assessments, and academia, have explained in detail the process of selection for the indicators and priorities.

The main challenge for this model has been how to balance pragmatism with robust scientific methods. It was important to develop a model that could be used easily, rather than a complex model that may have strong theoretical validity, but lack practical feasibility. The challenge was to get a balance between what we would have liked to have and what is feasible to get. We have carefully developed a model that balances optimal ignorance and appropriate imprecision with the increasing opportunistic costs of being more precise. Another limitation is that the model assumes that the values of the indicator are based on reliable data. Nevertheless, the indicators are the "best available" and are what pledges and allocations are built on. We also removed aspects of the original Utstein template that did not have a reliable numeric indicator. These non-quantifiable aspects should be included in the qualitative analytical work done by donors before they decide on what country is more in need. Even with a general consensus that funding should be needs-based, we assume that political aspects are taken into consideration when funding decisions are made. Our model does not cover these aspects, but could be used as a objective and transparent tool to balance this.

The suggested model will need testing and validation to show its value. In forthcoming work, we explore the relevance of the model in defining severity and needs by applying it to ongoing CE, as well as on historical CE data. We welcome colleagues to comment and provide input to improve the model. We are convinced that a solid and accepted model that enables donors to direct funding to those most in need has the potential to improve humanitarian assistance, save lives and alleviate suffering.

ANNEX 1 Development of Conceptual models for severity scoring of complex emergencies

ANNEX 2 Indicators, their meaning and relevance

Competing Interests

The authors have declared that no competing interests exists.

Biographies

• Anneli Eriksson is a registered nurse specialized in anesthesia care, with a master in international health. She presently works as project leader at Karolinska Institutet with a research team focusing on health-care needs related to disasters. In 1995 Anneli started to work with Medecins Sans Frontieres (MSF) and has since then had several positions in field-missions and at office level.

• Team Lead, ERRB US Centers for Disease Control and Prevention and Professor Emeritus, Columbia University

• MD. PhD. Associate professor, Specialist in general surgery Centre for reserach on health care in disasters Department of Public Health Karolinska Institutet Stockholm, Sweden

Funding Statement

This study was funded with a grant from the Swedish International Development Cooperation Agency (Sida) and a grant from The Swedish National board of health and welfare. The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Contributor Information

Anneli Eriksson, Public Health Science, Centre for Research on HealthCare in Disasters, Health Systems and Policy Research Group, Karolinska Institutet, Stockholm, Sweden.

Ylva Kristina Ohlsén, Technology and Health, Red Cross University College, Stockholm, Sweden.

Richard Garfield, ERRB, Centers for Disease Control, Atlanta, Georgia, USA.

Johan von Schreeb, Department of Public Health Sciences, Health System and Policy, Karolinska Institute, Stockholm, Sweden.

References

1. UNISDR. Terminology. 2009 UNISDR terminology on disaster risk reduction2009.

2. Guha-Sapir; D, Hoyois; P, Below R. Annual Disaster Statistical Review 2014: The Numbers and Trends. Brussels: CRED; 2015.". 2015.

3. Heudtlass P, Hosten E, Kayouli E. People affected by conflict 2013. Humanitarian needs in numbers. 2014.

4. Guha-Sapir D, Hoyois P, Below R. Annual Disaster Statistical Review 2013 – The numbers and trends. Centre for Research on the Epidemiology of Disasters (CRED) Institute of Health and Society (IRSS), Université catholique de Louvain – Brussels, Belgium, 2014.

5. Sundnes KO, Birnbaum ML. Health disaster management: Guidelines for evaluation and research in the Utstein style: Prehospital and Disaster Medicine; 2003. [PubMed: 10558317]

6. Salama P, Spiegel P, Talley L, Waldman R. Lessons learned from complex emergencies over past decade. The Lancet. 2004;364(9447):1801-13. [PubMed: 15541455]

7. GHD. Principles and practice of good humanitarian donorship [web page]. 2003 [cited 2014 April 25]. Available from: http://www.goodhumanitariandonorship.org.

8. Development-Initiatives. Global HUmanitarian Assistance report (GHA) 2014. Development Studies - Global Humanitarian Assistance Programme, 2014.

9. Darcy J, Hoffman C. According to need? Needs assessmentand decision-making in the humanitarian sector. HPG - Odi. 2003(15).

10. Maslow AH. A theory of human motivation. Psychological review. 1943;50(4):370.

11. Sphere-Project. Humanitarian Charter and Minimum standards in Humanitarian Response 2011.

12. von Schreeb J, Unge C, Brittain-Long R, Rosling H. Are donor allocations for humanitarian health assistance based on needs assessment data? Global Public Health. 2008;3(4):440-7.

13. Olin E, von Schreeb J. Funding Based on Needs? A Study on the Use of Needs Assessment Data by a Major Humanitarian Health Assistance Donor in its Decisions to Allocate Funds. PLoS currents. 2014;6. [PMCID: PMC4032382] [PubMed: 24894417]

14. ACAPS. Global Emergency Overview, GEO, launched 2012 2012 [cited 2015]. Available from: http://geo.acaps.org.

15. ECHO. Global Vulnerability and Crisis Assessment (GNA) 2014 [cited 2014]. Available from: http://ec.europa.eu/echo/files/policies/strategy/gna_fca_2013_2014_map.pdf.

16. IASC-EC. infoRM: Inter-Agency Standing Committee and the European Commission.; 2015 [2015 06 09]. Available from: http://www.inform-index.org.

17. UNOCHA. 2013 Global Focus Model. 2013.

18. Bayram JD, Kysia R, Kirsch TD. Disaster metrics: a proposed quantitative assessment tool in complex humanitarian emergencies-the Public Health Impact Severity Scale (PHISS). PLoS currents. 2012;4. [PMCID: PMC3441152] [PubMed: 22984643]

19. UNOCHA. Concolidated Appeal Process 2012 [cited 2014 2014 11 25]. Available from: http://www.unocha.org/cap/appeals/by-year/results.

20. UNOCHA. Consolidated Appeal Process 2010 [cited 2014 2014 11 25]. Available from: http://www.unocha.org/cap/appeals/by-year/results.

21. Garfield R. Measuring humanitarian emergencies. Disaster medicine and public health preparedness. 2007;1(2):110. [PubMed: 18388638]

22. Brooks N, Neil Adger W, Mick Kelly P. The determinants of vulnerability and adaptive capacity at the national level and the implications for adaptation. Global environmental change. 2005;15(2):151-63.

23. Pelling M, Maskrey A, Ruiz P, Hall L, Peduzzi P, Dao Q-H, et al. Reducing disaster risk: a challenge for development. 2004.

24. Schneiderbauer S. Risk and vulnerability to natural disasters–from broad view to focused perspective. FU Berlin, digital dissertation Available at< www diss fu-berlin de/2007/498/indexe html# information> (accessed March 2008). 2007.

25. Peduzzi P, Dao Q-H, Herold C, Mouton F. Global Risk And Vulnerability Index Trends per Year (GRAVITY) Phase III: Drought analysis. 2003.

26. Peduzzi P, Dao H, Herold C, Mouton F. Assessing global exposure and vulnerability towards natural hazards: the Disaster Risk Index. Natural Hazards and Earth System Science. 2009;9(4):1149-59.

27. UNEP/DEWA/GRID. 2009. Available from: http://www.unep.org/

28. Peduzzi P, Dao H, Herold C, Mouton F. Global risk and vulnerability index trends per year (GRAVITY). Phase II: Development, analysis and results, UNDP/BCPR. 2002.

29. Cardona OD. Indicators of Disaster Risk and Risk Management: Program for Latin America and the Caribbean: Summary Report. Inter-American Development Bank, 2005.

30. Peduzzi P, Chatenoux B, Dao Q-H, De Bono A, Deichmann U, Giuliani G, et al. The global risk analysis for the 2009 global assessment report on disaster risk reduction. 2010.

31. Dao Q-H, Peduzzi P. Global evaluation of human risk and vulnerability to natural hazards. 2004.

32. World-Health-Organization. World health statistics 2007: World Health Organization; 2007.

33. Bremer R. Policy development in disaster preparedness and management: lessons learned from the January 2001 earthquake in Gujarat, India. Prehospital and disaster medicine. 2003;18(04):372-84. [PubMed: 15310051]

34. Esrey SA, Habicht J-P. Epidemiologic evidence for health benefits from improved water and sanitation in developing countries. Epidemiologic reviews. 1986;8:117-28. [PubMed: 3533581]

35. Bollin C, Hidajat R, Birkmann J. Community-based risk index: Pilot implementation in Indonesia. Measuring vulnerability to natural hazards: Towards disaster resilient societies. 2006:271-89.

36. SMART. Standardized Monitoring and Assessment of Relief and Transition, Measuring Mortality, Nutritional Status, and Food Security in Crisis Situations: SMART methodology 2006.

37. Spiegel PB, Burkle FM, Jr., Dey CC, Salama P. Developing public health indicators in complex emergency response. Prehospital and disaster medicine. 2001;16(4):281-5. [PubMed: 12094787]

38. Toole M, Steketee RW, Waldman RJ, Nieburg P. Measles prevention and control in emergency settings. Bulletin of the World Health Organization. 1989;67(4):381. [PMCID: PMC2491262] [PubMed: 2805216]

39. Young H, Jaspars S. Review of Nutrition and Mortality Indicators for the IPC. 2009.

40. Cutter SL, Boruff BJ, Shirley WL. Social vulnerability to environmental hazards*. Social science quarterly. 2003;84(2):242-61.

Figures and Tables

The published figures and tables were removed from the article and re-inserted in their original format, due to formatting errors in the published article. No alterations were made.

Textbox 1. Model and concepts

The Utstein Template defines damage as a product of risk, hazard and vulnerability in the following way:

Damage (probability) = *f* (Probability of hazard (Risk))(Hazard) (Vulnerability) [5].

In the literature terms such exposure and coping, are also used to describe and capture severity. Our model builds on these terms using the following definitions and highlighting their limitations

A *hazard* is a dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage [1]. Measures of hazard vary widely, focusing mainly on their validity [5, 9].

Vulnerability is characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard [1].

Coping can be interpreted as the contrast to vulnerability and defined as the ability of people or a society to use resources and skills to mitigate adverse conditions [1]. Coping can thus be interpreted as defining the level of vulnerability. Coping is **not** part of the Utstein model.

Severity or Damage is the negative result of the impact of a hazard on the population and environment. In this document the term severity will be used to describe the degree of damage. Damage may manifest in multiple ways and forms. The degree of damage produced by the hazard is dependent on the vulnerability and the population that is exposed to the specific hazard [5].

Risk is the probability that a hazard will occur [5], or in combination with the damage the hazard likely will bring [1].

Exposure is defined by UNISDR (2009) as the people, property, systems, or other elements present in hazard zones that are thereby subject to potential losses. Number of people affected, number displaced and magnitude of mortality are recognised proxy indicators for exposure [21].

Textbox 2. Recognised and readily available indicators

We define a recognised and readily available indicator in the following way:

A recognized indicator is referred to in literature and used as an indicator by known databases. The indicator should also be recognised as expression of vulnerability or exposure. Readily available, means that an indicator can be found easily: on recognized databases and in humanitarian reports, such as the UN consolidated appeals.

It also means that the indicator is updated on a regular basis, at least once per year, or is seen as time-resistant, in such a way that significant changes usually take several year

Table 1: Seventeen single indicators identified as valid in relation to vulnerability.

Category	Used in	Indicator	Correlation with disaster mortality found by	Suggested by
Economic	Global Needs Assessment (GNA), Human Development Index (HDI), Disaster Risk Index (DRI), Global Focus Model (GFM)	GNI per capita at PPP	(21) (22) (23) (24) (25)	(21-23) (26, 27)
Environmental	Prevalent Vulnerability Index (PVI), GFM	Arable land	(22) (24, 25, 27)	(22 – 24) (28)
Political		Voice and accountability	(21, 29)	(21)
Population	PVI	Rural population growth rate	(22, 29)	
	PVI	Urban population growth rate	(22, 24, 25) (27, 29,30)	(22 -24) (27, 28)
	PVI	Population density	(24, 27)	(22 -24) (27, 28)
Health	GNA, HDI, GFM	Life expectancy at birth	(21)	(21 - 24) (27) (31, 32)

Category	Used in	Indicator	Correlation with disaster mortality found by	Suggested by
	HDI, Household Vulnerability Index (HVI), GFM	Improved water source, Access to improved Water	(24) (30)	(21 - 24) (27) (31, 33, 34)
	HDI, HVI, GFM	Access to improved sanitation	(21)	(21, 24, 27, 33)
	GNA, GFM	Child mortality rate, U-5		(22, 24) (33,35)
	Sphere project	Crude mortality per 10 000/day	(5) (17, 20).	(5) (17, 20)
		Excess mortality	(17, 20)	(17, 20).
	GNA	Vaccination coverage (measles)	(36, 37)	(33)
	GNA, Gender Inequality Index (GII), HDI, GFM	Maternal mortality per 100 000	(21)	(21) (33)
	GNA, DRI, HDI, GFM	Prevalence HIV/AIDS, TB, malaria		(21, 23)
	GNA, GFM	Malnutrition weight for age		(23) (38)
		Calorie intake per capita	(21)	(21)
Education	HDI, GNA, GFM	Literacy rate (>14yrs) F/M	(21)	(21 - 24) (26) (33)(39)

Category	Used in	Indicator	Correlation with disaster mortality found by	Suggested by
Population	GNA, GFM	Uprooted people (Internally Displaced – IDP +refugees)		(21) (23)

Table 2. Indicators used to capture the situation for at least nine countries of the 2010 and 2012 UN Consolidated Appeal documents

Sector	Indicator	Source
Economic status	**Gross domestic product per capita (PPP $) or GNI per capita**	UNDP, HDR, ssnbs***
	Percentage of population below income poverty line PPP $1.25/per/day or 1 dollar/pp/day	UNDP/HDR, National survey, ssnbs
Health	**Life expectancy at birth (in some divided in Female and Male)**	UNDP/HDI, INS forecast, SSDP ****, MoH, WHO
	Number of health workforce (MD+nurse+midwife) per 10,000 population	MSP, WHO, MIS CIV
	Measles vaccination rate (12-23 months) or up to 15 years.	SSDP, MICsIV
	Under Five mortality (U5M)	Unicef, MICS, ED-SIV,Child Info Côte d'Ivoire Country Profile, SSDP, MoH, MMS, Nat survey, WB
	Maternal mortality	Unicef, WHO, UNFPA, WB, EDS-IV**, DIPE, national household survey, MoH, ZMIPS
Food Security	Number of people in food and acute livelihood crisis	IPC, ESASU, In-depth food security survey
Water, sanitation and hygiene (WASH)	**Percentage of population with/without access to protected water sources**	UNDP/HDR, n.a, MICS, Wash sector update, Unicef, FSNAU/SWALIM
Refugees/Displaced	**Number Refugees, in-country and abroad, number of displaced**	UNHCR, OCHA, MoH, Unicef, CAPMYR
Nutrition	Percentage of acute malnutrition among (6-59 months) GAM	Recent surveys (by Unicef, ACF, MSF), MIC, National nutrition surveys, SMART survey, SSDP MoPH , NNS
	Percentage of sever acute malnutrition (6-59 months)) SAM	MIC, SMART survey, SSDP, MoPH
Education	**Literacy Rate adult.**	DHS,IFPRI, MDG/UN, SSDP, UNESCO, MoEducation, MIC, WHO, UNDP
Reference indicators	HDI (an index)	UNDP/HDI

Sector	Indicator	Source
General	Number of people affected	Estimate within document
***Enquête Démographique et de Santé -IV - 2010 Burkina Faso*		
**** South Sudan National Bureau of Statistics, http://ssnbs.org/,*		
***** South Sudan Development Plan*		

Table 3. Ranking of indicators for vulnerability and exposure, if indicated

Indicator	Sum of ranking*
Uprooted people (Internally Displaced +refugees) (exposure and vulnerability)	8
Affected people (exposure)	8
GNI per capita at PPP	7
Child mortality rate, U-5	7
Vaccination coverage (measles)	7
Malnutrition weight for age	7
Number of people in food and acute livelihood crisis	7
Literacy rate (>14yrs) F/M	6
Percentage of population below income poverty line PPP $1.25/per/day or 1 dollar/pp/day	6
Improved water source, access	6
Improved sanitation, access	6
Number of health workforce (MD+ nurse+ midwife) per 10,000 population	6
Prevalence HIV/AIDS, TB, malaria	6
Percentage of acute malnutrition among (6-59 months) GAM	6
Percentage of sever acute malnutrition (6-59 months) SAM	5
Population density	5
Arable land	5
Rural population growth rate	5
Urban population growth rate	5
Life expectancy at birth	5
Calorie intake per capita	5
Maternal mortality per 100 000	5
Excess mortality (exposure)	5
Increase of Crude Mortality above emergency thresholds (exposure)	5
Voice and accountability	3
***** Each indicator was ranked per a) relevance and relation to best practices b) timeliness c) likelihood of availability. Each area was given between 1 and 3 points, giving the highest possible score of 9 and lowest 3.***	

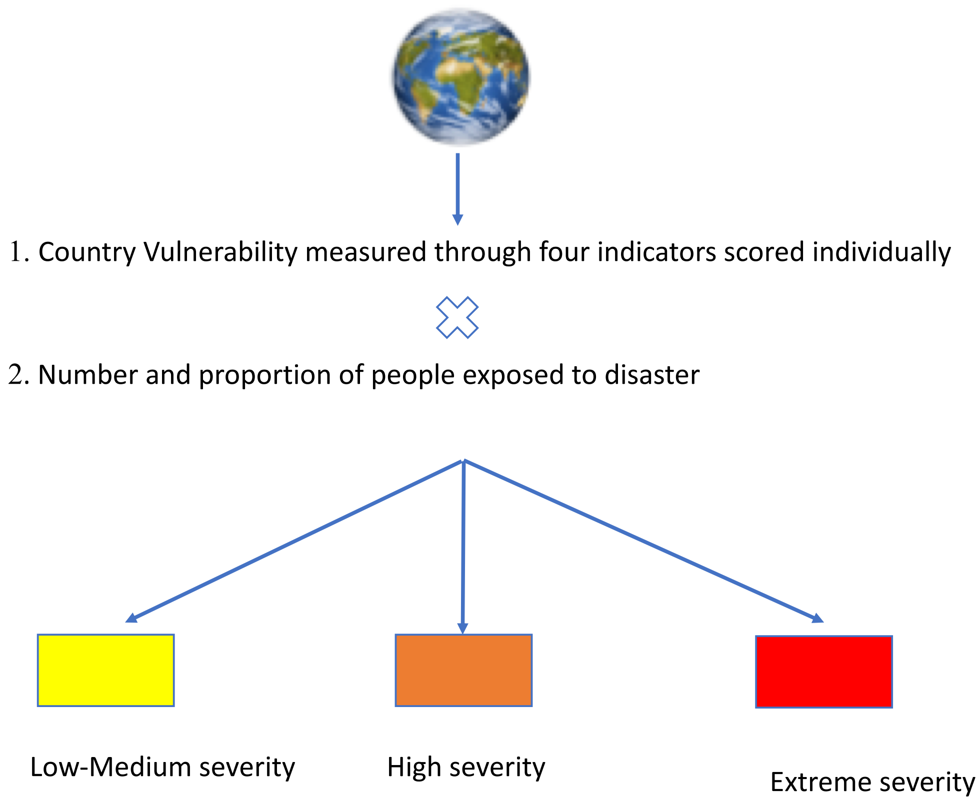


Figure 1. Illustration of the model

Table 4. Scoring of the vulnerability indicators

Indicator for Vulnerability	Low-Medium	High	Extreme
GNI per inhabitant on PPP	> 1960	1110-1960	< 1110
Mortality rate, U5/ 1000 live	< 75	75-110	> 111
Literacy adult % (over 14y)	> 70	56-69	< 55
Underweight: (weight for age) % pop U5	< 15	16-30	> 30

Table 5. Scoring of indicators for exposure

Indicators for Exposure	Low-Medium	High	Extreme
Nb uprooted in million	< 0.6	0.6 - 1	> 1
Proportion uprooted % of total population	< 4%	4 % - 6%	> 6 %
Nb affected, in million	< 2.6	2.6 - 4	> 4
Proportion affected: % of total population	< 18%	18% - 33%	> 33%

The scoring builds on information for 15 CAP countries presented in the 2012 overview.

1. Country Vulnerability measured through four indicators scored individually

Indicator for Vulnerability	Low-Medium	High	Extreme
GNI per inhabitant on PPP	> 1960	1110-1960	< 1110
Mortality rate, U5/ 1000 live	< 75	75-110	> 111
Literacy adult % (over 14y)	> 70	56-69	< 55
Underweight: (weight for age) % pop U5	< 15	16-30	> 30

2. Number and proportion of people exposed to disaster

Indicators for Exposure	Low-Medium	High	Extreme
Nb uprooted in million	< 0.6	0.6 - 1	> 1
Proportion uprooted % of total population	< 4%	4 % - 6%	> 6 %
Nb affected, in million	< 2.6	2.6 - 4	> 4
Proportion affected: % of total population	< 18%	18% - 33%	> 33%

Low-Medium severity

High severity

Extreme severity

ANNEX 1. Development of Conceptual models for severity scoring of complex emergencies

The Utstein model is used to predict how serious a disaster might become.

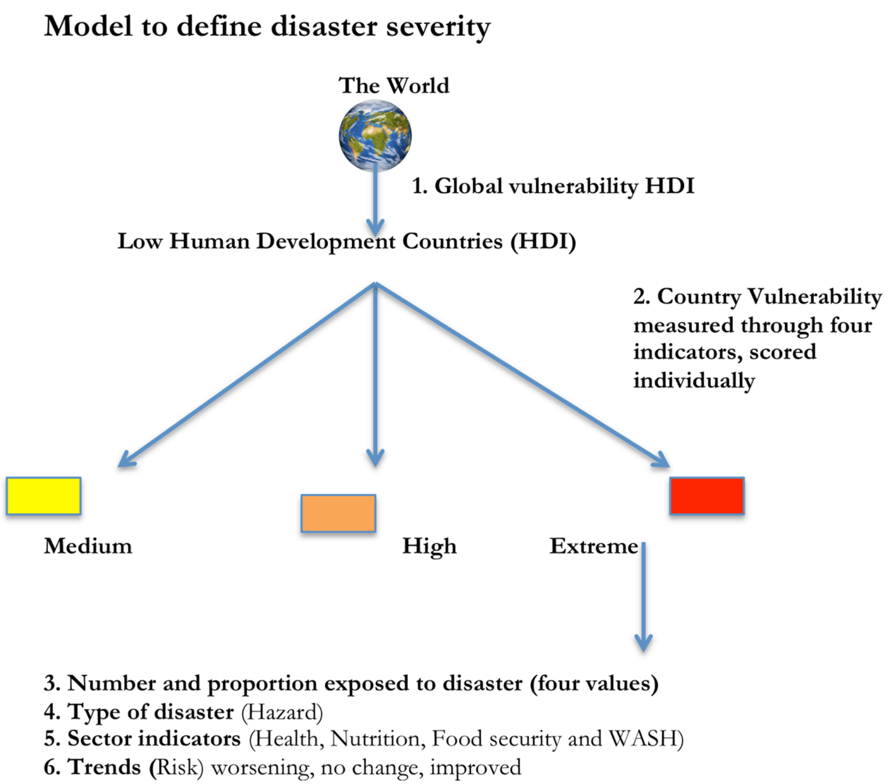
Damage (probability) = f (Probability of hazard = Risk)(Hazard) (Vulnerability)

In the study we set out to adapt the model to fit with our aim; to develop a model, building on well-defined and readily available indicators, that distinguish levels of severity between countries affected by complex emergencies (CE).

As we focus on already ongoing disasters, the risk will instead be linked to the trend – is the situation getting worse or better? Initially we therefore exchanged the risk with trend. To capture severity of an ongoing disaster – the level of exposure is an important part. Our initial adaptation of the Utsteintemplate therefor had the following concepts:

Disaster severity - damage =f (Hazard) (Exposure)(Trend - risk) (Vulnerability (global) (country)(sector vulnerability))

The model was illustrated in the following way:



In further discussions, in the research group, the different categories, their relevance, possibility to measure and the availability of indicators in the model was reviewed. The aim was to simplify the model in order to enable use and interpretation, yet maintaining the Utstein logic. The following changes were made.

1. Global Vulnerability - Human Development Index: while this is a recognized index used in many frameworks and suggested as a way to measure vulnerability, it builds on several of the single indicators that are suggested in the next category. It was therefor seen as a double measure of vulnerability and thus not bringing more information to the model. HDI is also not available for all the countries to which the model was to be applied. **Global Vulnerability - HDI as a category was therefor removed from the model**. The HDI is used as a way to score the indicators in category two, using the values from the individual indicators among the countries with a low HDI.
2. ***The country vulnerability indicators are kept in the model.***
3. ***The exposure indicators are kept in the model***
4. Type of disaster (Hazard): while the type of disaster is a very important aspects for assessing severity, there are no known indicators available to measure whether one type of disaster is more serious than another. The model is developed for complex emergencies, which is a broad type of disaster in itself. Instead of trying to **score different type of hazards, - disasters it was removed as a category in the model** – keeping in mind that context and the type of disaster has to complement the analysis of any disaster situation.
5. Sector indicators: The original model included four sectors with two indicators per sector. The intention was to get a quick answer to what sectors were most in need of support. While this category gives interesting information, it was deemed as insufficient, as it doesn't include all sectors relevant for humanitarian funding. The indicators also give a broad country overview, while this category would benefit from a more specific analysis. **The sector vulnerability category was removed from the model** - suggesting that when disaster severity is measured, an analysis of needs per sector will have to be added in order for a donor to fund relevant sectors.

6. Trend (risk). The intention with the category was to capture the risk of a worsening situation. Yet, we could not find an indicator that predicted how the situation would develop. We assessed the relevance of using databases, such as INFORM or GNA. Inform shows the trend of risk for disasters over a three-year period and naturally gives a general high risk to all countries with an ongoing CE, which makes it less useful as an indicator in our model. GNA can be compared from one year to another. GNA gives an estimation of the development of the situation until present but falls short of predicting the future. **The trend – risk category was removed**. This again will have to be taken into account in an analysis of the context.

The final model thus remains with only two main categories:

Disaster severity – damage= f (Vulnerability) (Exposure)

This is illustrated in figure 1 in the article.

ANNEX 2: Indicators, their meaning and relevance

1. Country Vulnerability					
Indicator	*Measurement*	*Meaning*	*Relevance*	*Source:*	*Link*
GNI per capita, PPP	Gross National Income per capita based on purchasing power parity	Helps to show the economic strength of the citizens of a country, as it is the value produced by all the citizens within a country. Comprises the total value of all goods and services produced in a country, together with the income that nationals have earned abroad per year. Calculated measuring the relative purchasing power of different countries currencies over the same types of goods and services, despite differential rates of inflation.	• An important determinant of vulnerability. • Correlation of levels of income per capita and the eruption of CHEs. • Several countries with a history of CHE, show pre-ceding years of slow or negative economic deterioration. • The least developed countries have been the most vulnerable. High rates of poverty outside the elite governing group are seen in almost all cases of CHE[1] • Suggested by several assessment initiatives *(1) (2) (3) (4) (5) (6) (7)*	World Bank data base	http://data.worldbank.org Annual updates

[1] (UNU/WIDER, 1997; UNU/WIDER, Klugman, 1999).

1. Country Vulnerability					
Indicator	*Measurement*	*Meaning*	*Relevance*	*Source*	*Link*
Under five Mortality rate (U5MR)	The probability of dying between birth and exactly five years of age, per 1000 live births, if subject to current age-specific mortality rates .	Measures child survival and is also called child mortality Mortality rates are often used to identify vulnerable populations. The indicator is said to reflect not only the level of child health, such as childhood diseases but also food shortages and the overall development in countries	• Considered as one of the most basic and critical health indicators and useful to identify needs • Captures more than 90% of global mortality among children under the age of 18. • Changes in child mortality are used to indicate the health impact of disaster. • Child mortality rates is especially high among internally displaced people (IDP) • Rates worsens in countries affected by CHE • U5MR is one of the UN 48 MDG indicators and also a MICS indicator • Suggested as a prioritized indicator (literature and assessment tools) *(8) (2) (9) (3) (10) (11) (12)*	World Bank WHO	http://data.worldbank.org http://www.who.int/gho/publications/world_health_statistics/en/ Annual updates

1. Country Vulnerability

Indicator	*Measurement*	*Meaning*	*Relevance*	*Source*	*Link*
Adult literacy rate	Adult literacy rate, % of people ages above 14	*The number of literate persons aged 15 and above, expressed as a percentage of the total population in that age group (UNESCO 2006).* Includes those who can both read and write with understanding a short simple statement on his/her everyday life, as well as have simple arithmetic skills. Adult literacy rate reflects the effectiveness of the educational system in a country The indicator is often seen as a proxy measure of social, economical and political development and is considered critical for improving the capacity of people.	• Strong relationship with mortality associated with humanitarian emergencies • Important vulnerability indicator. • CEs protracted crisis situations have often lead to stagnated or reduced education due to damaged school buildings, lack of teachers and safe access for students or due to uprooted populations • Adult literacy rate - a stable long term measure and less sensitive to change as youth literacy rates that may change more quickly and therefore needs to be measured more often. • *(3, 13) (14)(Bremer 2003) (5) (4, 15)*	World Bank WHO	http://data.worldbank.org http://www.who.int/gho/publications/world_health_statistics/en/ Updates infrequent, oldest data from 2005

1. Country Vulnerability					
Indicator	*Measurement*	*Meaning*	*Relevance*	*Source*	*Link*
Underweight among under- five year olds.	Weight-For-Age (WFA), % of population under five years	The proportion of children under five years old whose weight for age is less than minus two standard deviations of an international reference group. Below minus three standard deviations from median WFA, is called severe underweight A composite index, including both acute and chronic malnutrition The indicator could possibly be changed to measuring chronic malnutrition height/age if this becomes a standard measure with regular updates.	• A key public health indicator and • Linked to poverty, low levels of education, poor access to health services and food insecurity • Often used to identify vulnerable populations. • CEs and protracted crisis and slow onset disasters such as drought situation are major causes of acute hunger • One of the UN 48 MDG indicator, also a MICS indicator • Suggested as priority vulnerability indicator *(16) (17, 18) (18, 19) (5) (20) (11) (12)*	World Bank data base	http://data.worldbank.org/indicator, http://www.who.int/gho/publications/world_health_statistics/en/ Irregular updates, data from 2005-2011, majority of countries

2. Exposure to disaster					
Indicator	*Measurement*	*Meaning*	*Relevance*	*Source*	*Link*
Uprooted	The indicator incorporates the number of refugees, internally displaced people (IDP) and returnees, expressed in number and as a percentage of the total population.	A refugee is a person who is outside the country of origin unwillingly or is unable to return due to persecution, war, or violence. IDPs, internally displaced persons have left their homes but remain in their country of origin. Returnees are refugees and IDPs who return to their home country.	• Uprooted (especially IDPs,) are among the most vulnerable people in a humanitarian crisis • Consequence of CEs. • The higher the number of uprooted, the more severe humanitarian crisis • Both a vulnerability indicator and indicator of severity • *Uprooted* is used in the ECHO-index Global Needs Assessment (GNA). *(4); (5) (21) (22)*	UNHCR For oPT: UNRWA CAPs and other forms of flash appeals.	http://www.unhcr.org http://www.unrwa.org/etemplate.php?id=253 Annual updates. In crisis situation with displacement the figures are updated more frequently. http://www.unocha.org/cap

3. Exposure to disaster					
Indicator	*Measurement*	*Meaning*	*Relevance*	*Source*	*Link*
Affected	Number affected by a crisis or per sector Proportion of population affected Number/total country population	Affected are people who are adversely affected by a crisis or a disaster and who are in need of urgent humanitarian assistance.	• Important for capturing the severity and the magnitude of humanitarian need • Enables comparisons of the level and source of needs in and between countries • Used in the Global Emergency Overview (GEO), presented on a weekly basis by ACAPs *(4, 21) (5) (18) (10)*	CAP documents and assessment reports ACAPs	http://www.unocha.org/cap http://geo.acaps.org/

References for ANNEX II

1. Peduzzi P, Dao Q-H, Herold C, Rochette DS, Sanahuja H. Feasibility Study Report on Global Risk and Vulnerability Index–Trends per Year (GRAVITY). 2001.
2. Dao Q-H, Peduzzi P. Global evaluation of human risk and vulnerability to natural hazards. 2004.
3. Pelling M, Maskrey A, Ruiz P, Hall L, Peduzzi P, Dao Q-H, et al. Reducing disaster risk: a challenge for development. 2004.
4. Brooks N, Neil Adger W, Mick Kelly P. The determinants of vulnerability and adaptive capacity at the national level and the implications for adaptation. Global environmental change. 2005;15(2):151-63.

5. Schneiderbauer S. Risk and vulnerability to natural disasters–from broad view to focused perspective. FU Berlin, digital dissertation Available at< www diss fu-berlin de/2007/498/indexe html# information>(accessed March 2008). 2007.
6. Peduzzi P, Dao H, Herold C, Mouton F. Assessing global exposure and vulnerability towards natural hazards: the Disaster Risk Index. Natural Hazards and Earth System Science. 2009;9(4):1149-59.
7. Peduzzi P, Chatenoux B, Dao Q-H, De Bono A, Deichmann U, Giuliani G, et al. The global risk analysis for the 2009 global assessment report on disaster risk reduction. 2010.
8. Guha-Sapir D, van Panhuis WG, Degomme O, Teran V. Civil conflicts in four African countries: a five-year review of trends in nutrition and mortality. Epidemiologic reviews. 2005;27(1):67-77.
9. Bremer R. Policy development in disaster preparedness and management: lessons learned from the January 2001 earthquake in Gujarat, India. Prehospital and disaster medicine. 2003;18(04):372-84.
10. UNOCHA. Assessment and classification of Emergencies (ace) project. Mapping of key emergency needs assessment and analysis initiatives: Final report.: UNOCHA; 2009.
11. Sphere-Project. Humanitarian Charter and Minimum standards in Humanitarian Response 2011.
12. SMART. Standardized Monitoring and Assessment of Relief and Transition, Measuring Mortality, Nutritional Status, and Food Security in Crisis Situations: SMART methodology 2006.
13. UNEP/DEWA/GRID. 2009 [Available from: http://www.unep.org/.
14. Cutter SL, Boruff BJ, Shirley WL. Social vulnerability to environmental hazards*. Social science quarterly. 2003;84(2):242-61.
15. Peduzzi P, Dao Q-H, Herold C, Mouton F. Global Risk And Vulnerability Index Trends per Year (GRAVITY) Phase III: Drought analysis. 2003.
16. Young H, Jaspars S. Review of Nutrition and Mortality Indicators for the IPC. 2009.
17. Black RE, Victora CG, Walker SP, Bhutta ZA, Christian P, de Onis M, et al. Maternal and child undernutrition and overweight in low-income and middle-income countries. The Lancet. 2013;382(9890):427-51.
18. IPC. Integrated Food Security Phase Classification Technical Manual. Version 1.1. FAO. Chief, Publishing Policy and Support Branch, Office of Knowledge Exchange, Research and Extension, FAO, Viale delle Terme di Caracalla, 00153 Rome, Italy.: Food and Agriculture Organisation FAO; 2008

19. Burkle FM. Complex humanitarian emergencies: a review of epidemiological and response models. Journal of postgraduate medicine. 2006;52(2):110-5.

20. Mock N, Garfield R. Health tracking for improved humanitarian performance. Prehospital and disaster medicine. 2007;22(05):377-83.

21. Garfield R. Measuring humanitarian emergencies. Disaster medicine and public health preparedness. 2007;1(2):110.

22. UNHCR. Handbook for emrgencies, 3d edition. Geneva: UNHCR; 2007.

II

PLoS Currents
Rapid Sharing of Research in Progress

Version 1. PLoS Curr. 2016 June 28; 8: ecurrents.dis.d59e0fa39887031e1c3763851a6e5c2a.
Published online 2016 June 28.
doi: 10.1371/currents.dis.d59e0fa39887031e1c3763851a6e5c2a: 10.1371/currents.dis.d59e0fa39887031e1c3763851a6e5
Research Article

PMCID: PMC5419815
PMID: 28503357

How Bad Is It? Usefulness of the "7eed Model" for Scoring Severity and Level of Need in Complex Emergencies

Anneli Eriksson,*
Martin Gerdin, Richard Garfield,*
Thorkild Tylleskar,*
and Johan von Schreeb*

Anneli Eriksson, Department of Public Health Sciences, Health System and Policy, Karolinska Institute, Stockholm, Sweden;
Contributor Information.

Abstract

Background:

Humanitarian assistance is designated to save lives and alleviate suffering among people affected by disasters. In 2014, close to 25 billion USD was allocated to humanitarian assistance, more than 80% of it from governmental donors and EU institutions. Most of these funds are devoted to Complex Emergencies (CE). It is widely accepted that the needs of the affected population should be the main determinant for resource allocations of humanitarian funding. However, to date no common, systematic, and transparent system for needs-based allocations exists. In an earlier paper, an easy-to-use model, "the 7eed model", based on readily available indicators that distinguished between levels of severity among disaster-affected countries was presented. The aim of this paper is to assess the usefulness of the 7eed model in regards to 1) data availability, 2) variations between CE effected countries and sensitivity to change over time, and 3) reliability in capturing severity and levels of need.

Method:

We applied the 7eed model to 25 countries with CE using data from 2013 to 2015. Data availability and indicator value variations were assessed using heat maps. To calculate a severity score and a needs score, we applied a standardised mathematical formula, based on the UTSTEIN template. We assessed the model for reliability on previous CEs with a "known" outcome in terms of excess mortality.

Results:

Most of the required data was available for nearly all countries and indicators, and availability increased over time. The 7eed model was able to discriminate between levels of severity and needs among countries. Comparison with historical complex disasters showed a correlation between excess mortality and severity score.

Conclusion:

Our study indicates that the proposed 7eed model can serve as a useful tool for setting funding levels for humanitarian assistance according to measurable levels of need. The 7eed model provides national level information but does not take into account local variations or specific contextual factors.

Background

Humanitarian assistance is designated to save lives and alleviate suffering among people affected by disasters [1,2]. In 2014, close to 25 billion USD was allocated to humanitarian assistance globally, the bulk of it from governmental donors and EU institutions [3]. The majority of humanitarian funding is channeled through UN coordinated appeals to contexts that that can be defined as complex emergencies (CE) [3]. Major donors have agreed that need should determine funding priorities for humanitarian assistance, and that allocations should be made in proportion to needs [2,4].

There is, however, no agreed model or tool to help determine needs-based humanitarian funding [5,6].

The process of assessing the overall severity of the situation challenge funders. The tools needed to address this challenge are different than the operational needs assessments tools that provide detailed information on needs to guide interventions [6,9] . Existing tools typically 1) look at specific sectors, 2) other are field and intervention oriented or 3) assess severity globally but do not sufficiently discriminate among the most severe CEs. Below some examples:

1) The IPC (Integrated Food Security Phase Classification) is a specific sector oriented index that looks at food security and allows a comparison between contexts but only in this area [22].

2) The PDNA (Post Disaster Needs Assessment) is a tool to define sector needs after disasters [23] . It is to a large extent a tool to be used at the disaster site. So is the MIRA manual (multi sector initial rapid assessment) to be used after sudden onset disasters. It provides guidance for remote assessments but focus lays on "at site assessments" [24.]

3)Several initiatives such as the Global Emergency Overview (GEO), the Global Needs Assessment (GNA), Index for Risk Management (inFORM) and the Global Focus Model (GFM) have in recent years been developed to provide information on global needs and risks. However, where these initiatives define needs, they do not distinguish between levels of needs among the worst CE affected countries and do not allow for comparison of severity and magnitude of needs [8,9,10,11].

To enable needs-based humanitarian funding we developed a model using quantifiable indicators to measure and compare severity of and between CEs [13], the "7eed model", a combination of both severity and need - seve(rity)need. The 7eed model is presented in Annex 1. The aim of this study was to determine the usefulness of the model by assessing 1) availability of the indicator data, 2) variations between CE effected countries and sensitivity to change over time, and 3) reliability in capturing severity.

Setting

Our 7eed model was developed for Complex Emergencies (CE), defined as a situation with a breakdown of authority due to conflict that requires a multi-agency response [13]. In our definition we also included situations where the mortality among the civilian population has increased significantly compared to baseline, due to direct or indirect causes of conflict, such as malnutrition and/or spread of communicable diseases [14]. We also include contexts where governmental policies contribute to the development of a disastrous situation, such as food insecurity and high rates of malnutrition, or so-called complex political emergencies [14,15]. We defined reliability as the agreement between the model output and severity, and we defined severity as excess mortality.

The 7eed Model

The Utstein framework [12] is:"A conceptual framework that describes the progression of a hazard that becomes an event, which causes structural damage and a decrease or loss of function (functional damage), that, in turn, produces needs that lead to a disaster" [16].

In our 7eed model we kept the Utstein logic, but adapted it to situations where the hazard is an on-going event. The model has the following components:

Disaster severity = Vulnerability X Exposure

As a next step – to relate severity with level of need - we suggested that the number of people in need is used as a single factor in the model in the following way:

Level of Need = Severity X People in Need

How we identified and selected the indicators of vulnerability and exposure included in the model has been described previously [11].The 7eed model is presented in Annex 1.

The 7eed model provides an estimate of the severity of a CE based on the resulting score of 4 indicator values for vulnerability and 4 for exposure. The vulnerability indicators were assigned scores according to the 2012 Human Development Index values for the least developed countries. The exposure indicators were assigned scores using information from the UN-consolidated appeals for 2012.

Method

To test the 7eed model, we conducted the following analyses:

1. We applied the 7eed model to 16 countries affected by CE over three consecutive years. Nine additional countries were assessed for one or two years. With these results, heat maps were developed and reviewed for indicator availability, variations over time, and variations between countries.

The 16 countries selected for inclusion were the ones that had UN consolidated appeals assembled during this period. They were therefore deemed relevant for severity scoring and funding decisions. We used the definition for CE presented above to identify these countries. The countries were: Afghanistan, Burkina Faso, The Central African Republic (CAR), Chad, Djibouti, Democratic Republic of Congo (DRC), Haiti, Mali, Mauretania, Niger, occupied Palestinian Territories (OPt), Somalia, South Sudan, Sudan, The Syrian Republic and Yemen. In 2013 and 2014, Kenya and Zimbabwe were selected, and in 2015 Cameroon, Gambia, Iraq, Myanmar, Nigeria, Senegal and Ukraine were added.

Most of these countries are or were at the time going through periods of armed conflict or instability. In the Sahel region food insecurity and high levels of malnutrition were the driving causes of the disaster, aggravated by displacement and regional or internal instability. For Zimbabwe food insecurity was the main cause of the disaster and for Kenya and Djibouti food insecurity and high numbers of refugees were the main cause.

We used the World Banks data web (http://data.worldbank.org) to obtain values for the vulnerability indicators. When information was unavailable or the values were older than three years, we searched for information from other sources, such as Multiple Indicator Cluster survey (MICS) and other surveys referred to in the UN appeals. If no indicator value was found, we marked the indicator information as not available (na).

Values for the exposure indicators were derived from UN appeals. We obtained data for 2013 and 2014 from CAP documents, and for 2015 from the UN's Humanitarian Response Plans. In 2015, the UN appeals changed the terminology from "affected" to "people in need of humanitarian assistance" which is estimated using a coordinated field process where data on humanitarian needs are consolidated [17].

We subsequently changed the terminology in our model to "people in need", as the terms are comparable. Values on "number of uprooted" was from UNHCR, if unavailable in the appeal. To obtain information on the proportion data, total population size was obtained from the UN appeals or the World Bank database. The framework was populated with indicator values and scored according to predefined cut-offs for each individual country.

The results were presented as heat maps using colour coding to determine the different levels of severity for the indicator values; yellow indicates low/medium severity, orange is high severity, and red is extreme severity. When information or values were unavailable, the square was left blank.

2. We established a standardised mathematical formula, building on the UTSTEIN framework to calculate a severity and needs score

During scoring, each indicator was given a numeric value based on the indicator severity from 0,5 (low-medium) to 1 (high), to 1,5 (extreme). Vulnerability and exposure were added up separately and then multiplied. The severity score could thus range from 4 (lowest severity) to 36 (highest severity). To obtain a needs score, the number of people affected or in need was added to the equation by multiplying by the number of millions affected (2013 and 2014) or in need (2015).

3. We tested the 7eed model for reliability on a number of previous complex disasters with a documented outcome of excess mortality.

Excess mortality is a recognized measurement of severity of a disaster situation [18]. However, excess mortality is a late sign of a deteriorating situation and mortality data is often difficult and complex to obtain [19,20]. In CE, excess mortality is particularly challenging to determine. Consequently there is lack of reliable data. Following a careful search of available publications, we decided to use information on excess mortality in CEs from a publication by The Geneva Declaration Organization [21]. This is a referenced publication on the subject and attempts to methodically assemble and compare data on mortality in conflict. Estimates of direct and indirect mortality per 100 000 people, per year were used to assess the 7eed model, in the following way: Information on mortality from 11 conflict-related complex emergencies that occurred partly or completely between 1993 and 2005 was used. The countries were Kosovo (1998–1999), Iraq (2003–2007), Northern Uganda (2005), Democratic Republic of the Congo (DRC) (1998–2002), Burundi (1993–2003), Sierra Leone (1991–2002), Darfur, Sudan (2003–2005), South Sudan (1999–2005), Angola (1975–2002), Liberia (1989–1996), and East Timor (1974–1999).

We applied the 7eed model on the same countries with values for the different indicators from the relevant years and compared the severity score of the countries with excess mortality rates.

Results

Availability of indicator data: All the vulnerability indicator information was available for eleven of the sixteen countries assessed over three years. Five countries had missing data in 2013, but by 2015 only Somalia lacked information, and only on one vulnerability indicator. The indicators adult literacy and underweight were updated less frequently than once per year. Indicators for exposure were included in the majority of the UN appeals. For the number of uprooted people, the UNHCR website also provided annually updated information, while the UN appeals updated this information for every update in the appeal, depending on the situation. Information on number of people affected by the CE was not consistently presented; sometimes it was presented as per intervention sector, such as health or food security, and sometimes presented as an overall number. When presented per sector, the total number of affected was uncertain, as a significant overlap between sectors was likely. For countries where the number of affected per sector varied significantly (Afghanistan, Burkina Faso, Mauretania, Zimbabwe), we calculated a median number. The number of people in need was available for the all assessed countries in the 2015 UN appeals.

Variations between countries and sensitivity to change over time: The vulnerability scoring showed variations among countries. No country scored red on all four vulnerability indicators (extreme); however, Somalia scored red on the three available indicators. For 2015, four countries had an overall yellow score (low – medium). These were Iraq, oPT, Syria and Ukraine. Seven of the 16 countries assessed over three years had vulnerability indicators that improved over time.

The exposure indicators had significant variations among the countries, with four countries standing out with red for three out of four scores (extreme) for at least two of the three years. These were oPT, Somalia, South Sudan, Sudan and Syria. For oPT, the number and proportion of uprooted includes a majority of people uprooted several decades previously. None of the countries had an all yellow score for exposure over three years, although Haiti, Mauretania, and Ukraine had an all yellow score for exposure in January 2015.

Variations between countries - scoring of severity and needs.

The severity score shows the variation between countries. While the possible severity scores ranged from 4 and 36, the highest score in the assessment was 33, which was assigned to Somalia. For Somalia, information on one of the vulnerability indicator GNI per inhabitant on PPP was missing. In the calculation we assumed that the value of the indicator would be extreme, based on our understanding of the context.

The scores ranged from 4 to 33. In total, five countries scored above 20: Afghanistan, CAR, DRC, Somalia and South Sudan. Ukraine had the lowest score of 4, as both vulnerability and people displaced and in need were relatively low.

Scoring of needs - for assessed countries in 2015 is presented in figure 4.

The need score had wide variation among countries. The highest score was 216 for Syria and the region, while the lowest was below 2 for Djibouti. Afghanistan, DRC and South Sudan all had high severity and high need scores. CAR and Somalia had the highest severity scores but lower need scores, while Syria and the region had the absolute highest need score, but only the tenth highest severity score.

Previous CE – assessing the reliability of the model in capturing severity.

In the table, a heat map for the eleven countries is presented and below the severity score and the estimated excess mortality per 100 000 people. In figure 6 the severity score and excess mortality is plotted.

The severity score follows the estimated excess mortality in ten of the eleven tested historical CE countries. The exception is DRC, where the estimated excess mortality suggests a more severe situation than what we found when we applied the severity scoring model to the same context

Discussion

Our assessments indicate that the 7eed model is based on indicators with a value that is readily available, provides scores that vary among countries and over time, and in addition, reliably captures levels of severity. The developed heat maps visually illustrate the severity and the variation among countries. They show that both vulnerability and exposure together form the severity of a CE, while the scoring provides measurable comparisons that can support needs based decision-making.

The results in figure 7 show a high correlation between excess mortality and severity score, which indicates that the model is capable of capturing severity when using excess mortality as an outcome variable. Considerable inaccuracy may exist in available data on excess mortality,. The results from the assessment of reliability must therefore be interpreted with caution.

In the scoring of severity Somalia and the Central African Republic stood out as the most severe contexts during 2015, while the Syrian Republic and region only reached a moderate severity. This is in line with the estimated excess mortality as an absolute measurement of severity for historical CE. Here the indirect mortality due to a CE is much higher in countries with higher vulnerability, meaning that while the conflict in Syria in 2015 was, and still is, very violent with high numbers of direct victims of violence, the number of indirect deaths were likely lower than in Central African Republic and Somalia. As the number and proportion of people in need and displaced in Syria and the region is very high compared to any other ongoing CE, this makes the need score the highest in the assessment for 2015, regardless of the moderate severity.

The 7eed model with the suggested scoring levels captures variations of severity between CE affected countries in more detail than existing indices. As such, it may serve as a useful complement to measuring severity. However, it must be highlighted that the model compares "the worst of the worst" and a low severity score does not automatically imply a lack of need.

There are several limitations to the model and our assessment of the model. First, it is based on a limited number of vulnerability indicators that have been selected for their relevance and availability, in addition to ease of use. Priority has been given to indicators that have a quantifiable value. In some cases, despite being readily available, some of the vulnerability indicator values were several years old, which introduced imprecision. In contrast, indicators for exposure were frequently updated and presented, for example in the UN appeals. The validity of these data could be a concern. For instance, the definition for and methods to estimate people "in need", as well as the previously used people "affected", remain subjective and imprecise. We are also aware that in calculating the total need score, we are using the same indicator value twice - "people in need" - and that this is a potential source of error for the model. Nevertheless, in absence of more reliable data, this data remains the most useful.

In our analysis we relied on information from the institutions requesting funding, which could bring the independence of the analysis into question. The 7eed model is, however, a potential tool for a donor, where key information from the appeals can be interpreted and analysed among countries and across years. It is a way to make use of the available data in a systematic and objective manner that provides transparently derived results.

The 7eed model results must always be interpreted in context. They do not provide exact guidance on the absolute funding needs, but serve as a support tool together with other facts and considerations. Additional qualitative information must be part of the narrative analysis, such as violations of human rights and other factors that our model does not capture. The 7eed model also doesn't take into account important regional or local variation, and is meant to be used at macro level.

While the scoring may provide information on the severity of a situation it does for instance not take into account so called "donor fatigue", that may occur for contexts where the CE is lasting over longer periods, sometimes decades without any significant improvement of the situation or with a peaceful solution in sight, nor does it pay attention to geopolitical considerations that may influence funding decisions. More studies are therefore needed to document the significance of needs in relation to other factors that influence funding decision. The 7eed model is developed for ease of use and interpretation. It uses few indicators and a basic scoring system and where the information search and scoring requires a few minutes. It can be used for comparisons across countries. To what extent donors are ready implement such an analytical tool individually or per donor remains to be seen. The model could potentially also serve as a severity index or as a part of a severity index to be publicised and made available for donors and other stakeholders.

More than a decade has gone by with limited progress towards the goal of needs-based resource allocations. We believe that the results of this assessment are a promising step towards more systematic needs-based funding. We encourage other colleagues to assist in exploring humanitarian funding processes and assessment of needs-based allocations.

Appendix 1

Competing Interests

The authors declare that they have no competing interests that have or may have influenced this study: the study design, data collection, data analysis, decision to publish, or preparation of the manuscript.

Acknowledgments

Tina Ohlsén who contributed to the development of the assessed model and the search for relevant indicators, in our previous work. Dell Saulnier, for editing the language and contributing to the overall presentation.

Biographies

- Anneli Eriksson is a registered nurse specialized in anesthesia care, with a master in international health. She presently works as project leader at Karolinska Institutet with a research team focusing on health-care needs related to disasters. In 1995 Anneli started to work with Medecins Sans Frontieres (MSF) and has since then had several positions in field-missions and at office level.

- Team Lead, ERRB US Centers for Disease Control and Prevention and Professor Emeritus, Columbia University

- Thorkild Tylleskär is a paediatrician and professor in International Health since 2001. His focus is on child health in a global perspective, nutrition, HIV and health informatics. He has his medical degree, his PhD training and his specialist training in paediatrics from Uppsala University and Uppsala University Hospital. In addition, he has a French Master in African Linguistics from Sorbonne University after field work in present-day Democratic Republic of Congo (former Zaire). His medical thesis in 1994 describes the toxico-nutritional causation of 'konzo', a paralytic disorder permanently crippling women and children in some pockets in Africa, https://en.wikipedia.org/wiki/Konzo. Since his appointment as full professor in Bergen, Norway his focus has been shared between 1) child health and nutrition, especially on the nutritional problems accentuated by HIV and how to solve the breastfeeding and postnatal HIV transmission, 2) birth care and 3) improved data collection and management for health in low resource settings.

- MD. PhD. Associate professor, Specialist in general surgery Centre for reserach on health care in disasters Department of Public Health Karolinska Institutet Stockholm, Sweden

Funding Statement

This study was funded with a grant from the Swedish International Development Cooperation Agency (Sida) and a grant from The Swedish National board of health and welfare. The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Contributor Information

Anneli Eriksson, Department of Public Health Sciences, Health System and Policy, Karolinska Institute, Stockholm, Sweden.

Martin Gerdin, Department of Public Health Sciences, Health System and Policy, Karolinska Institute, Stockholm, Sweden.

Richard Garfield, ERRB, Centers for Disease Control, Atlanta, Georgia, USA.

Thorkild Tylleskar, Centre for International Health, University of Bergen, Bergen, Norway.

Johan von Schreeb, Department of Public Health Sciences, Health System and Policy, Karolinska Institute, Stockholm, Sweden.

References

1. Burkle FM. Complex humanitarian emergencies: a review of epidemiological and response models. Journal of postgraduate medicine. 2006;52(2):110-5. Epub 2006/05/09. PubMed PMID: 16679674. [PubMed: 16679674]

2. GHD. Principles and practice of good humanitarian donorship [web page]. 2003 [cited 2014 April 25]. Available from: http://www.goodhumanitariandonorship.org.

3. Development-Initiatives. Global Humanitarian Assistance report (GHA) 2015. 2015.

4. Swedish-Government T. Saving lives and alleviating suffering. Policy for Sweden's humanitarian assistance 2012 - 2016. In: och Efu, Information UsiS, editors. 2010. p. 36.

5. (IASC) IASC. Task Force on Needs Assessment web text concerning needs assessments. 2007 Available from: http://www.humanitarianinfo.org/iasc/pageloader.aspx?page=content-subsidi-common-default&sb=75.

6. von Schreeb J, Unge C, Brittain-Long R, Rosling H. Are donor allocations for humanitarian health assistance based on needs assessment data? Global Public Health. 2008;3(4):440-7.

7. Darcy J, Hoffman C. According to need? Needs assessment and decision-making in the humanitarian sector. HPG - Odi. 2003;(15).

8. ACAPS. Global Emergency Overview, GEO, launched 2012 2012 [cited 2015]. Available from: http://geo.acaps.org.

9. IASC-EC. infoRM: Inter-Agency Standing Committee and the European Commission.; 2015 [2015 06 09]. Available from: http://www.inform-index.org.

10. ECHO. Global Vulnerability and Crisis Assessment (GNA) 2014 [cited 2014]. Available from: http://ec.europa.eu/echo/files/policies/strategy/gna_fca_2013_2014_map.pdf.

11. Eriksson A, Ohlsen T, Garfield R, Von Schreeb J. Who is worst off? Developing a severity-scoring model of complex emergency affected countries in order to ensure needs based funding. PLOS current Disasters. 2015. [PMCID: PMC4648580] [PubMed: 26635996]

12. Sundnes KO, Birnbaum ML. Health disaster management: Guidelines for evaluation and research in the Utstein style: Prehospital and Disaster Medicine; 2003. [PubMed: 10558317]

13. (IASC) I-ASC. Working Paper on the Definition of Complex Emergencies. Proceedings of meeting held in Geneva, December 9, 1994. 1994.

14. Salama P, Spiegel P, Talley L, Waldman R. Lessons learned from complex emergencies over past decade. The Lancet. 2004;364(9447):1801-13. [PubMed: 15541455]

15. WHO-HAC. Humanitarian Health Action, Definitions: emergencies 2015. Available from: http://www.who.int/hac/about/definitions/en/.

16. Birnbaum ML, Daily EK, O'Rourke AP, Loretti A. Disaster research/evaluation frameworks, part 1: an overview. Prehospital and disaster medicine. 2014:1-12. [PubMed: 24625734]

17. UNOCHA. Guidance: 2015 Humanitarian Needs Overview. 2015.

18. Toole MJ, Waldman RJ. Prevention of excess mortality in refugee and displaced populations in developing countries. Jama. 1990;263(24):3296-302. [PubMed: 2348541]

19. Garfield R. Measuring humanitarian emergencies. Disaster medicine and public health preparedness. 2007;1(2):110. [PubMed: 18388638]

20. Checchi F, Roberts L. Documenting mortality in crises: what keeps us from doing better? PLoS medicine. 2008;5(7):e146. [PMCID: PMC2443202] [PubMed: 18597552]

21. Declaration G. Global Burden of Armed Violence. London: Geneva Declaration Secretariat, 2008.

22. IPC. Integrated Food Security Phase Classification Technical Manual. Version 1.1. . Chief, Publishing Policy and Support Branch, Office of Knowledge Exchange, Research and Extension, FAO, Viale delle Terme di Caracalla, 00153 Rome, Italy.: Food and Agriculture Organisation FAO, 2008

23. PDNA Post Disaster Needs Assessment Guideline. the European Comission, The united Nations development group, The World Bank 2013 revised.

24. MIRA Multi Sector Initial Rapid Assessment guidance. UNOCHA, 2015 revised version.

Figures and Tables

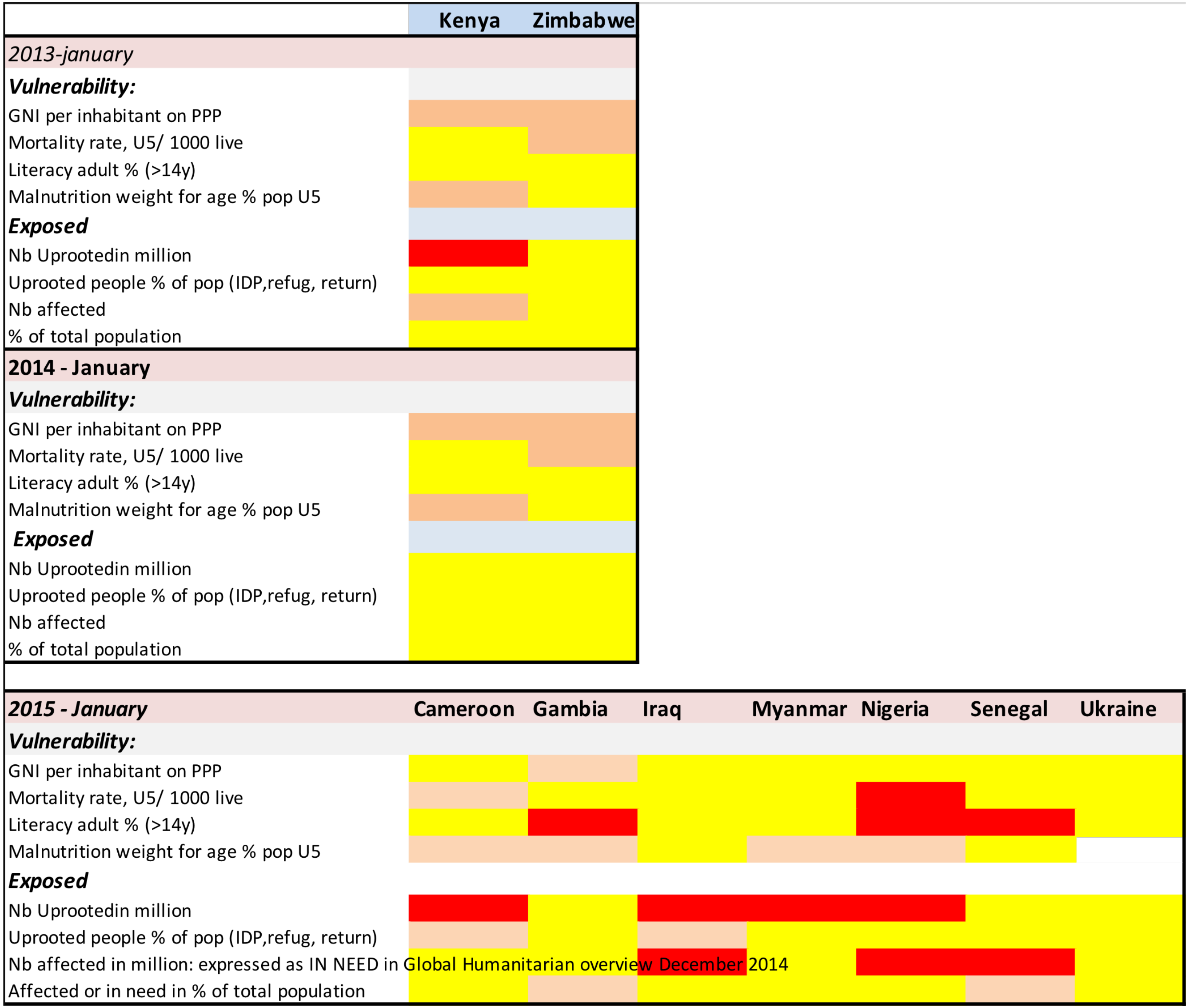
The published figures and tables were removed from the article and re-inserted in their original format, due to formatting errors in the published article. No alterations were made, with three exceptions:

- *Acorrection of the heading of the second heat map where "linked to" was removed.*
- *In the Severity score 2015, the explanatory note was corrected: affected was removed and exposed included.*
- *The formulas for the severity score and the needs score was also added to in the figures for clarity.*

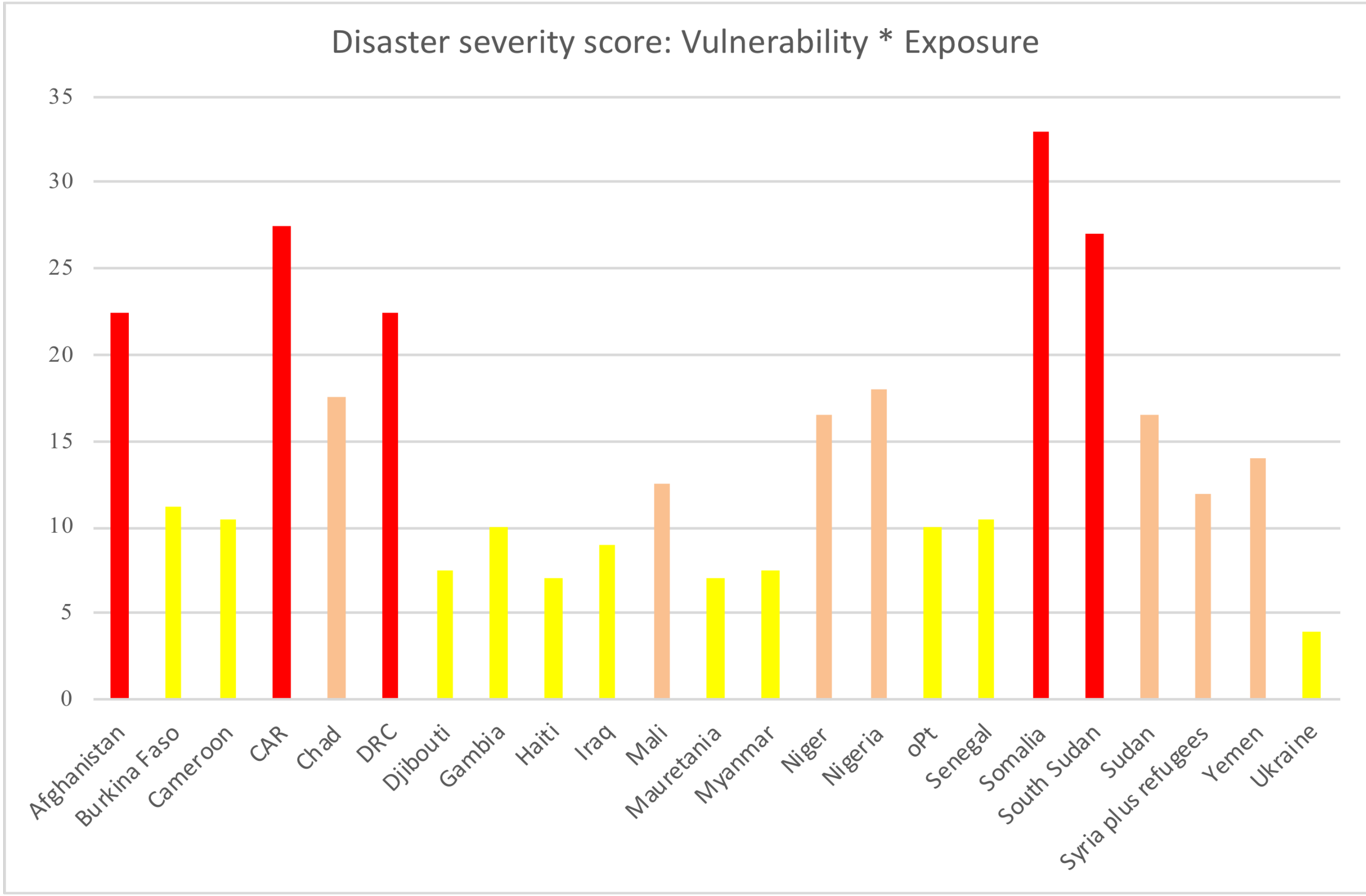
- Heat maps 2013 – 2015 for 16 CE affected countries with Consolidated UN appeals
- Heat maps for additional CE countries and Sahel countries with on-going food insecurity 2015
- Severity score January 2015
- Need score January 2015
- Heat map, severity score and excess mortality for 11 historical CEs
- Plotting of severity score and average excess mortality/year
- Annex: The 7eed model

Heat maps 2013 – 2015 for 16 CE affected countries with Consolidated UN-appeals

Heat maps for additional CE countries and Sahel countries with on-going food-insecurity 2015

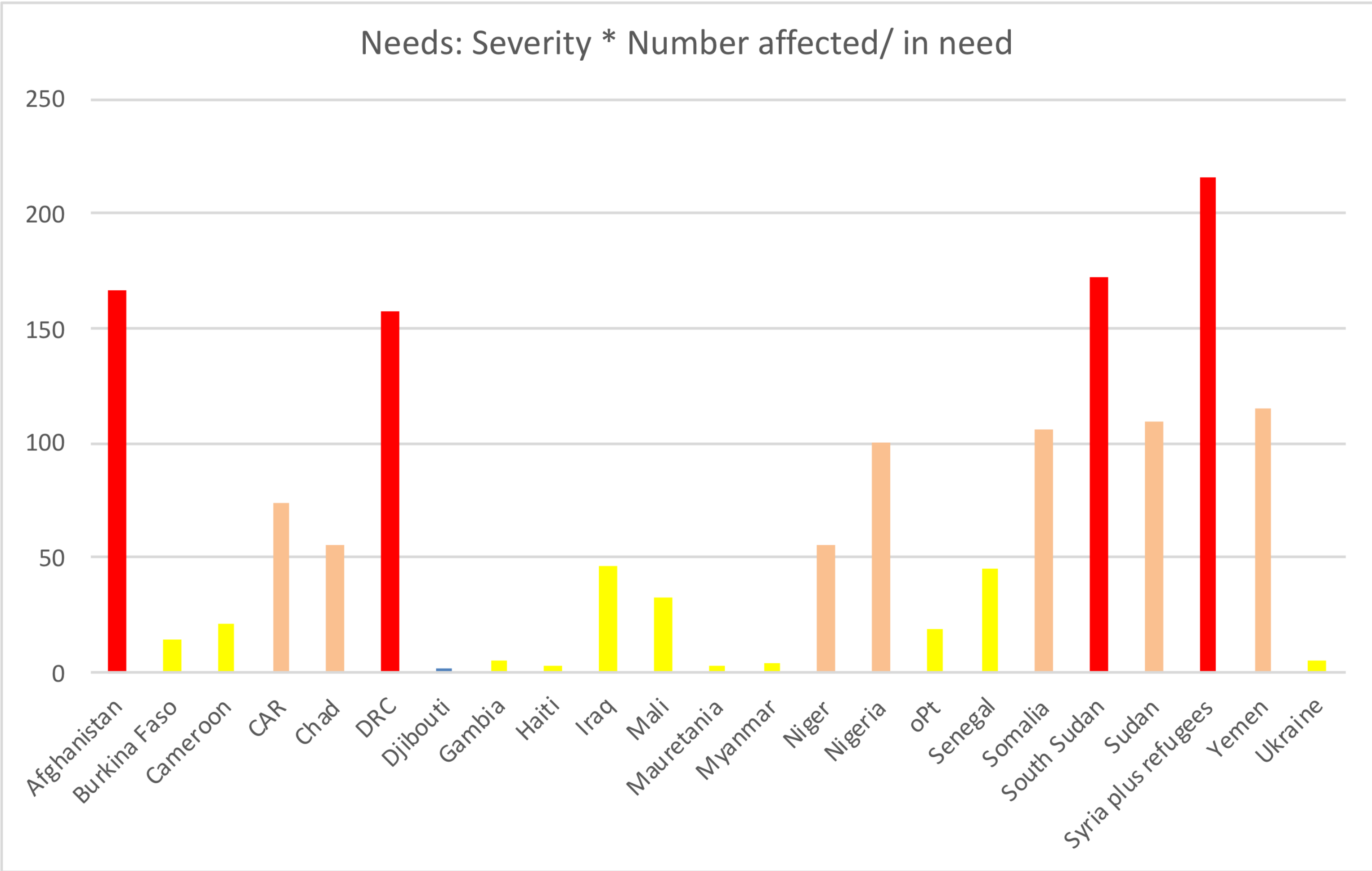


Severity score January 2015



The Y-axis displays the severity score based on vulnerability * exposure, with possible variations between 4 and 36. In the graph a severity score above 20 results in a red bar, severity between 10 and 19 an orange bar and severity below 10 a yellow bar

Need score January 2015

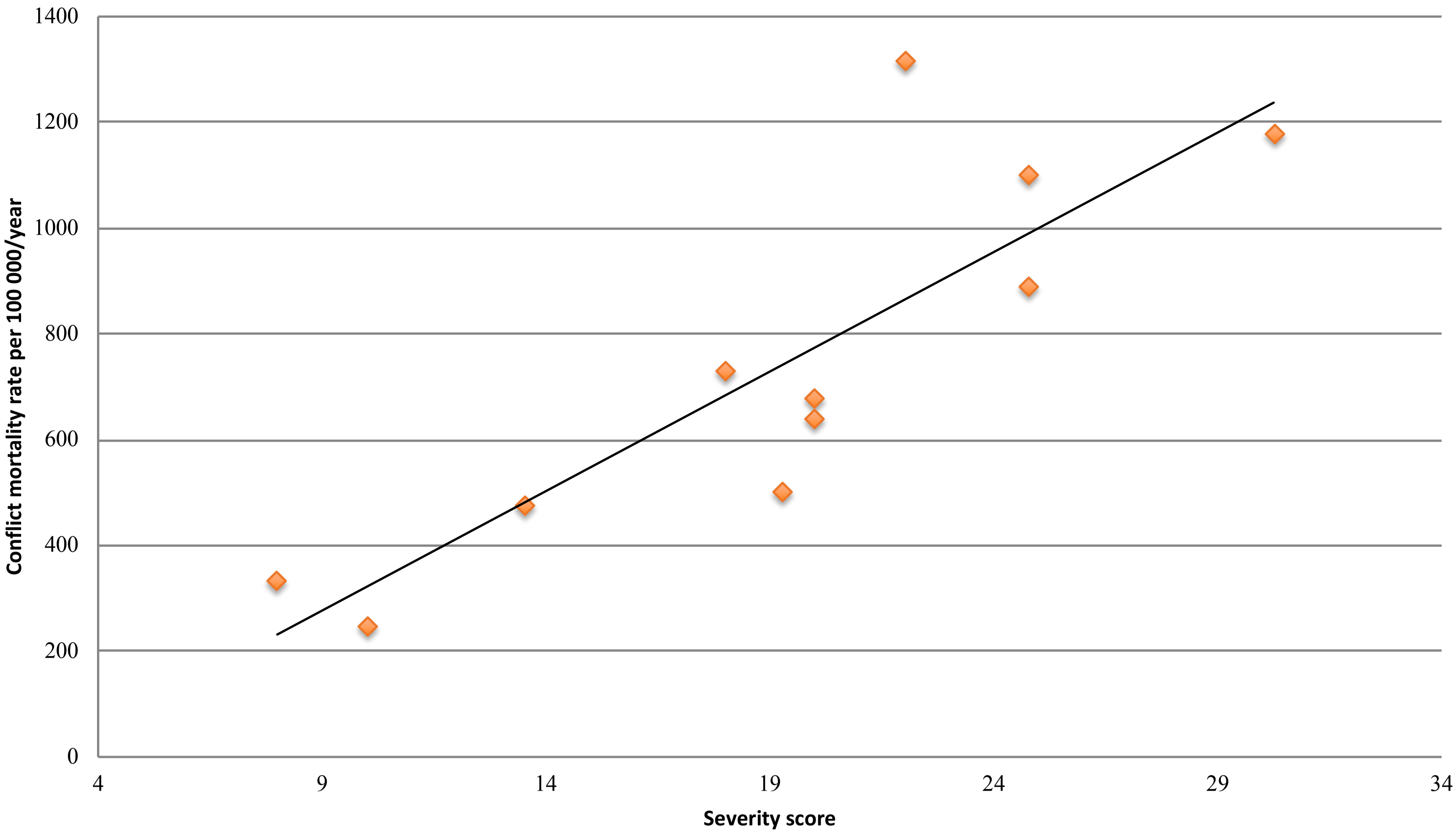


The Y-axis displays the need score based on severity score* million in need. In the graph a need score above 150 results in a red bar, a need score between 50 and 149 an orange bar and a need score below 50 a yellow bar.

Heat map, severity score and excess mortality for 11 historical CEs

Countries *years of conflict and year assessed in bold*	Kosovo, 1998–**99** *Assessed - Serbia*	Iraq, 2003–07 **2004**	Northern Uganda, **2005**	DRC, 1998–**2000**	Burundi, 1993–2003 **/2002**	Sierra Leone, 1991–**2002**	Darfur, Sudan, 2003–05/ **2002**	South Sudan, 1999–2005/**200 2**	Angola, 1975–**2002**	Liberia, 1989–**96/1997**	East Timor, 1974–99l/**2000**
1. Vulnerability scoring:											
GNI per inhabitant on PPP*											
Mortality rate, U5/ 1000 live* , 2013 WB											
Literacy adult % (>14y) *											
Malnutrition weight for age % pop U5*											
2. Exposed											
Nb Uprootedin million,UNHCR											
Uprooted people % of pop (IDP,refug, return)											
Nb affected in million:											
Affected or in need in % of total population											
3. Disaster severity score: Vulnerability * Exposure	**8**	**10**	**13,5**	**22**	**19,25**	**24,75**	**18**	**30,25**	**20**	**24,75**	**20**
4. Average excess mortality /100 000	**334**	**26**	**476**	**1316**	**500**	**1101**	**730**	**1178**	**676**	**889**	**638**

Plotting of severity score and average excess mortality/year



Countries plotted: Angola, 1975–2002, Burundi, 1993–2003, Darfur, Sudan, 2003–05, East Timor, 1974–99, Northern Uganda, 2005, DRC, 1998–2002, Liberia, 1989–96, Sierra Leone, 1991–2002, South Sudan, 1999–2005, Iraq, 2003–07, Kosovo, 1998–99

ANNEX: The 7-eed model

1. Country Vulnerability measured through four indicators scored individually

Indicator for Vulnerability	Low-Medium	High	Extreme
GNI per inhabitant on PPP	> 1960	1110-1960	< 1110
Mortality rate, U5/1000 live	< 75	75-110	> 111
Literacy adult % (over 14y)	> 70	56-69	< 55
Underweight: (weight for age) % pop U5	< 15	16-30	> 30

2. Number and proportion of people exposed to disaster

Indicators for Exposure	Low-Medium	High	Extreme
Nb uprooted in million	< 0.6	0.6 - 1	> 1
Proportion uprooted % of total population	< 4%	4 % - 6%	> 6 %
Nb affected, in million	< 2.6	2.6 - 4	> 4
Proportion affected: % of total population	< 18%	18% - 33%	> 33%

Low-Medium severity

High severity

Extreme severity

III

Graphic design: Communication Division, UiB / Print: Skipnes Kommunikasjon AS

uib.no

ISBN: 9788230850589 (print)
9788230857991 (PDF)