Disaster Relief by Air: A Need for More Equipment?

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Abstract

This research analyses academic and policy papers, databases, internet sources, and an interview in order to explore two questions: firstly, whether global population increases affect the frequency and/or intensity of natural disasters, and secondly, whether the need for humanitarian air equipment can be expected to increase in the future. The results suggest that a link between the global increase in population and an increase in natural disasters cannot be clearly demonstrated, due to the many limiting concerns that make it difficult to establish a correlation between the two. Furthermore, present indications are that the need for humanitarian air equipment will most likely not increase, however this will depend on multiple factors, such as the level of equipment exchange between organisations and nations in the event of humanitarian disasters.

Keywords: disaster management, crisis management, humanitarian assistance, population increase, humanitarian equipment

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Chapter 1 – Introduction

From the devastating 1876 drought-famine in China, which killed at least 9.6 million people, to the more recent horror story of hurricane Katrina in 2005, natural disasters have and always will be a feature of human existence. People dead or injured, houses and businesses destroyed, and governments financially weakened, are just a few of the consequences that a natural disaster can have on a community. The common denominator in every single one of the most destructive natural disasters is that for governments and organizations, the breadth of the impact was unexpected. Although scientific forecasts might have foreseen these events, this knowledge in itself couldn't prevent the extent of the damage.

We live in an era in which climate change is a pressing issue for humanity. Global and regional agreements such as the 2015 Paris Agreement aim to reduce the impact of climate change via the reduction of greenhouse gas emissions. For the majority of people, it now seems that the human responsibility for climate change is beyond doubt, and the groups and individuals who disagree with the belief that climate change is actually happening or that it is the result of human activities are strongly criticized.

1.1 The global population increase & natural disaster trends

This thesis takes as a starting point the widely-held notion that climate change is an indirect result of the world's increasing population. It is generally accepted that the main cause of modern climate change is human activity, which has increased our ecological footprint over the years. Activities stemming from modern lifestyles, such as the increasing use of cars and consumer behaviour, which increase industrial production, are often said to increase proportionally with the population - the larger the population, the higher the need for energy. Most energy is consumed in the form of fossil fuels, and their burning increases the amount of carbon dioxide in the atmosphere, which, according to most climatologists, increases global warming. As a result, population growth is often seen as an important factor in climate change. In turn, climate change is thought to lead to more hurricanes, droughts, floods, and other natural disasters. As the world's population continues to grow, the link between climate change and natural disasters will result in an increase in the frequency and intensity of natural disasters.

It is a commonly-held belief that natural disasters have been increasing throughout recent decades. Mainly, it is believed that this increase is to be blamed on human activity (gas emissions, deforestation, etc.) and the ecological footprint that this entails. It is believed that these activities cause alterations in the climate and can lead to an increase in natural disasters. At the same time, since the world's population is also drastically increasing, it is often assumed that this equates to a larger ecological footprint, resulting in even more natural disasters.

Technological advances that have led to an increase in food production, the development of medicine and the elimination of many fatal diseases, and more generally, a better quality of life, have all played a role in the world's population reaching almost 7.5 billion people. This number is expected to reach 8.6 billion by 2030 and 11.2 billion in 2100 (UN, 2015). The increase in the global population is indirectly blamed for the increase in natural disasters. The variables of population size and disasters are often considered to be interconnected.

One of the supposed effects of climate change is an increase in the number and intensity of natural disasters. However, it is important to test this common assumption. Since the 1960s, two major events served to bring much focus on natural disasters: the establishment of the two major databases of natural disasters (Office of Foreign Disaster Assistance (OFDA) in 1960 and The International Disaster Database (EM-DAT) in 1973), and the spread of television. The former has led to the detailed recording of natural disasters, allowing us to gather more knowledge about their occurrence and evolution. The spread of television has offered a more direct method of communication with the public and enables the more rapid dissemination of information. Since we are more knowledgeable about, and aware of, natural disasters, we can now ask if they have in fact increased. Although some types of disasters are increasing number and frequency in certain parts of the world, in other parts they are decreasing (Guha-Sapir et al., 2013). Furthermore, for other types of disasters there is no scientific proof of increase as of yet. It is therefore important to research natural disaster trends together with increases in population in order to determine if there is actually a cause-and-effect relationship.

The increase in the global population has been demonstrated by reliable sources such as the World Bank and the UN ("Total population graph", n/d; "World Population Projected…", 2017).

To determine whether this increase is responsible for an increase in natural disasters, we need to initially investigate three assumptions: Firstly, that human activities are responsible for the increase in greenhouse gases in the atmosphere. Secondly, that greenhouse gases cause climate change. And thirdly, that climate change is causing an increase in natural disasters. If all of these assumptions are true, then population growth will indeed lead to an increase in natural disasters. The syllogism formed is the following:

1. Increase in population = more gas emissions
2. More gas emissions = alteration of climate
3. Alteration of climate = increase in number and/or intensity of natural disasters

➡ Increase in population = increase in number and/or intensity of natural disasters

1.2 The need for humanitarian equipment

States and the global community respond to natural disasters with commercial or military equipment. This equipment is used for the transport of essential commodities, medical staff, and first aid in general. The equipment is crucial to meet the needs of disaster victims quickly. In the event of natural disasters, air equipment is often needed, as it has the advantage of being able to avoid the difficulties faced by sea and land transport (damaged roads, for example). It also provides the most rapid method of transfer for goods and persons.

In order to home in on the question of whether humanitarian needs are increasing, it is necessary to first examine the importance of preparing for natural disasters and the factors that increase people's vulnerability to natural disasters, as the rapid delivery of aid can help to reduce the number of victims and deaths (Albores et al., 2011; Afshar et al., 2012; Duran et al., 2011). The importance of the availability of air equipment is then examined, with the help of two examples in which air equipment has proven to be crucial for saving lives. These include the case of the Pakistan earthquake in 2005 and the 2014 genocide of the Yazidi led by ISIS in Iraq. The budgets of some of the world's biggest military forces (e.g. the United States) are then analysed in order to determine how much money is spent on humanitarian equipment.

After discussing the budget allowances made by nations for humanitarian equipment, this work then delves into the logistics of humanitarian operations. Based on an analysis of data regarding equipment needs provided by aid organizations, the question of whether the need for humanitarian equipment will increase in the future is investigated.

1.3 Research questions

The main research questions that this research aims to answer are the following:

1. Is there a correlation between the increase in the number and/or intensity of natural disasters and the increase in the global population?

2. Is the need for humanitarian air equipment going to increase in the future?

The global population is expected to continue to grow. Determining whether there is a correlation between population growth and the number of natural disasters can serve as a tool for a more robust prediction of natural disaster trends in the future. Shedding light on this issue will be of great value to governmental, non-governmental, intergovernmental, and humanitarian organisations involved in providing aid to victims of natural disasters.

Not only non-governmental and governmental organizations that aim to devise and implement financial and executive plans for natural disasters, but also the insurance industry, is interested in risk and investment estimates. This study aims to improve our understanding of the effects of population size on natural disasters, with the goal of strengthening disaster management and the humanitarian industry.

1.4 Academic and Practical Relevance

This research first aims to determine whether there is a relationship between a (possible) increase in natural disasters, and an increase in the global population. If this link is indeed found, along with future increases in the global population, an increase in natural disasters will also be observed. This would indicate that population size may be partly responsible for natural disasters. Although causation cannot be clearly demonstrated in such a study, this could potentially mean that increases in population affect the climate. In any case, if there is a positive correlation, stakeholders should prepare for an increase in natural disasters in the future.

In a practical sense, this research will offer stakeholders a picture of the trends that natural disasters may follow in the future. Natural disasters have a considerable impact on the economy. When natural disasters are not managed properly, this can lead to massive financial losses and major consequences on growth and poverty. If natural disasters become more frequent and/or more intense, these effects will become even more perceptible (Laframboise et al., 2012) and the costs to national governments will become more substantial. The International Disaster Database and the United Nations Office for Disaster Risk Reduction (EM-DAT, UNISDR) (2015), suggests that in the years 1995-2015, the cost of weather-related disasters was more than US $1.891 billion, and that economic losses amounted to between US $205-300 billion. Moreover, the EM-DAT-UNISDR (2015) report notes that this cost is likely to be even higher, as only 35% of natural disaster-related reports include economic data. Of the reports available for natural disasters in Africa, only 16.7% include economic data (UNISDR-CRED, 2015). As The Economist ("Counting the cost of calamities", 2012) framed it, nowadays a greater amount of money goes to repair and rescue after a tragedy than "enhancing tools beforehand". According to the World Bank, 20% of humanitarian aid is spent responding to disasters, while only 0.7% is spent on preventive measures ("Counting the cost of calamities", 2012). Knowing whether population increases have an impact on the number of natural disasters could help to enhance investment in preventative measures.

Often, other policy issues such as "poverty elimination, economic development, education and health" (Huppert et al., 2006) gain more attention because their effects on people and on politicians' reputations are more immediate. Unfortunately, disaster predictions usually come into play politically only after a major disaster has taken place. Consequently, crisis preparedness exercises are usually neglected. Boin (2009) distinguishes three reasons why preparedness is not a priority for governments: First is the high cost of crisis preparation. Preparedness for an event that "might" happen steers investment away from more "hot issues" such as "crime, education, unemployment, defense, and critical infrastructures" (Boin, 2009, pg. 371). A second reason is the difficulty of planning for events that cannot be accurately predicted. How can a team be prepared when natural disasters don't have specific patterns? Third is the political tension that crisis preparation creates (Boin, 2009). These limitations can be partly overcome when there is knowledge of disaster trends. The current work can therefore serve to inform the implementation of disaster preparedness measures, as these types of measures offer advantages such as a decrease in the "social, political, legal, financial, communal, environmental costs of disasters, and they offer better training and acknowledgement of participant's vulnerabilities" (UK Cabinet Office, 2011).

Therefore, the results of this research will be of use to a range of state and commercial agencies engaged in disaster management by providing an indication of whether natural disasters will increase in the future. Moreover, determining whether humanitarian needs will increase will help organisations better prepare for the future. As we shall see, equipment is crucial for the success of a humanitarian operation. Complete preparedness in terms of equipment needs means that more lives will be saved. Not only will this research shed light on the future need for equipment, but it will also provide an indication of how stakeholders can best invest time and money to improve infrastructure and mechanisms to cope with the effects natural disasters.

1.5 Three Case Studies

The United States is a vast country. Due to its diverse geography, the country is subject to much regional climatic variation. This makes the United States a convenient ground for studying a wide range of natural disasters on a large scale. At the same time, it is the fourth-largest country in the world in terms of population (CIA, 2017a). The US population is a relatively rapidly growing population, as opposed to much of the developed world where population size is declining or growing at a slow pace. It therefore presents an interesting case for the examination of natural disasters and population trends. Moreover, the US is a country with a fairly developed disaster management science. Many individual state and non-governmental organizations are involved in both the monitoring of natural disasters and in relief efforts. Lastly, but equally important, is the wide range of sources of available data and literature about population and natural disasters in the United States.

Somalia is a country that suffers greatly from natural disasters, mainly from drought. As we will see below, a country's response to a natural disaster and its GDP are directly linked. Therefore, in a poor country such as Somalia, the effects of any natural disaster are magnified due to a lack of adequate coping mechanisms, resulting in hunger, illness, and death for many victims. As humanitarian aid to Somalia is to a large extent provided by major organizations such as the UN and the World Food Program, a large base of information regarding natural disasters and their relief efforts are also available for Somalia.

Thailand was chosen as a third case study to allow for the examination of disaster relief in a range of continents, cultures, and climates. Although sources of information from Thailand are not abundant (particularly in English), Thailand remains an interesting case study since in contrast to other countries in southeast Asia, it does not suffer significantly from natural disasters. Thailand therefore provides a point of contrast to the other two case studies, and examining the reasons for its relative lack of natural disasters can be particularly enlightening.

1.6 Organisation

This thesis is divided into two parts: The first part examines whether there is a relationship between the global population increase and an alleged increase in natural disasters. It also examines whether deaths attributed to natural disasters are increasing due to the population increase. The second part of the analysis questions whether the need for humanitarian disaster equipment is likely to increase in the future. Using data from various humanitarian organisations as indicators, this research will try to determine whether there is a relationship between the global population increase and an increasing need for humanitarian airlift equipment.

Briefly, the structure of the thesis is as follows:

- Introduction
- Part 1: The global population increase and natural disasters
- Part 2: Future needs for humanitarian air transport equipment
- Conclusion

As previously mentioned, the first part of the analysis takes the global population increase as a fact, contrary to the supposed increase in natural disasters, which is questioned. The global increase in population is a *commonly accepted* truth that has been demonstrated scientifically and can be assessed through accurate population databases such as the World Bank's database

("Health, Nutrition and Population", n/d). On the other hand, natural disasters are a more complex issue. Although many writers state that natural disasters are increasing, there are a few factors that cloud the validity of this statement. For example, are *all* natural disasters increasing? Are they increasing in intensity, number of victims, or in frequency? Are there regional differences? It is necessary to examine these questions before accepting that natural disasters are in fact increasing in number.

The perception that natural disasters are increasing is quite as generalized statement, because as we will see, there are variations in terms of both the type of natural disaster and the region being referred to. For some categories of natural disaster, there is a degree of uncertainty as to whether their occurrence or intensity is caused by climatic factors. Moreover, not all types of natural disasters are increasing in number. Furthermore, knowledge about some categories of natural disaster is still incomplete. These issues necessarily lead to questions about the general view that the number and intensity of natural disasters are linked to climatic factors, and more specifically, to climate change.

If there is a link between population growth and natural disasters, then we should expect more natural disasters in the years to come, and the global community would do well to prepare for an imminent increase in financial, technological, and infrastructural damage, as well as the potentially increasing need for natural disaster response equipment.

1.7 Literature Review

Whether a sudden and destructive natural occurrence is a disaster depends on certain criteria set by the organisations involved in recording and monitoring them. Often, the definition of a natural disaster varies according to the particular organisation. For example, the definition of the UNISDR gives more weight to their impact on the integrity of people, the environment, materials, and the economy ("Terminology", n/d). On the other hand, the definition of the World Health Organization (WHO) is much shorter and focuses more on the impact natural disasters have on humans and the interruption to the normal flow of their lives (WHO, 2002). The definition of the Intergovernmental Panel on Climate Change (IPCC) is the most comprehensive, as it includes all of the criteria referred to by the other organizations. The IPCC defines a natural disaster as a disorganization of the community, harm to people, the economy, society, and the possible need for external assistance as a result of a severe natural phenomenon (IPCC, 2012).

Whether a natural phenomenon ends up being called a disaster depends largely on the vulnerability of people and societies. Despite this, vulnerability is mentioned as a factor only in two definitions. The first is the UNISDR definition, which defines a natural disaster as a natural phenomenon whose impact "exceeds the ability of the affected community or society to use its own resources" ("Terminology", n/d). The second definition in which reference is made to vulnerability as a criterion for natural disaster is in EM-DAT ("Glossary", n/d). EM-DAT has a list of specific criteria, of which at least one must be met in order for an event to be classified as a natural disaster. One of these criteria is the failure of states to manage the effects of natural disasters, judged by a request for assistance from other states and/or organisations ("Glossary", n/d).

Differences between organisations make it difficult to record and monitor natural disasters. Having different definitional criteria, recording methods are also different in every database. This makes it difficult to paint an overall picture of natural disaster trends, and precludes the validity that would result from coherent recording across multiple databases.

Regardless of the differences in the definitions of what a natural disaster is, these events generally need to be categorised further. The second level of categorisation has to do with the factors that cause natural disasters. At this level, organisations again use different categories and definitions. The Integrated Research on Disaster Risk (IRDR) categorises disasters into three main levels: *family*, *main events*, and *perils* (IRDR, 2014). The *family* category includes five subcategories: geophysical, hydrological, meteorological, climatic, biological, and extra-terrestrial (IRDR, 2014). The IRDR's second level of categorisation is *main events* (IRDR, 2014). This further categorises the events according to particular characteristics. For example, the *family* category "hydrological" includes flood, landslide, and wave action (IRDR, 2014). The third level of categorisation, *perils*, provides an even more detailed distinction between the types of the disasters (IRDR, 2014). The WHO, on the other hand, classifies natural disasters into one of two types: *physical* and *technological* (WHO, 2002). Physical disasters include four further categories: *meteorological*, *topological*, *tellurian and tectonic disasters*, *and accidents* (WHO, 2002). Each of the above categories includes subcategories that have to do with the particular natural disaster (for example, hydrological disasters are divided into floods and mass movement, and these can be categorized into even more specific types) (WHO, 2002).

On the other hand, EM-DAT's categorization of natural disasters has five levels ("Classification", n/d). The *disaster generic group, disaster group, disaster main-type, disaster sub-type and disaster sub-sub-type*. There are two generic disaster groups, the *natural* and *technological* groups. Technological groups don't refer to natural disasters, rather to man-made disasters like industrial accidents. Natural disasters –which is the category that concerns us-, is further categorized into six more categories, the "disaster sub-groups". Those include the geophysical, meteorological, hydrological, climatological, biological and extra-terrestrial disasters. These disaster sub-groups include natural disasters based on their natural causes. For example, the geophysical disasters sub-category includes disasters "originating from solid earth" ("Classification", n/d). The next levels of categories, disaster main-type, disaster sub-type and disaster sub-sub-type, categorize disasters into more specific types ("Classification", n/d).

On a more fine-grained level, the definitions of the various individual types of natural disasters also differ. For example, EM-DAT's definition of a drought is based on duration, meaning that drought is a deficiency in average rainfall, or more generally, of water, which lasts for an extended period ("Definitions", n/d). The IPCC's definition is also based on duration, but is more specific, categorizing droughts into meteorological droughts (periods with substantial low levels of precipitation) and megadroughts (drought periods that last more than ten years) (IPCC, 2012). The National Weather Service's definition is much shorter and only refers to the effects of drought "on people, animals or vegetation", although it too generally refers to a drought as a "deficiency of moisture" (NWS, 2012).

Secondary definitions such as "vulnerability" and "affected" also vary across organisations. UNISDR defines vulnerability as "the characteristics and circumstances of a community, system or asset that makes it susceptible to the damaging effects of a hazard" (UNISDR, 2010). The IPCC defines vulnerability according to the extent to which a system is able or unable to manage the impacts of climatic phenomena (IPCC, 2012).

Concerning the term "affected", UNISDR makes a difference between directly and indirectly affected. In the first case, there is a direct impact on health and accommodation, as well as social impacts on culture, but also variations in everyday life ("Terminology" UNISDR, n/d). In contrast, EM-DAT more narrowly considers those affected to be people who require immediate assistance during a period of emergency (EM-DAT).

In this research, we will use the definition of natural disasters provided by EM-DAT since this database of natural disasters is a well-known and authoritative source. The definition is as follows:

For a disaster to be entered into the [EM-DAT] database at least one of the following criteria must be fulfilled:
1. Ten (10) or more people reported killed
2. Hundred (100) or more people reported affected
3. Declaration of a state of emergency
4. Call for international assistance. (EM-DAT explanatory notes)

At the time this research was being carried out, the database was openly accessible, however at the time of writing, it is no longer available to the general public. Other sources considered include:

- The “National Geographical Data Center – National Oceanic and Atmospheric Administration” (NGDC-NOAA) - only focuses on three categories of natural disasters: tsunamis, earthquakes, and volcanic eruptions

- The “Global Risk Data Platform” - easy to use and comprehensive, however the information only concerns the recent past.

- The “Socioeconomics Data and Applications Center” (SEDAC) - only includes data from recent years.

- The “Center of Hazards of Columbia” - focuses only on specific countries, and does not offer a database.

EM-DAT was considered the most appropriate option for collecting evidence on natural disaster trends, as it was openly available during the data collection period, it provides flexibility in the presentation of data (charts), it includes many different types of natural disasters, and it categorizes information based on country or type of natural disaster.

With regard to linking population growth to the increase in the number and/or intensity of natural disasters, there are many sources reporting that population growth is the cause of an increase in natural disasters. In some, an element of doubt is mentioned, and in others it is not, but none of them establish a rationale and argument for this statement. In order to establish both that the global population is increasing and that natural disasters are on the rise, data about natural disaster trends and population growth and its causes were also consulted.

1.8 Methodology

In this research, a mix of quantitative and qualitative methods were used. In order to answer the question of whether the global population increase has led to an increase in the number and/or intensity of natural disasters, academic papers related to the science of meteorology and natural phenomena were consulted, as well as official reports. The EM-DAT database was used to identify the study cases' trends in natural disasters (US, Somalia, Thailand).

For the second aspect of this research regarding the potential for an increase in the need for humanitarian airlift equipment, a qualitative method was used. The quantitative analysis of the airborne instruments used in natural disasters, while initially preferred, could not be achieved as there is no available database in which the use of equipment in humanitarian crises is recorded. As we will see, determining how fleets have developed over the years is problematic, as states and humanitarian organisations often contract out or are donated equipment. For this reason, a qualitative analysis was deemed appropriate, and the trends regarding the use of air equipment was gauged through an analysis of defence expenditure documents and official statements. Information published in news outlets such as The Guardian and the BBC were used to obtain further details on the issues of the Yazidi genocide and the earthquake in Pakistan. A questionnaire about the future need for air equipment was sent by e-mail or through online contact forms to many organizations such as the World Food Programme (WFP), the United Nations (UN), the Logistics Cluster, and the North Atlantic Treaty Organization (NATO). Only the WFP responded. Finally, open source websites, official papers, and academic literature were also consulted in order to gain a comprehensive view of the current and past use of humanitarian air transport equipment, with the aim of better understanding future needs.

The timeframe examined ranged from 1960 to 2016, as it is only in 1960s that the systematic recording of natural disasters began. As previously mentioned, the basic definition of a natural disaster used here is that of the EM-DAT database, repeated here for convenience:

For a disaster to be entered into the [EM-DAT] database at least one of the following criteria must be fulfilled:

1. Ten (10) or more people reported killed

2. Hundred (100) or more people reported affected

3. Declaration of a state of emergency

4. Call for international assistance.

(EM-DAT)

In order to determine whether the need for humanitarian aid is likely to increase in future, three types of source were consulted: budgets, official statements/documents, and an interview. By analysing the budgets of both governmental and non-governmental agencies, we attempted to determine whether (and to what extent) they have provided for humanitarian airborne equipment. Finally, the case studies of the Yazidis and Pakistan demonstrate the importance of cooperation between organizations and the importance of air transport equipment. These two cases involved both domestic and international players providing equipment, and both were major issues that are discussed at length in the literature.

Chapter 2 – Analysis: Population and natural disasters

To what extent is the global population increase the cause of the increase in the number and/or intensity of natural disasters?

Answering the question of whether a population increase is to blame for the increased number and/or intensity of natural disasters, three common beliefs have to be tested. First of all, we need to determine whether a larger population actually results in more greenhouse gas (GHG) emissions. Second, the idea that emissions are linked to climate change must be established scientifically. Last but not least, the link between climate change and the number and/or intensity of natural disasters must also be tested.

In short, we test the following reasoning:

1. Increase in population = more GHG emissions
2. More GHG emissions = alteration of climate
3. Alteration of climate = increase in number and/or intensity of natural disasters

➡ Increase in population = increase in number and/or intensity of natural disasters

2.1 An increase in population leads to more greenhouse gas emissions

It is easy to assume that as population numbers increase, so do greenhouse gas emissions, as transportation or electricity needs increase as well. However, while this might seem apparent, there are technological and societal parameters that determine GHG emission trends, and these are not necessarily in line with population trends. This is demonstrated by the fact that although since 1990 there has generally been a constant increase in emission rates, there were periods during which these rates were reduced. In contrast, rates of population increase have not slowed. Rather, these have followed a constant exponential rate of increase (World Bank, n/d; UN, 2017), showing that GHG emission rates do not necessarily parallel population levels.

The most important greenhouse gases emitted by humans are nitrogen oxide, methane, carbon dioxide, and the so-called F-gases (EPA, 2017). Anthropogenic gas emissions are distributed across five sectors: electricity emissions, transportation, industry, commercial and residential emissions, and agricultural emissions (EPA, 2017). The first sector, electricity, involves the production of electricity to generate energy for the other sectors (the "end-use sectors") through the consumption of fossil fuels (EPA, 2017). The burning of fossil fuels emits carbon dioxide (CO_2), which is the most abundant greenhouse gas in the atmosphere (EPA, 2017). In the US in 2015, after electricity-related emissions were distributed to the end-use sectors, transportation activities accounted for 34.5% of CO_2 emissions (EPA, 2017). The main types of transportation that contributed to this number were passenger cars (42.3%), medium and heavy-duty trucks (23.6%) and light-duty trucks (17.1%) (EPA, 2017). As the EPA (2017) report mentions, the main reason for the observed increase in transportation CO_2 between 1990 and 2015 can be attributed to an increase in traveling (in 2015, commercial aircraft use accounted for 6.8% of the total transportation CO_2 emissions).

Industrial processes are also responsible for a large amount of gas emissions. In 2015 the industrial sector produced 27% of the total CO_2 emissions (that were produced from fossil fuel combustion) (EPA, 2017). Since 1990, industrial emissions in the US have decreased, partly because of the move towards an economy based more on services than on industry, but also because of an increase in the use of alternative fuels and the improvement of energy efficiency (EPA, 2017). In contrast, since 1990, residential emissions in the US have increased by 8%, and commercial emissions by 20% (EPA, 2017). Residential emissions include the electricity consumption for lighting, heating, cooling, and operating household appliances in homes, while commercial emissions in businesses (EPA, 2017).

In the European Union (EU), most sectors have noted a decline in GHG emissions. One sector however, transportation, has increased its emissions by 23% since 1990 (Eurostat, 2017).

2.1.1 Variation between countries/regions

It is indisputable that global GHG emissions have greatly increased. Since 1970, global GHG emissions have increased by 90% (EPA, 2017). However, there is variation across countries and regions. For example, GHG emissions in the EU have been decreasing (Olivier et al., 2016). From 1990 to 2014, the EU (of 28 member states) has decreased its total GHG emissions by 23% (Eurostat, 2017).

Another example of a country that has decreased its GHG emissions is the United States, where in 2014-2015, GHG emissions were reduced by 2.3% compared to the year 1990 (EPA, 2017). This decrease was driven by a reduction in CO_2 emissions from fossil fuel combustion (EPA, 2017). This was a result of multiple factors, including an increase in the consumption of natural gas (over coal) in the electric power sector, warmer winter conditions in 2015 that resulted in a decreased demand for heating in the residential and commercial sectors, and a slight decrease in electricity demand (EPA, 2017).

2.1.2 Population and emissions

Despite the fact that the overall population of the EU has increased in a slow (but steady) manner since 1990, GHG emissions per person in the EU have decreased slightly (Eurostat, 2017). Population increased by 5% between 1995 and 2014 (Eurostat, 2017). In the US, population increased as well. The EPA states that population growth is a cause of increased CO_2 production, but that it is not the sole cause (EPA, 2017). Other long term and short term factors, like the economic trends, the progress in the technological field, political decisions, as well as the availability of alternative fuels, all contribute to the decrease or increase of the CO2 trends (EPA, 2017).

2.1.3 Uncertainty

It must be noted that there is a range of about 5-10% uncertainty in national CO_2 emissions records (Olivier et al., 2016). This is mostly due to the fact that some of the states that provide data have rapidly changing economies, and data may not reflect the most recent emissions levels (Olivier et al., 2016. The level of uncertainty for China and the Russian Federation is about 10%, while the EU, US, Japan, India, and other member countries of the Organization for Economic Co-operation and Development (OECD) have uncertainty levels of about 5% (Olivier et al., 2016).

2.1.4 What affects CO2 emissions?

Explanations for a reduction in CO_2 emissions for a particular activity are either that the frequency of the activity that was causing the emission was reduced, or the way that the activity is carried out has changed in terms of energy efficiency (Eurostat, 2017). Consequently, the improvement of technology towards energy efficiency determines whether carrying out an activity on the same (or a larger) scale can result in fewer GHG emissions. The greater the efficiency in energy consumption, the lower the GHG emissions will be for that activity (Eurostat, 2017). Despite the fact that manufacturing and the amount of services offered have increased in the EU since 1993, GHG emissions have decreased. This can be attributed to an improvement in energy efficiency and the types of energy sources used (Eurostat, 2017).

The emergence of alternative sources of energy plays a role in the reduction of GHG emissions. In the US, CO_2 emissions decreased by 2.6% in 2015, mainly due to a decrease in coal consumption (13%) (BP, 2016). The move from coal to natural gas for electricity production is one of the main the reasons for the decrease in energy-related CO_2 emissions over the past decade. At the same time, electricity demands have increased since 2015 (EIA, 2016 cited in Olivier et al., 2016).

Economic conditions are another factor in CO_2 emission levels, but only in the short term. Some individual states in the EU showed reduced CO_2 emissions in 2009 due to the economic crisis, which decreased emissions in all source sectors (Eurostat, 2017). This effect was observable on the global scale as well, as during 2009 there was a 1% decrease in global CO_2 emissions compared with the previous year (Olivier et al., 2016). However, the economy only has a short-term effect on GHG emission trends (EPA, 2017). Gross Domestic Product (GDP) and GHG emissions should therefore not be considered correlated, as economic activity is irrelevant to GHG emissions, at least in the long run (Eurostat, 2017). In the EU for example, during the years 1995-2014 there was a (slight) decrease in GHG emissions, despite the fact that GDP increased by 36% (Eurostat, 2017). This demonstrates that GDP and GHG emissions are not linked in the long term (Eurostat, 2017).

Weather is another factor that affects GHG emissions, as colder winters generally result in an increased need for heating. In the Netherlands, natural gas is used for heating most buildings. This causes an increased use of gaseous fuel for heating in winter (Olivier et al., 2016). The winter of 2011 in the Netherlands was mild, compared to that of 2010 (Olivier et al., 2016). This led to a lower demand for heating fuel, which then led to about a 7% decrease in GHG emissions compared to 2010 (Olivier et al., 2016). Conversely, in 2015 there was an increase of 4% in GHG emissions in the Netherlands compared to 2014. This can be attributed to an increase in electricity production in coal fired plants during that year (but also to an increase in fuel combustion in all sectors), which was a result of the severity of the 2015 winter (Olivier et al., 2016).

2.1.5 Conclusion

The above data indicate that population increases cannot be directly linked with increases in greenhouse gas emissions. In cases like the EU, despite a population increase, GHG emissions have been reduced by 23% since 1990 (Eurostat, 2017). We have seen that the increase or decrease in GHG emissions depends on multiple factors such as weather conditions, demand for alternative fuel sources, energy efficiency improvements, and the economy (in the short run). This means that we cannot directly link population increase with GHG emissions, as these do not necessarily increase in response to population growth.

2.2 Gas emissions alter the climate

Changes in the temperature of the atmosphere or Earth's surface happen naturally, and climate change is a natural process that our planet has experienced many times in the past (Riebeek, 2010). Small shifts in the Earth's orbit, as well as the sun's energy variations have from time to time decreased or increased Earth's exposure to sunlight, causing changes in temperature (Riebeek, 2010). However, what makes modern temperature increases different is the speed at which the temperature changes are occurring. Nowadays, the climate is changing at a very fast pace (Riebeek, 2010). Many scientists believe that greenhouse gases are to blame for this rapid increase in temperature, and thus that the burning of fossil fuels, which produces GHG, is the ultimate cause of modern climate change (Riebeek, 2010).

Some of the impacts of global warming – apart from the increasing temperatures – are that it "modifies rainfall patterns, amplifies coastal erosion, lengthens the growing season in some regions, melts ice caps and glaciers, and alters the ranges of some infectious diseases" (Riebeek, 2010). Greenhouse gases can affect the climate directly, through an increase in temperatures, but also indirectly, with so-called "climate feedbacks", which are side effects of the Earth's warming (Riebeek, 2010). One example is the melting of snow and ice. As the ice melts, a large surface that was previously reflecting solar energy back into the atmosphere is lost, and more heat is absorbed (Riebeek, 2010). Moreover, melting ice raises the sea level, leading to an increase in the size of the sea surface. Because the ocean water is dark, it absorbs heat, which makes the ocean warmer (Riebeek, 2010).

The amount of CO_2 present in the atmosphere isn't necessarily proportional to CO_2 emissions. Annual increases in CO_2 concentrations in the atmosphere depend on the amount of vegetation taking up CO_2 in the process of photosynthesis, and therefore vary due to forest fires and deforestation, which reduce the amount of vegetation (Olivier et al., 2016). The oceans also absorb CO_2, and the rate at which they do so also varies over time (Olivier et al., 2016).

As the consumption of fossil fuels continues, GHG concentrations are going to rise, (Riebeek, 2010) and so will do the Earth's temperature. Based on valid scenarios, until the end of the 21st century Earth's temperature might increase two to six degrees Celsius (Riebeek, 2010). This increase will happen even if the world reduces GHG emissions. As the earth hasn't full adjusted to the climate change, some outcomes of climate change are irreversible (Riebeek, 2010).

2.3 Climate change results in an increase in the number and/or intensity of natural disasters

The question of whether there is a connection between GHG emissions and severe climate events has not yet been answered beyond a shadow of a doubt, however this connection is gaining more and more supporters (Anderson et al., 2006). As we have already seen, historically, climate change has been a natural phenomenon (Anderson et al., 2006). No matter how much disaster science develops, we can never be completely certain that a natural disaster was caused by anthropogenic climate change, or whether it is a result of the Earth's natural processes (Anderson et al., 2006). This indicates a degree of uncertainty when trying to determine the influence of anthropogenic pollution on natural disasters (Anderson et al., 2006). Consequently, climate change can only be examined through statistical trends, and not by taking into consideration individual incidents (Anderson et al., 2006).

The extreme temperatures and increases in precipitation in recent decades are generally believed to mostly be a result of climate change, but there is no certainty about this (ADB, 2013). There is a difficulty in predicting natural disasters and monitoring their behaviour through time. Natural disasters are complex and sporadic phenomena, which makes the gathering of data and any comparison difficult. Comparing average conditions and extreme weather is also difficult (ADB, 2013). For example, records for hurricanes do not go very far back in time, which makes it hard to determine with certainty if they have actually increased in number (ADB, 2013). Moreover, while disasters like heat waves and intense rainfall have a clear link with climate change, for others such as hurricanes, there is no clear connection (ADB, 2013).

2.3.1 Global trends

From the 1960s, when a proper registry of natural disaster incidents was established, the global number of climatological disasters has steadily but slowly (EM-DAT) increased. In general, increase rates are not that high, with exceptions in a few years such as 1983 and 2000, when the number of incidents exceeded 40 and nearly reached 60, respectively (EM-DAT). Numbers remain fairly stable, as in the years between 2003-2014, when the number did not exceed 35 (EM-DAT).

Despite the fact that there has been no steep increase in climatological disasters, hydrological and meteorological disasters are clearly increasing rapidly (EM-DAT). Between 1964 and 1976, the number of hydrological disasters did not exceed 40. In contrast, between 1980 and 1993 there were never fewer than 60 cases per year (in five of those years, the number of cases even exceeded 100) (EM-DAT). After 1993, a constant increase can be observed, reaching a peak in 2006 with 270 incidents (EM-DAT). In the six-year period between 2010 and 2016, a 20% increase in the number of floods was observed, compared to the period between 1965 and 2015 (EM-DAT). Meteorological disasters also show a rapidly increasing trend. While before 1976 the number did not surpass 62 incidents, after that year, an increasing pattern can be observed, with 190 incidents in 2000 and a peak in 2005, with around 390 incidents (EM-DAT).

Since 1970, the global land area experiencing severe drought (a climatological disaster) has doubled (Saunders, 2005 cited by Anderson et al., 2006). The magnitude of a drought and the extent of its impact depends on several factors such as “its duration, the degree of moisture deficiency and the size of the affected area, as well as the capacity of the community to manage the lack of water” (Coppola, 2007). Therefore, the level of the disaster has to do with the ability of the particular area to cope with its effects. Sometimes, a drought takes many months to develop and may last for a long time (months or years) (“a creeping hazard”) (Coppola, 2007). It is not well understood what causes or triggers drought, however their broader cause is often the constantly changing climate patterns (Coppola, 2007).

Meteorological disasters include storms, extreme temperatures, and fog (which will not be analysed here) (EM-DAT). Major improvements in the monitoring of storms only began at the start of 1970 (Landsea et al., 2006). Consequently, there is not much agreement regarding the trends (IPCC 2001). Increases and decreases in the number of storms varies according to region, and it is hard to determine whether windstorms (in Europe) are actually increasing in frequency or intensity. During certain periods, like the beginning of 90s, there is a decrease in the frequency and intensity of these, but in other areas, the opposite happened; in the Baltic Sea, wind speed has increased over the last 50 years. Consequently, at least in Europe, the trends vary according to time period and location. (Anderson et al., 2006). In regards to other types of storms, what is known is that their strength is related to the water vapour in the air (Frei et al., 2001), and increased sea surface temperatures significantly influence the intensity of storms (Emmanuel, 2005). This means that storms may have higher winds and produce more rainfall due to the effects of global warming (Trenberth, 2005). Despite the fact that the science of hurricanes has made progress over the years and that it is now easier to determine whether climate change affects hurricanes, this limited knowledge regarding storms does not allow for certainty when analysing storm trends through time (ADB, 2013).

The number of high rainfall events has generally been increasing in Europe since 1950. More specifically, precipitation has increased during winters in the UK (Osborn et al., 2000) and in Alpine regions (Frei et al., 2001). An increase in extreme precipitation incidents is believed to be linked to anthropogenic GHG emissions (O'Gorman and Schneider 2009; Min et al., 2011) and with the global increase in temperatures (Lenderink et al., 2010; Trenberth, 2011), resulting in an average increase in the number of extreme rainfall events around the world (Westra et al., 2012). However, there is still not much certainty, as "there is yet to be any evidence of any long-term relationship between GHGs and average precipitation" (ADB, 2013, pg. 4). Moreover, Sander et al. (2013) have argued that "there is a relationship between climate change and thunderstorms in the US, but still, there is no certain link although they note that final attribution is not possible" (ADB, 2013, pg. 4).

Flooding falls into the category of hydrological disasters. On a global level, it is difficult to observe a clear-cut trend (Anderson et al., 2006). It may be that the number of extreme flooding events is increasing (Milly et al., 2005), but small flooding events do not appear to be increasing (Robson, 2002).

2.3.2 Global population

The industrial revolution caused an immense improvement in the general quality of life after the 18th century. Famines and epidemics were mostly eliminated in many regions, living standards were raised, and people began living easier and safer lives (PRB, n/d). Consequently, only 50 years after 1750, when the global population was 760 million, the population reached 1 billion (PRB, n/d). Then, after World War II, another huge population increase occurred. From 1960 to 1975 - only 15 years – the world's population increased by one billion. Today, there are more than seven billion people on the planet (PRB, n/d).

Future population predictions are characterized by a degree of uncertainty, as they rely highly on fertility rates (UN, 2017). In general, a future decline in fertility is expected in countries with high birth rates, while an increase in fertility is expected in countries where women give birth to less than two children (UN, 2017). While there is a 27% chance that the global population will stabilize or even begin to decrease around the year 2100, the most likely scenario is that the population will continue to increase (UN, 2017). In 2030, the population is expected to be between 8.4 and 8.7 billion, and between 9.6 and 13.2 billion in 2100. In 2050, Africa is expected to have 1.3 million additional people, making it the largest contributor to the global population (UN, 2017). Europe is the only region expected to have fewer people in 2050, despite the fact that the birth rate will increase from 1.6 births per woman (the observed birth rate for 2010-2015) to 1.8 in 2045-2050 (UN, 2017). This is attributed to the lower fertility rates (UN, 2017).

Urbanisation is a major factor that increases vulnerability to natural disasters. In 1950, the global urban population had reached 746 million (UN, 2014). At present, approximately 3.6 billion people (54% of the world's population) live in urban areas. By 2050, 2.5 billion more people are expected to live in urban areas, an increase of 66% (UN, 2014). Asia has 53% of the world's urban population, whereas Europe has 14%, and Latin America and the Caribbean, 13% (UN, 2014). The sheer number of people living in these densely populated urban centres means that any disaster hitting those areas is likely to have a higher death toll, and affect many more people than those hitting rural areas.

2.4 Case Studies

2.4.1 United States

2.4.1.1 Population

The US is the world's third most populated country (Kent et al., 2002), and its population continues to follow a stable increase (UN, 2015). In 1950, the US population counted 157 million people (Worldometers, n/d). In 2015, the population reached 321 million people. According to forecasts, by 2050 the US population is expected to exceed 300 million (UN, 2015). These predictions are contrasted by those for other countries/regions of the developed world (Kent, 2002). For example, by 2020 European countries are expected to stop growing in population, and Japan is expected to face population decrease (Kent, 2002). These variations in population growth have to do with three variables: fertility rates, mortality rates, and migration (Kent, 2002). As the developed countries have lower mortality rates that the developing ones, what play a big role in population growth are mostly the fertility rates and the migration rates. In the US, migration rates are high, and fertility rates are relatively high as well (1.8 births per woman in 2014) (World Bank, n/d). In contrast, Japan has lower fertility rates (1.4 births per woman in 2014) and smaller migration rates (0 migrant(s)/1000 population in 2017) (World Bank, n/d; CIA, 2017a). Europe on the other side, has very low fertility rates (1.5 in 2014) (Eurostat, 2017).

A major factor in the projected increase in the US population is the rapid growth of the young American population; in 2002, more than the one fifth of the US population was under the age of 15 (Kent, 2002). Another contributor is high migration rates towards US and its high fertility rates in comparison to the rest of the developed world (Kent et al., 2002). Future forecasts predict that by 2050, half of the world's population growth is expected to be concentrated in nine countries, one of which is the US (UN, 2015).

2.4.1.2 Meteorological disasters

Storm/hurricane trends

The most frequent natural hazard in the US is storms. In the period of 1950-2015, the US recorded 525 storm incidents (EM-DAT). Particularly since 1995, there has been a clear increase in storm incidents (EPA, n/d). Since 1990, six out of ten of the most active years since 1950 have been observed (EPA, n/d). Specifically, the intensity of hurricanes and cyclones is increasing (Elsner et al., 2010), but when it comes to an increase in number, hurricanes don't indicate a clear trend as to whether they are increasing or decreasing (EPA, n/d). An increase in tropical cyclone activity is apparent however, but it is difficult to estimate the extent of the increase, since monitoring methods have changed throughout the years (EPA, n/d). On a scientific level, "there is no empirical evidence, modelling result or theoretical argument that indicates the number of hurricanes will increase in a warmer world" (Elsner et al., 2010). However, intense storms might increase in number. The atmospheric heat and humidity levels and the increased sea surface temperature might cause increase in the speed of tropical storms (Riebeek, 2005).

Temperature

Unlike storm trends, there is a good amount of certainty regarding global temperature increases (EEA, 2004). On a global scale, all of the top ten warmest years on record have occurred since 1998 (NASA, 2015). Moreover, in every modelled scenario, by 2080, the frequency, intensity, and duration of heat waves is expected to increase (Melillo et al., 2014).

Precipitation

Since 1901, there has been an average rainfall increase of 0.08 inches per decade (EPA, n/d). In the US, most of the yearly rainfall has come occurred in single day events (EPA, n/d). Between 1910 and the 1980s, the number of precipitation events remained fairly steady, but since the 1980s, these have risen significantly (EPA, n/d). In the US as a whole, nine out of the ten years with the highest number of extreme one-day precipitation events have occurred since 1990 (Melillo et al., 2014). However, there is some variability: some years didn't see abnormally wet areas, but others had abnormally high precipitation totals over ten percent or more of the contiguous 48 states' land area. For example, 1941 was extremely wet only in the West, while 1982 was very wet nationwide (EPA, n/d). However, changes in the intensity of precipitation and variation in the interval between precipitation events can also lead to changes in overall precipitation levels (EPA, n/d).

Global long term precipitation trends show no clear evidence of increase (IPCC, 2001b). There is some scientific indication that precipitation has increased over land and at high latitudes since 1950, and possibly also over tropical oceans, but it has also decreased over tropical land (New et al., 2001). There is therefore not enough evidence regarding the magnitude of heavy rainfall.

2.4.1.3 Hydrological disasters

Flooding

Increases and decreases in the frequency and magnitude of floods are linked to increases and decreases in the frequency of heavy rainfall events ("River flooding", n/d), but also to sea levels. For example, the US coastline is experiencing an increase in floods because of rising sea levels (Melillo et al., 2009). Changes in streamflow, the timing of snowmelt, and the amount of snowpack that accumulates in the winter can also affect flood patterns (EPA, n/d). There is still a dearth of scientific evidence regarding the magnitude and/or frequency trends of floods globally, which leads to some uncertainty (IPCC, 2013). It is possible that climate change may lead to more significant floods, or increase their frequency, as increasing temperatures lead to more water being evaporated from the land and oceans (EPA, n/d).

In the US, some areas have experienced changes in flood patterns. In some places, floods have increased in frequency, like in the North Pacific Northwest (Mallakpour et al., 2015), but in others, flood frequency has decreased, like in the Southwest and the Rocky Mountains (EPA, river flooding).

An increased in magnitude has been observed in the West, Western Appalachia, Northern Michigan, and the Southeastern US (Melillo et al., 2009). An increase in the frequency of high magnitude floods has also occurred in the Pacific Northwest (Mallakpour et al., 2015). However, there are some places, such as the Central US, where there has been no significant increase in the magnitude of floods (Mallakpour et al., 2015).

2.4.2 Somalia

2.4.2.1 Population

Somalia is located in East Africa, and takes up a large section of the "Horn of Africa". Consequently, it borders both the Gulf of Aden and the Indian Ocean. Because of its morphology and its arid or semi-arid climate, Somalia faces severe droughts, frequent dust storms, and floods (CIA, 2017b).

Somalia's population can only be estimated based on the last official population measurement which took place in 1975 (CIA, 2017b). At that time, 3.2 million people were counted (CIA, 2017b). The large number of nomads as well as the intense refugee movements due to famine, clan warfare, drought, and floods make Somalia the 3rd highest source country for refugees, and makes the task of population estimation quite difficult (CIA, 2017b). The CIA (2017b) estimates that in 2016, the population reached almost the 11 million people. 2016 estimates of the population growth rate suggest that this number is 1.92% (CIA, 2017b). By 2100, Somalia's population is expected to increase at least five-fold (UN, 2015).

With an average population density of about 15 people per square kilometre, Somalia is considered a sparsely populated country in which 75 per cent of the people have historically lived in rural areas (CIA, 2017b). Recent estimates (2015) indicate that those living in urban areas now account for 39.6% of the population (CIA, 2017b). This urbanisation process indicates that a majority of Somalis now reside in towns, which increases their vulnerability (UNEP, 2001).

2.4.2.2 Hydrological disasters

Rainfall/precipitation

Concerning rainfall, Somalia will be analysed as part of the broader area of the Horn of Africa as there is no sufficient data for Somalia itself. The Horn of Africa has experienced a decrease in rainfall over the last 30 years. This decrease has mainly taken place during the long rains season and during the June-July-August dry season (Tierney et. al, 2015). The long rains season, which occurs in the months of March, April, and May, is the primary rainy season in the region (Tierney et. al, 2015). During the short rains season (September-October-November), there has been a "slight increase in rainfall centred near the Great Lakes region" (Tierney et. al, 2015). It is unclear however, if this is a consequence of the "anthropogenically" driven warming in the Indian Ocean or Western Pacific region. In their research, Tierney et al. (2015) state that there is an "anthropogenic component" to this 20th century drying, due to the fact that the recent rise in global temperatures can be attributed to greenhouse gas emissions (Tierney et. al, 2015). Total precipitation during the long rains season has been reported to be in decline in recent decades (Williams et al., 2011). This decline has been attributed to a contemporaneous upward trend in sea surface temperatures (SSTs) in the south-central Indian Ocean and western Pacific Ocean (Tierney et. al, 2015). The suggested physical link is that increasing SSTs in this region favour a local enhancement of precipitation with the resultant latent heating altering regional wind and moisture flux patterns, ultimately reducing long rains precipitation in East Africa (Lyon et al., 2012). As for future predictions, Tierney et al., (2015) suggest that global warming will cause an increase in rainfall over the eastern Horn of Africa, primarily during the short rains season. Tierney et al.'s (2015) simulations of historical climate did not result in a mean annual drying trend in the Horn. Rather, they suggest slightly wetter conditions on average, with an increase in both the short and long rains, in contrast with previous research, which predicted that the greater East Africa region will become more arid in response to future increases in greenhouse gases (Tierney et. al, 2015).

Floods

Between 1961 and 2004, 18 floods were recorded in Somalia, killing 2671 people and affecting the lives of almost 1.8 million (UNEP, 2005). Flooding and storms are the most frequent natural disasters in the country; between 1990 and 2014, floods comprised 57.1% of natural disasters, and storms, 25.7% (EM-DAT). However, the most fatal natural disasters have been earthquakes, which were responsible for 72.1% of mortality attributed to natural disasters (EM-DAT). Flood follows in the second place with 23.6% of natural disaster mortality (EM-DAT).

2.4.3 Thailand

2.4.3.1 Population

Thailand's population counts 67 million people (Columbia, n/d). The capital, Bangkok, amounts for 15% of the population (Kisner, 2008).

2.4.3.2 Natural Disasters

May to October is the rainy season in Thailand, and September and October are the height of the monsoon season (UK, n/d). The most frequent natural disaster in Thailand is flooding caused by storms (Columbia, n/d; UK, n/d), followed by cyclones (Columbia, n/d). Flooding is also the most costly natural disaster, causing the 95.9% of the "economic issues" ("Thailand", n/d). During the rainy season, these phenomena are magnified (UK, n/d). Despite floods being the most frequent disaster (57.1%), earthquakes cause the most casualties (72.1% of natural disasters casualties) ("Thailand", n/d).

Morphologically, Thailand is divided into four regions (ADRC, n/d). Each one is prone to different types of disasters (ADRC, n/d). The northern region's landscape is composed of mountains, natural forests, and valleys, and is therefore susceptible to flooding, landslides, earthquakes, and forest fires (ADRC, n/d). The central part of Thailand consists mainly of valleys and is prone to floods and earthquakes (ADRC, n/d). The Northeast is a dry region with undulating hills, and is subject to floods and droughts (ADRC, n/d). Finally, the South is hilly to mountainous, with forests, and is prone to floods, tropical storms, landslides, and forest fires (ADRC, n/d).

Natural disasters that frequently occur in Thailand include floods, droughts, tropical storms, and forest fires, whereas earthquakes and landslides occur only occasionally (ADRC, n/d). Generally, the sudden onset natural disasters cause the most damage to lives and property (ADRC, n/d). Rural areas are the most vulnerable to disasters because of infrastructure underdevelopment (ADRC, n/d). Moreover, the rural population, which consists mainly of that poor agriculturists, are unable to invest in resources in order to reduce their vulnerability to disasters (ADRC, n/d).

Droughts are becoming more intense in Thailand (ADRC, n/d). Population increases and economic development have increased the need for water for agricultural and industrial purposes (ADRC, n/d). Agriculture is the biggest economic sector in Thailand, as it employs 49% of the population and contributes to 10% of the country's GDP (Kisner, 2008). The main cause of droughts is deforestation, in combination with the dry climate (ADRC, n/d).

Thailand is not a big polluter though; only 0.8% of global CO_2 emissions are produced by Thailand, and its per capita emissions rates are lower than the global average (Kisner, 2008). However, during 1991-2002, Thailand's CO_2 emissions doubled (Kisner, 2008). Thailand has taken measures to tackle this increase and the effects of natural disasters. There is an attempt to shift towards organic agriculture, and the country has implemented an Action Plan to reduce greenhouse gas emissions coming from vehicle and energy use (Kisner, 2008).

2.5 Future Predictions

In the future, it is predicted that climate change will have serious consequences (Anderson et al., 2006). It is highly likely that extreme events will become more frequent as GHG emissions increase (Anderson et al., 2006). Changes in precipitation patterns will trigger more incidents of flooding and drought (Anderson et al., 2006). Sea levels will rise, and the intensity of rain and flooding will increase (Anderson et al., 2006). As for windstorms, they are also expected to increase, and the number of intense storms will rise by 30% by 2100 (Anderson et al., 2006). These changes in the patterns of natural disasters will also lead to a series of equally serious side effects such as forest fires and avalanches (Anderson et al., 2006). These extreme events present the greatest challenge for vulnerability, rather than the average change in climate conditions (IPCC, 2001a, cited by Anderson et al., 2006).

Chapter 3 – Analysis: Humanitarian equipment

Is the need for humanitarian air equipment going to increase in the future?

3.1 Introduction

In natural disaster situations, effective emergency management is crucial for the survival of those affected. One aspect of emergency management is logistics management, which not only refers to the distribution of food, medicine, medical supplies and other goods to affected people, but also the transport of medical staff (Albores et al., 2012). Humanitarian organisations use various means (i.e. land, sea, air) to achieve the best possible speed-efficiency ratio for the transportation of goods and staff. This often faces problems however. For example, accessibility to affected areas is usually problematic (WFP, 2016a; ATAG, 2014). If this is the case, the most common and useful way of carrying staff and personnel is by air (ATAG, 2014).

Air transport has the ability to deliver goods in a rapid and more secure way (ATAG, 2014). Security issues on land and sea can prevent cars and ships from reaching their destinations (WFP, 2016). Moreover, air transport equipment has been proven crucial when it comes to evacuations (WFP, 2016). As air transport equipment is so significant in natural disaster relief operations, it is important for nations and humanitarian or intergovernmental organisations to be adequately prepared for equipment needs that will come up in the future.

This chapter examines whether the need for humanitarian air transport equipment is likely to increase in the future. Firstly an overview of the humanitarian supply chain means of transport will be presented. More specifically the problems that sea, road and air humanitarian equipment face when delivering humanitarian assistance. Using the cases of the Somalian humanitarian crisis, the Yazidi humanitarian crisis in 2014 and the 2015 Pakistan earthquake, the importance of taking into consideration equipment management in crisis situations will be highlighted. In all of these three humanitarian disasters, the assistance of the air force was crucial, and a significant number of people were saved due to its involvement. Despite that cases analyzed don't concern exclusively natural disasters, they still they demonstrate the importance of air equipment in cases of disaster, in general. Next, the factors that contribute to vulnerability and end up classifying a natural phenomenon to a disaster will be presented. Last, the military budgets of some major military powers, such as the United States and the Netherlands, will be presented. This data serves to give an indication of the level of attention that nations give to their needs for humanitarian air transport equipment.

3.2 The humanitarian supply chain

Predicting future needs for humanitarian equipment is not an easy task. Estimations would be far more accurate if humanitarian disasters could be forecasted, but unfortunately this is not the case. No accurate estimation regarding the exact time that they will hit, or their magnitude, or the number of people that will be affected is possible. If the demand for supplies and the number of people affected could be estimated, then to a large degree, the demand for equipment could also be estimated. In contrast to commercial supply chains, where there is a certain degree of uncertainty about demand, in humanitarian supply chains this uncertainty is magnified as it is near impossible to predict the outcome of an upcoming disaster and how many people will be in need of assistance (Albores et al., n/d).

While humanitarian distribution and commercial distribution might look similar, humanitarian operations face an important problem that is not as significant in commercial enterprises: the unavailability/scarcity of resources (time, supplies, personnel, vehicles, transportation, and communication infrastructure) (Albores et al., n/d). The life-or-death nature of delivering supplies and aid in relief operations is another important difference which makes efficiency in relief operations particularly crucial (Balcik et al., 2008).

The aim of every disaster relief operation is to provide assistance to the affected population in the most effective way, so as to save as many lives as possible (Balcik et al., 2008; Afshar et al., 2012). Assistance can include the provision of food, shelter, and medical assistance. In order for supplies and personnel to reach their destinations, various means of transport can be used (sea, air, and land). However, providing assistance and the necessary supplies to the affected people is not enough in itself. Time plays a crucial role in these operations, and the supply chain must be mobilised as quickly as possible. The faster the supply chain moves, the more lives can potentially be saved (Albores et al., 2011; Afshar et al., 2012). When humanitarian actors fail to deliver assistance quickly, casualties and suffering can increase further (Duran et al., 2011).

Humanitarian assistance faces a wide range of problems that can delay the process of delivering aid. One of these problems involves a lack of humanitarian transport equipment (Balcik et al., 2008). Usually, transport equipment shortages are felt in the last step of the supply chain of relief operations - the “last mile relief distribution” (Balcik et al., 2008). This phase of the supply chain is the most important, as it connects the goods and assistance to the affected populations (Albores et al., 2011). According to Albores and colleagues (2011), the success of the “last mile” phase is determined by four logistical decisions: facility location, inventory management, transportation decisions, and distribution decisions (Albores et al., 2011).

The last two decisions, transportation and distribution, involve decisions about equipment management. Transportation decisions concern the movement of the relief items (Albores et al., 2011). The efficiency and speed of inflow and outflow of the relief materials depends on the capacity of vehicles and the size of the fleet, among other things[1] (Albores et al., 2011). The factors that affect transportation decisions (which assets are going to be used) have to do with the geography of the area of the disaster (mountainous, flat, or coastal area), the disaster type (earthquake, flood, etc.), the number of people affected, and the degree of coordination between the actors participating in the relief operation (e.g. NGOs, governments). Weather and the quantity of items to be transported also play a role in that decision (Albores et al., 2011). Distribution decisions must also take into account the safety and security of the affected people, the personnel, and the goods, and the time required for distribution (e.g. the time required to distribute and hand out the relief material) (Albores et al., 2011).

The distribution of aid from a centre of distribution to the affected people often faces problems (Afshar et al., 2012). One of the most common problems is the unavailability/scarcity of transportation equipment and of emergency supplies, as well as the inaccessibility of the affected areas due to damaged infrastructure. In addition, difficulties in the coordination of the participating relief actors are often responsible for logistical issues that commonly arise in the last mile stage (Afshar et al., 2012; Balcik et al., 2008; WFP, 2016a). Due to limited equipment (and personnel), the success of distributing goods is often undermined.

[1] Other factors include “the size and the number of the facilities, the efficiency of managing relief materials and the accessibility to the filed warehouse and the distribution centre” (Albores et al., 2011)

The amount of goods and aid workers needed in a given humanitarian relief operation varies greatly depending on many factors. These include “the type and the impact of the disaster, demographics, and social and economic conditions of the area (Balcik et al., 2008). The demand for “Type 1” items (as defined by Balcik and colleagues) is typically very large. Type 1 items are critical items that are needed immediately after a disaster strikes. These include emergency supplies such as tents, blankets, tarpaulins, jerry cans, and mosquito nets, among other items. Therefore, meeting all Type 1 demands in a timely manner can prove to be impossible, not only because of supply unavailability, but also because of vehicle capacity limitations (Balcik et al., 2008). Transportation capacity and supply availability are the most significant issues that can come up in the last mile phase of an operation (Balcik et al., 2008). Unlike in commercial systems, the relief system is unlikely to be able to rapidly adjust the quantity and type of the vehicles, as this can be very difficult in crisis situations (Balcik et al., 2008). “A unique characteristic of the last mile distribution system is the unpredictability related to resource levels over time […] the same uncertainty exists for vehicle availability because the number and composition of vehicles in the fleet may vary over time” (Balcik et al., 2008).

Inaccessibility is another common and significant problem in humanitarian operations. For example, in one report, Logistics Cluster mention that the logistics of humanitarian cargo transport involves many challenges in Somalia (Logistics Cluster, 2016). Armed non-state actors, and more generally, the unsecure situation in the country make humanitarian relief operations (access, safe passage, delivery, and distribution of humanitarian relief) very difficult (Logistics Cluster, 2016). Alternative means of transferring cargo are needed, such as coastal transshipments and the re-routing of cargo to various ports. Some areas are only accessible by air, and others are completely inaccessible (Logistics Cluster, 2016).

Although limitations related to transportation resources and damaged transportation infrastructure are some of the biggest challenges in the last mile phase of relief operations, it is important to keep in mind that the problems faced throughout relief efforts differ according to the type, impact, and location of the disaster, and the situation in the affected areas, among other factors (Balcik et al., 2008). Taking Somalia as an example, below I discuss the problems that face the three transportation options when it comes to humanitarian assistance (sea transport, road transport and air transport).

3.2.1 Sea transport

Despite the problems that might be faced, transportation by sea is often the only option. These problems can include “port closures, naval activities, insecurity, port congestion, suspension of liner services and piracy” (WFP, 2015). The importance of these types of shipments is demonstrated by their increase in 2016 (WFP, 2016). The World Food Programme (WFP), one of the leading organisations in Somalia offering humanitarian assistance, has reported a rapid increase in the quantity of cargo sent by sea. In 2015-2016, Somalia was among the top ten port destinations for unloading humanitarian assistance (WFP, 2015). In 2016, in order to deliver food to various locations in Somalia, the WFP used up to 15 ships each month, as well as a time-charter vessel and 200 contracted trucks (WFP, 2016).

3.2.2 Land transport

As land vehicles are an important asset in the last mile stage of relief operations, the execution of this stage relies greatly on the capacity of these. While road transport can be a viable option, it is often disrupted or delayed due to various reasons. In Somalia, for example, violent conflict or the presence of militants often causes problems (WFP, 2016). In August 2016, due to militant attacks against the local government office in North Galkayo, a ban was imposed on commercial trucks passing through the area (WFP, 2016). Although the WFP found alternative ways to deliver food, this event highlights that road transport can often be difficult or impossible (WFP, 2016). Illegal checkpoints, road blockages, skirmishes along major access roads, inadequate infrastructure, as well as direct threats to humanitarian and commercial goods during transit are often faced in Somalia. Somalia is suffering from a major humanitarian crisis, and due to these problems, regular and sustained access to affected areas is a critical challenge (WFP, 2016). This makes ports particularly important in the logistics of humanitarian relief operations, as Somalia has the longest coastline of any African country except Madagascar (WFP, 2016).

3.2.3 Air transport

Poor infrastructure and insecurity are the main challenges faced when delivering humanitarian cargo (Logistics Cluster, 2016). These issues often force humanitarian organisations to re-route cargo to various ports, and to use coastal transshipments (Logistics Cluster, 2016). Moreover, some key operational areas are only accessible by air, and some areas are completely inaccessible (Logistics Cluster, 2016).

However, air transport, like sea and land transport, faces challenges as well. Nevertheless, it remains the most valuable means of distributing humanitarian assistance (Ahmad et al., 2008). This is demonstrated by the fact that airlifting equipment is the most common type of equipment provided to affected countries by donor countries (Ahmad et al., 2008). For example, after hurricane Mitch in 1998 and the Iranian earthquake in 2003, "the most common type [of humanitarian equipment] provided was aircraft, particularly cargo planes for airlift operations" (Ahmad et al., 2008).

The importance of airlift equipment is highlighted by the fact that, despite its high cost, it is used extensively. For example, in 2015, the WFP contracted 1,636 air-drops, delivering 45 metric tons of food to people in need (WFP, 2015). This is a staggering volume, especially if we take into consideration the fact that airdropping is used only when there is no other alternative (WFP, 2015). Moreover, in 2016, the European Commission's Humanitarian Air Service (ECHO Flight) transported 27,000 passengers and around 170 tons of cargo in the areas where it is active (Sub-Saharan Africa) (European Commission, 2017). Air equipment, and especially cargo planes, are essential in areas that are inaccessible by road. In these cases, cargo planes are used to deliver "essential nutrition products" (WFP, 2016). Airlift assets are also used to deliver food and other essentials when there is such a need, as in the case of the cholera outbreak in Somalia in 2016, when WFP transported essentials on behalf of other humanitarian organisations (WFP, 2016).

The importance of air transport in humanitarian aid operations is demonstrated by the fact that international aid organisations have established services specifically aimed at providing humanitarian relief by air. Examples of these organizations are the previously mentioned ECHO Flight, as well as the United Nations Humanitarian Air Service (UNHAS).

3.3.2.1 The case of Somalia

An example of the importance air services is that in Somalia, where UNHAS is active, the only alternative is to transfer essentials by road (WFP, 2016). Because traveling by road often involves security and infrastructure challenges, the need for air services is significant (WFP, 2016). Services such as UNHAS offer safe and reliable air transport in areas where land and sea transport are problematic, like in Somalia and Kenya (WFP, 2016). Specifically, many areas in Somalia are not safe for road travel. Road travel in Somalia can be dangerous and time consuming (WFP, 2016; WFPa, n/d). Due to the fragile security situation in Somalia, UNHAS is one of the few safe options for humanitarian organisations to deliver food and transfer personnel (WFP, 2016). In 2016, UNHAS transported more than three thousand people from 146 humanitarian organisations, either as part of evacuations or in transporting medical personnel to affected areas in Somalia and in Kenya (WFP, 2016). Moreover, UNHAS delivered 434 metric tons of cargo to 34 locations in Somalia, including 10 metric tons of nutrition items delivered just between the months of May and June 2016 (WFP, 2016).

UNHAS' mission is to transport light cargo such as medical supplies, specialised foods, and IT equipment, and to provide a fleet for the evacuation of relief staff (WFP, 2016). UNHAS' budget for this special operation in Somalia and Kenya is US $60,850,000 (WFPb, n/d). UNHAS personnel carry out air cargo and passenger operations as well as emergency security and medical evacuations (WFP, 2016), and works with NGOs, the UN, donor organisations, and diplomatic missions, among others (WFPb, n/d).

The demand for air operations in Somalia is great. During 2015, 150 humanitarian agencies in Kenya and Somalia used UNHAS transport services (WFP, 2016). On average, UNHAS flew 500 hours per month, and 300 metric tons of cargo were delivered (WFP, 2016). 60 thousand passengers were transported by UNHAS in 2015, including 27 medical evacuations (WFP, 2016). Due to the drought in 2016 and the resulting food scarcity, the number of people needing humanitarian assistance in Somalia increased. As a result, the WFP's resource capacity was challenged (WPF, 2016). This highlights the fact that forecasting demand is a challenge.

In 2016, UNHAS chartered 6 aircraft to meet the demand for cargo and passenger transport (WFP, 2016). UNHAS-chartered aircrafts transported more than four thousand passengers in 2016 (WFP 2016). When a flood hit Beledweyne in May-June 2016, UNHAS delivered 10 metric tons of WFP nutrition items (WFP, 2016). Moreover, UNHAS carried out 45 medical evacuations from Kakuma and Dadaab (WFP, 2016). In 2016, UNHAS provided air transport services to 146 humanitarian agencies based in Kenya and Somalia, with an average number of 455 flight hours per month. Each month, more than three thousand passengers were transported, and in that year, 434 metric tons of cargo were delivered (WFP, 2016).

3.3.2.2 The Yazidi case

The attack on the Yazidi (or Yezidi) minority in 2014 by the Islamic State in Iraq and Syria (ISIS) is a case that demonstrates the importance of air transport equipment in humanitarian disaster situations. On August 3rd 2014, Mount Sinjar, a mountain close to the Iraq-Syria border in northern Iraq was attacked by ISIS, which was targeting the Yazidis, a Kurdish minority (Voorhoeve, 2015). The majority of Yazidis, around 1 million people, lived in this area (UNHRC, 2016). The Yazidi religion includes elements from Judaism, Christianity, and Islam. ISIS therefore considers it "a non-proper Islamic religion" ("Yazidi", n/d) and persecutes the Yazidi people as "devil worshipers" (UNHRC, 2016).

ISIS exerted its control over the Sinjar region in June 2014, when it began to gain control of the area of Mosul (UNHRC, 2016). Mount Sinjar had been protected by the Iraqi-Kurdish Peshmerga forces, who were maintaining "bases and checkpoints" on the mountain (UNHRC, 2016). However, in the face of ISIS troops, the Kurdish forces withdrew, leaving a large area of the Sinjar region unprotected (Voorhoeve, 2015). The decision of the Peshmerga to abandon the area wasn't "effectively communicated" to the Yazidi people, meaning that the Yazidis hadn't received orders to evacuate (UNHRC, 2016). This left the Yazidi people unaware of the threat that they were about to face (UNHRC, 2016).

The massacre of the Yazidi by ISIS was recognized by the UN Human Rights Council as an act of genocide (UNHRC, 2016). In the lower areas of Mount Sinjar, ISIS captured Yazidi men, women, and children in their villages, and stopped many of those who attempted to escape in cars (UNHRC, 2016). In addition, the 30 to 40 thousand people who managed to reach the higher areas of the mountain became trapped there (Voorhoeve, 2015).

The Iraqi government, being unable to manage the crisis by its own means, asked the US for assistance (UNHRC, 2016). The US President at the time, Barack Obama, announced that military operations would provide assistance to the Yazidi population trapped on Mount Sinjar (UNHRC, 2016). However, Barack Obama appeared more focused on bombing ISIS rather than providing immediate help to the Yazidi. On August 7th, he announced that the US would start air bombings against ISIS, but did not refer to assisting the trapped Yazidi (Voorhoeve, 2015). The next day, airstrikes against ISIS began, but only on August 9th did relief airdropping of supplies for the refugees begin (Voorhoeve, 2015).

Ten days after the start of the incident, the involved actors (the Pakistani government and the international actors providing assistance) began considering mounting an evacuation of the mountain (Voorhoeve, 2015). However, when the Syrian Kurdish fighters from north of the mountain eventually managed to create a passage for the refugees to escape, there wasn't enough space for everyone in the vehicles that had been sent to rescue them (Rovera, 2014). Instead, some people had to walk 13 hours to reach a safe area, while others were forced to remain (Rovera, 2014). On the 14^{th} of August, the US stated that most of the people in the mountain had been evacuated, however on the 25^{th} of August there were still some five to ten thousand people on the mountain (Voorhoeve, 2015).

Although evacuation can be difficult under any circumstances, if cooperation between the involved actors had been more effective, more lives may have been saved (Voorhoeve, 2015). Saving the refugees should have been a priority, not the bombing of ISIS (Voorhoeve, 2015). UN member states could have used an air bridge to speed up the evacuation (Borger et al., 2014). Despite the US announcing that the bombings had allowed for a safe passage for the refugees to be opened ("10 Days in Iraq…", 2014), thousands of people were left helpless.

The US, Great Britain, and France provided Kurdish Peshmerga fighters with weapons (Voorhoeve, 2015), and during the crisis, humanitarian aid was sent by airdrops. The US airdropped food, meals, and water, and the UK used helicopters and RAF Tornado jets for surveillance (Azim, 2014). Water purification containers, shelter kits, and solar lanterns were also sent. France sent two shipments of aid to Erbil, which included 20 tons of water, tents, and medicine (Azim, 2014), and Australia also contributed with airdrops (Wroe, 2014).

Despite the coordination of the national and international actors, many people still struggled for days on Mount Sinjar, and more people were captured by ISIS. Without air equipment, the operations would have had to have been conducted over land, and the few people that were saved probably could not have been. Land transport would have been even more dangerous and could have resulted in a greater cost to human lives. The Yazidi disaster is therefore a clear example of the importance of air transport for saving lives.

3.3.2.3 The 2005 Pakistan earthquake

The importance of air equipment is demonstrated by the aid response to the earthquake that occurred on October 8^{th} 2005, when Pakistan was hit by one of the most catastrophic earthquakes in its history. The 7.6 magnitude earthquake hit the Pakistani-administered section of the region of Kashmir (Kashmir is also controlled by India and China), causing around 80,000 deaths and leaving around four million people homeless (“2005 Kashmir Earthquake”, n/d). The effects of this earthquake were magnified by the severe winter that the region experienced soon after the catastrophe (“2005 Kashmir Earthquake”, n/d).

Due to the scale of the disaster, the Pakistani government requested assistance from NATO. This request was received two days after the earthquake hit, on October 10th (EADRCC, 2005). The following day, NATO approved the provision of assistance, and on October 13th, airlifting began (EADRCC, 2005). Finally, on October 14th, the first supplies arrived in Pakistan (EADRCC, 2005). However, assistance from other sources met with political limitations. For instance, Pakistan rejected an offer of assistance from India because Indian soldiers would have accompanied the helicopters (Cosgrave et al., 2008). This decision illustrates that even in the biggest emergencies, political constraints still become barriers between humanitarian aid and the people who need it.

Although the assistance from NATO and other parties was important, more lives could have been saved if mobilisation had been faster, as time is extremely important in cases of natural disasters. In the Pakistani earthquake, people who had survived the collapse of buildings but were still trapped under the debris needed urgent help, something which couldn’t be provided at that point, as there wasn’t enough equipment to move the debris (“Kashmir earthquake: Broken city, broken promises”, 2015). Although the NATO operation successfully evacuated over 7,650 people, it may have been more successful if the process had been faster; it took Pakistan two days to request assistance from NATO, and another four for the first supplies to arrive (“Pakistan earthquake relief operation”, 2010).

NATO assistance during the Pakistan earthquake was crucial because of the volume of the required cargo; the operation would have been much slower if the flights had been operated by commercial airplanes (“Lessons learned in Pakistan…”, 2006). NATO operated many cargo flights during this operation (“Lessons learned in Pakistan…”, 2006). Initially however, NATO established an air bridge with Turkey and sent helicopters to approach the affected areas, as the cargo planes could only land in large cities (Islamabad and Lahore) (“Lessons learned in Pakistan…”, 2006). Helicopters are also very important in these types of situations, as they can land in difficult terrain without the need for an airstrip. Particularly in cases of flood and earthquakes, helicopters are often the best way to access affected areas (Cosgrave et al., 2008).

In the end, the evaluation of the response to the Pakistani earthquake was mixed. Many hold the opinion that the response was very successful (Cosgrave et al., 2008). However, some evaluations, such as that of the Fritz Institute, characterize the response as unsuccessful, as the basic needs of the affected people were not met, even after a significant amount of time had passed since the disaster (Cosgrave et al., 2008). Poor infrastructure is one of the main reasons for the high number of deaths, as buildings were not built to withstand such a strong force, and many collapsed easily ("Kashmir's Earthquake…", 2005). Less than two weeks before the harsh winter would strike, The Economist noted that 3.3 million people remained homeless and humanitarian aid still hadn't reached some remote villages ("Kashmir's Earthquake…", 2005). Deaths from the cold, hunger, and diseases were predicted ("Kashmir's Earthquake…", 2005).

Pakistan is the seventh-largest military force in the world (Bamforth and Quereshi, 2007). Having sent out 18 peace missions since 1960 within the framework of the UN, it has developed a culture of cooperation and gained experience in the coordination of different organisations (Cosgrave et al., 2008). For this particular earthquake, Pakistan sent 60,000 troops to affected areas (Bamforth and Quereshi, 2007).

The successful management of air transport assets played a determining role in the relief operation (Cosgrave et al., 2001). Despite the high cost of using helicopters, these were (and are) still widely used, as helicopters are the best alternative when the affected areas are inaccessible by land (Cosgrave et al., 2001). In the case of the 2005 earthquake, the affected areas were located in mountainous regions, which made access by roads very dangerous (Cosgrave et al., 2001). Cheaper than military helicopters is the option of commercial helicopters. However, due to of the extent of damage and the need for extensive humanitarian assistance, only military assets were sufficient in quantity to meet the requirements of the relief operation (Cosgrave et al., 2001).

3.4 Why should we pay attention to equipment capacity?

Statistically, it is more likely for a person to die in a car accident than in a natural disaster ("Number of road traffic deaths", n/d). The total number of fatalities from natural disasters during the 2000s did not exceed 70,000[2] (Roser, 2017). However, this does not mean that the need for progress in humanitarian assistance should be underestimated. The total number of deaths from natural disasters might not be that impressive, but nevertheless, the international and national communities have an ethical and legal obligation to assist in the best possible way. The death toll from natural disasters, no matter how big or small, highlights the significance of adequate preparation for these types of events.

While people affected from natural disasters are declining, the number of deaths is increasing (CRED, 2015). The decrease in the affected people can be explained mostly from the population increase (CRED, 2015). But the increased death tool is due to the fact that vulnerability is increasing (CRED, 2015). What determines the probability of people dying in disasters is their level of vulnerability. Vulnerability is measured by many factors. For example, according to Donner and Rodriguez (2011), population growth, but also its distribution - in a word, urbanisation - can increase vulnerability. By building in disaster prone areas (earthquake zones, flood prone areas or overpopulated cities) people put themselves in higher risk (CRED, 2015).

As discussed in section 1.8, according to EM-DAT, a natural disaster fulfills at least one of the following criteria:

1. Ten (10) or more people reported killed

2. Hundred (100) or more people reported affected

3. Declaration of a state of emergency

4. Call for international assistance. (EM-DAT)

Therefore, whether an event is classified as a natural disaster greatly depends on the vulnerability of the particular area/population.

3.4.1 Urbanization as a vulnerability factor

Population growth and distribution plays a significant role in vulnerability. Urbanisation is an important vulnerability factor because often, there is no proper city planning, and escape routes

[2] This number includes fatalities from wildfires, volcanos, mass movement wet, mass movement dry, floods, extreme temperatures, earthquakes, droughts, and storms. Roser, M. (2017) – 'Natural catastrophes'. *Published online at OurWorldInData.org.* https://ourworldindata.org/natural-catastrophes/ Accessed in July 2017.

are therefore limited (Donner and Rodriguez, 2011). Population congestion together with dense infrastructure increases the likelihood of death and injures (Qujia et al., 1992). For example, in China, researchers predict that cities are more likely to experience deaths and injuries than towns, and that towns would suffer more deaths and injuries than rural areas (Qujia et al., 1992).

Urbanization, meaning "the overall rates by which people have relocated from rural areas into cities", began to take place in industrialized nations around 1954 (Coppola, 2007). In 1950, less than 30% of the world's 2.5 billion people were living in cities (Coppola, 2007). In 1998, this percentage was 45% (of a population of 5.7 billion), and in 2025 it is expected to reach 60% (of a projected population of 8.3 million) (Coppola, 2007). This massive movement towards the cities means that large numbers of people are concentrated in particular areas (Britton 1998). This increase in urbanisation is therefore accompanied by an increase in people affected by any natural disasters that hit those areas.

High population density not only means that more individuals are exposed to disasters, but population growth also has effects on the environment (e.g. deforestation activities), which might increase the likelihood of disasters (Donner et al., 2011). Moreover, some research suggests that high population densities can affect meteorological conditions, leading to an increase in potentially disastrous events such as high intensity storms, due to high pollution rates and higher humidity, among other factors (Elsom et al., 1982; Snider, 1977).

3.4.2 Poverty as a vulnerability factor

Poverty plays an important role in disasters, being a strong determinant of vulnerability (UNDP, 2004). One of the reasons why poverty is a primary factor affecting vulnerability is that it that affects how individuals perceive risk and how well they understand and respond to warnings (Donner et al., 2011).

Moreover, poor people do not have the financial resources to construct housing that is resistant to various types of disaster. Affordable housing is more vulnerable to disasters. At the state level, poorer countries lack safety standards, zoning regulations, and building codes that could result in more resistant infrastructure (Coppola, 2007).

Poverty is also a factor in the aftermath of disasters. Countries with low GDP are less protected against the effects of disasters, and in poorer countries, disaster management often ranks low in terms of budgetary priorities (Coppola, 2007). For example, in 1998, Hurricane Mitch destroyed 70% of the infrastructure in Nicaragua and Honduras (UNISDR, 2004, cited by Coppola, 2007). This same disaster is blamed for reversing development rates in these and other Central American countries by at least a decade, and in some areas 20 or 30 years (Oxfam, 1998). In 2001, earthquakes occurred in both El Salvador and in the United States, each causing approximately 2 billion US dollars in damages. Despite the similar level of damage, it was only El Salvador's GDP that decreased by 15% that year (UNDP, 2004).

3.4.3 Secondary Factors

There are also some secondary factors that can increase vulnerability. For example, lower levels of education can people more vulnerable, as they may not have received adequate education about how to protect themselves during disasters (Coppola, 2007).

3.5 Military Expenditure

Estimating precisely how much of a military budget is devoted to equipment for natural disasters is not an easy task, as disaster assistance and logistical means for rescue and relief are secondary to the main priority of the military, which is defence. The primary purpose of military equipment is never simply to assist humanitarian relief missions (Ahmad et al., 2008). However, an overview of the defence budgets of some key players in terms of military equipment capacity demonstrates the ability of those countries to respond to natural disasters in their own nation or when assisting others. After all, military assets are increasingly being used for rescue and relief after natural disasters. An example is Pakistan, which during the earthquake of 2005 and the flood of 2011 saw the largest humanitarian helicopter airlift operations in its history (Thevasthasan, 2015).

As far as humanitarian missions are concerned, any logistical means (i.e. fleets) that are available at the time of the disaster are generally used, as there is no specific equipment specially dedicated to humanitarian purposes. The primary purpose of military air equipment is defence. For example, the KC-46A tanker aircraft used by the United States Air Force (USAF, 2016) performs "in-flight warplane refueling, but its use can also support humanitarian missions as it can carry loads and passengers" (USAF, 2016). The same applies to many other types of transport equipment such as Hercules airplanes and helicopters.

Since 1989, the average defence expenditures of NATO member states have seen many fluctuations. As a share of GDP, defence expenditures dropped from an average of around 4.3% in 1989 to an average of 2.5% in 2014 (NATO, 2016). After that year, there was a progressive increase however, and in 2009, average defence expenditures reached 3.2% of GDP, the highest they had been since 1994 (NATO, 2016). After 2009, NATO members' defence expenditures began to decline again. For 2016, the estimation was an average of 2.43% of GDP (NATO, 2016).

The United States' defence budget has generally remained higher than the average defence budget of NATO members (NATO, 2016). In 1989, the U.S. spent 6% of its GDP on defence (NATO, 2016). However, after that year it decreased, and reached around 3.1% at its lowest (in 1999-2001) (NATO, 2016). Expenditure then increased, reaching 5.29% of GDP in 2009, after which it began decreasing again (NATO, 2016). In 2016, the US defence budget was estimated to be around $665 million (3.61% of GDP) (NATO, 2016). It is noteworthy that the United States defence budget far exceeds the 2% of GDP that NATO requires of its member states (NATO, 2016). In terms of defence, it is the largest spender among the NATO countries (NATO, 2016).

The United Kingdom is the third-largest spender among NATO countries and also exceeds the required defence budget of 2% of GDP (NATO, 2016). Between 2009 and 2015, defence spending in the UK ranged from 37 to 39 million pounds (between 2.5 and 2.7% of GDP) (NATO, 2016).

On the other hand, the Netherlands ranks quite low in terms of defence spending, compared to other NATO countries (NATO, 2016). In 2015, the Netherlands was in 18th place, spending only 1.13% of its GDP on defence (NATO, 2016). Interestingly, despite this low level of spending on defence, the Netherlands is one of the biggest providers of assistance when natural disasters strike (Ahmad et al., 2008). Some countries, such as Greece, spend much more of their GDP on defence (NATO, 2016). From 2009 to 2016 Greece was the second-largest spender among NATO countries, relative to GDP (NATO, 2016).

Looking specifically at equipment in the broader context of defence spending, we see that between 2014 and 2016, the US saw spending on equipment decrease, and it is now ranked sixth among the other NATO member states (NATO, 2016). This decline is a result of financial constraints (NATO, 2016). As stated in the US Air Force Capacity Report (USAF, 2016), "The air force's capacity in terms of number of aircraft has been on a steady downward slope since 1952". In contrast, the United Kingdom has been following a steady upward trend since 2015, and it is now the 9th biggest buyer of equipment. The Netherlands, on the other hand, has seen a remarkable decrease in spending on military equipment (NATO, 2016).

3.6 Country contributions to disaster aid

The most common military asset provided by countries in cases of disasters is air transport, and more specifically, cargo aircraft for airlift operations, since, as we have seen, moving people and relief items by air is the safest and least controversial mode of transportation (Ahmad et al., 2008). Providing military assets to a country after a natural disaster is an inherently political decision that can be driven by domestic or international considerations (Ahmad et al., 2008). A domestic consideration can be, for example, public opinion about sending assistance to another country. International considerations can be historical, political, or strategic (Ahmad et al., 2008). Another factor that can motivate the provision of assistance is reciprocity (Ahmad et al., 2008). The actual factors affecting a decision might differ from what the countries' leaders choose to state publicly however (Ahmad et al., 2008). Belgium, the Netherlands, and the US have stated that their decision-making regarding sending assistance to another country is based on the ability to save lives, the feasibility of responding to specific requests, the availability of the requested assets, as well as on the decisions of individual government departments regarding deployment (Ahmad et al., 2008). Other countries, including Canada and the UK, assist based on a combination of their own guidelines and the Oslo guidelines (Ahmad et al., 2008)[3]. Canadian guidelines state that Canadian forces do not normally assist in humanitarian aid activities, unless there is no other actor that can meet the needs of the affected area/people (Ahmad et al., 2008). In France, military means are used only as a last resort (Ahmad et al., 2008). The UK states that they will use military assets only if it is considered the best way to save lives and/or alleviate suffering (Ahmad et al., 2008).

[3] The "Oslo Guidelines" set the framework of humanitarian assistance in cases of natural disasters. The Oslo Guidelines can be found on the document "Oslo Guidelines - Guidelines on The Use of Foreign Military and Civil Defence Assets In Disaster Relief" of the Office for the Coordination of Humanitarian Affairs (OCHA).

3.6.1 U.S.A

The United States is the largest contributor of military assets for disaster relief (Ahmad et al., 2008). This can be explained by the country's capacity in terms of equipment, its financial capacity for resources, and because of the number of military bases it maintains outside of the United States (Ahmad et al., 2008). This last factor makes reaching affected countries easier and faster. Last but not least, the US follows a policy of maintaining an active international role for its military (Ahmad et al., 2008). The US reports having deployed military assets 15 times in response to overseas natural disasters between 2003 and 2006 (most of these in the Caribbean and Central America) (Ahmad et al., 2008).

For domestic natural disasters, the United States Disaster Relief Fund (DRF), is the major governmental organisation providing financial assistance for response and relief (Lindsay, 2014). The DRF is managed by the Federal Emergency Management Agency (FEMA) (Lindsay, 2014). The DRF financially assists individual "state, local and tribal governments", as well as non-profit organisations (Lindsay, 2014). Funds from the DRF are given to the affected actors once the President of the United States determines that it is appropriate, in accordance with the Stafford Act (Lindsay et al., 2016). The financial assistance can be used for future disaster recovery, but also for recovery from past disasters (Lindsay, 2014). The DRF is funded by Congress in a "no-year" system, meaning that the offered funds do not expire at the end of the fiscal year, but rather, they are added to the next one (Lindsay et al., 2016). In cases where the money is spent before the end of the fiscal year due to disaster relief needs, Congress generally provides additional financial assistance (Lindsay, 2014). In 2005, the congressional supplement was over 43 million US dollars, while in some years, like in 2011 and in 2009, there was no supplement (Lindsay, 2014). In 2005, the major hurricanes Katrina, Rita, and Wilma (KRW) all hit, costing FEMA around 50 billion US dollars (Lindsay et al., 2016). In 2012, when hurricane Sandy battered the east coast of the country, FEMA provided 12 billion US dollars to relief efforts (Lindsay et al., 2016). For disasters that are not covered for financial assistance under the Stafford Act, funding comes either from the individual states "without federal assistance", or "the assistance is provided by another federal entity under its own authority using its own funding mechanism" (Lindsay et al., 2016, pg. 1). Assistance to American farmers affected by natural disasters is provided by the US Department of Agriculture (USDA) (Lindsay, 2014).

3.6.2 Canada

Public Safety Canada manages the Disaster Financial Assistance Arrangements (DFAA) (Government of Canada, n/d). When the cost of disaster relief in individual provinces or territories exceeds the financial capabilities of the province or territory, the DFAA provides financial assistance (Government of Canada, n/d). Since 1970 (when the program began), more than CAD $3.4 billion has been given to affected areas (Government of Canada, n/d). The Canadian budget of 2017-2018 provides CAD $3.4 billion to Transport Canada for the improvement of infrastructure, in order to make it more resistant to natural disasters (Government of Canada, n/d). Moreover, the Canadian government will develop a shared-cost disaster mitigation and adaptation fund in order to assist large infrastructure projects for the improvement of resilience to natural disasters (Government of Canada, n/d).

3.7 The role of commercial aircraft in natural disaster relief

As we have previously seen, aviation services can be provided by the military or by specialist air services (e.g. UNHAS). One other provider of aviation assistance is commercial air services ("Disaster response", n/d). Due to the unpredictable nature of humanitarian crises, the air fleets available to humanitarian organisations are not always sufficient ("Disaster response", n/d). For this reason, humanitarian organizations often recruit the assistance of commercial providers ("Disaster response", n/d). Commercial air transport providers often assist in transferring cargo and/or relief workers to disaster zones. For example, Airbus, Turkish Airlines, and Fraport AG all participated in transporting relief supplies to Syrian refugee camps near Adana in 2013 ("Speeding Aid to…", 2013). Commercial providers also assist in cases of natural disasters, such as the massive forest fire that devastated the Swedish province of Västmanland in August 2014 ("Fighting fire…", n/d). Italy and France also sent water bombers to the area after a national emergency was declared ("Fighting fire…", n/d). Although Sweden had 15 civil and military helicopters, this proved insufficient to deliver the necessary water ("Fighting fire…", n/d). Italy and France's assistance was crucial in getting the fire under control, as the area was not easily accessible by land ("Fighting fire…", n/d).

Other examples of commercial providers assisting in cases of humanitarian disasters include the following:

- JetBlue airlines transported relief workers to New York City during hurricane Sandy ("Helping Communities After Hurricane Sandy", n/d).

- FedEx, UPS, and Virgin airlines offered flights and/or cargo space for supplies to drought-affected areas in East Africa in July 2011 ("Speeding Aid to East Africa", 2013). Moreover, British Airways carried essentials for water accessibility (water pumps and tanks) to Ethiopia and transported relief workers to Kenya ("Speeding Aid to East Africa", 2013). On behalf of the German Luftfahrt ohne Grenzen (Wings for help), Lufthansa Cargo donated two flights to carry relief supplies to Nairobi, to help affected areas and the largest refugee camp in the world ("Speeding Aid to East Africa", 2013).

- Norwegian Airlines often offers assistance to UNICEF, providing travel support and assistance with various campaigns (e.g. fundraising) ("Today, Norwegian Will…", 2014).

3.8 The future need for humanitarian equipment

Disasters are difficult to predict. For natural disasters, despite constant improvements in monitoring and modelling, the element of unpredictability cannot be eliminated. The most powerful tool in the face of this unpredictability is preparation. Apart from improvements in monitoring and "conflict development", flexibility and proper planning, as well as qualified staff ready to handle a crisis and the "capacity to deploy", is what makes NGOs most effective in responding to crises (WFP, interview). This "capacity to deploy" is achieved in the WFP through contracts with air operators in regions that often face emergencies (WFP, interview).

Despite the fact that equipment for humanitarian assistance is a crucial aspect of providing humanitarian relief and assistance, and despite research showing a tendency for disasters to increase (discussed in Chapter 2), there is not going to be a need for increase in the capacity of air fleet. The cooperation between countries and organisations that donate air equipment, is able to cover the humanitarian needs. If there is scarcity in humanitarian air equipment, it is not because the equipment is not available, but because the management of the available air fleet was not adequate.

Chapter 4 – Conclusion & Discussion

The first part of this research asked whether the continuing increase in the global population has an effect on the number and/or intensity of natural disasters. In order to answer this question, we firstly had to investigate three assumptions. The first assumption was that an increase in population results in more greenhouse gas (GHG) emissions. We concluded that more people doses not necessarily lead to more GHG emissions, as there are four other factors that might determine the level of GHG emissions: improvements in energy efficiency, the extent of the use of alternative gases, weather conditions, and the economy. Population can affect GHG emissions, but these other factors significantly impact the level of GHG emissions, regardless of population trends. For example, it was seen that in the EU, despite an increase in population, from 1990 to 2014, GHG emissions were reduced by 23%.

The second assumption tested was that GHG emissions affect climate change. Relying on scientific evidence, we concluded that indeed, GHG emission do affect climate change.

The third assumption was that climate change affects the number and/or intensity of natural disasters (scale, number of victims and damage). Specifically, the disasters examined included storm, heat waves, intense rainfall, drought, flooding, and precipitation. There appears to be much uncertainty regarding whether some natural disasters can be linked to climate change. Limited scientific knowledge about storms, droughts, and rainfall don't allow for any indisputable claims to be made about whether their occurrence and/or intensity is linked to climate change. Moreover, there is insufficient data about certain types of natural disasters, which prevents us from determining whether they are actually increasing in frequency or not. For hurricanes, there are no long-term records available, for example. For flooding, data is difficult to compare, as there is no commonly-accepted definition for what constitutes a flood. In addition, for some natural disasters, there is regional variation in intensity and frequency trends (for example, in Somalia rainfall has increased in some areas, while in others it has decreased). The only type of disaster that has a clear link to climate change is extreme temperatures. The increase in heat waves has a clear link to climate change, and the evidence shows that this is also the case for the increase in extremely cold events.

We saw that the categorization of a natural phenomenon as a natural disaster depends on the level of vulnerability of an area. For example, more densely populated areas are more vulnerable to disasters, seeing as more people would be affected in the event of a disaster. In addition, a natural phenomenon can become a disaster depending on the level of deforestation and the erosion of mountain sides and forests, which are features of the intense urbanisation seen in modern times.

Due to these factors, we conclude that the global population increase cannot be clearly linked to an increase in natural disasters. There is uncertainty about some types of natural disasters, as the data and the scientific knowledge is still not sufficient enough to demonstrate a correlation between population increase and natural disasters, let alone a causal relationship. As scientific knowledge about natural disasters improves, a link may eventually be found, however as of today, it is insufficient to demonstrate a correlation between population increase and natural disasters.

Therefore, the reasoning that an

1. Increase in population = more gas emissions
2. More gas emissions = alteration of climate
3. Alteration of climate = increase in number and/or intensity of natural disasters

➡ Increase in population = increase in number and/or intensity of natural disasters

cannot be confirmed. However, this does not mean that natural disasters will not increase in frequency. This study only found that there is no clear proof of a relationship. It is possible, and some scientists say it is even likely, that natural disasters will increase in the future. Interestingly, we also saw that although deaths from natural disasters are declining, vulnerability to natural disasters is increasing.

In Chapter 3, we examined disaster responses to the man-made disaster concerning the Yazidi people in Northern Iraq in 2014 and to the Pakistan earthquake in 2005, in order to highlight the importance of air equipment for humanitarian aid. Because humanitarian crises such as these are inextricably linked to political factors, predictions about whether they will increase or decrease in future are not possible, at least in this research. However, the fact that disasters for can include war, civil war and terrorism, as well as natural disasters, which may possibly increase in future, we can assume that the demand for humanitarian aid will increase.

This does not necessarily mean that the need for humanitarian air equipment is going to increase however. We saw that the humanitarian logistics' literature often refers to the scarcity of equipment as a common and significant problem in humanitarian operations. On the other hand, humanitarian groups have established organisations such as UNHAS and Logistics Cluster, which make use of the fleets of all participating countries and organisations in order to ensure that the demand for equipment will be met. Thus, equipment needs are met most of the time. Shortages in air transport equipment are not often faced, as there are many sources of this type of equipment at the disposal of humanitarian organisations.

The fact that countries don't prepare equipment specifically for natural disasters might be an indication that there is no shortage of air equipment in general. This may also indicate that humanitarian air support is not high on their agenda however. Moreover, the weight that governments place on disasters depends on political and economic policy factors that cannot be analysed on a large scale. Consequently, the need for humanitarian air equipment does not only depend on natural disaster trends, but is generally dependent on their type, size, the number of victims, and on political decisions about whether to ask for or provide disaster relief. The level of priority placed on natural disasters depends much on the political considerations of individual governments, and these are difficult to analyse on a large scale.

Moreover, the absence of a universal database regarding the number and type of equipment used during relief efforts in the past makes it difficult to form a conclusion based on past trends. However, through an analysis of past budget allocations, this research has determined that future demand for humanitarian air transport equipment is not likely to increase. The main reasons for this are that globally, the amount of available air equipment is sufficient to meet the needs of humanitarian crises, and that various government or commercial stakeholders assist by making air equipment available to the actors managing a crisis.

The first conclusion of this thesis was that we cannot link a population increase with an increase in the number and/or intensity of natural disasters. However, this does not mean that population growth is not *a* or *the* cause of climate change. It simply means that there is insufficient scientific evidence to prove it. Regardless of climate change, countries and regions with high population growth will experience growing needs for food, water, and other supplies, both under normal conditions and in cases of natural or man-made disasters. There are two solutions that together, may help humans overcome this challenge: a massive change in our way of life towards a more self-sustainable society (which, however, is contrary to the liberal economy of the Western world), and technological progress towards more eco-friendly production systems.

The second conclusion of this research is that future demand for humanitarian air transport equipment is not likely to increase. National air forces, governmental organisations, humanitarian organisations, and commercial air transport companies often collaborate to make use of various fleets in order to meet the needs of humanitarian crises relief operations. Although at present there is no need for additional air transport equipment, it is possible that in the long term, unforeseen factors not considered here will lead to an increase in the need for humanitarian air transport equipment.

A proposal for future research that will enhance the study of equipment management in natural and man-made disasters, could be the investigation of the methods and effectiveness of cooperation/coordination between the various stakeholders. It would be beneficial for future research to propose solutions on how to overcome political limitations that come into play in the management of disaster relief, and that prevent actors from using available fleets in order to improve their response ability. Despite the fact that overall, there is no shortage of air transport equipment, there are many times when relief efforts and the delivery of goods and services are hampered. An example of this is in Greece, which finds itself unable to manage forest fires almost every summer. This shows that there is a need for better coordination between those involved in relief efforts. Research focusing on how to improve coordination and cooperation between the states and the humanitarian organisations during disaster relief operations would greatly benefit all of those involved, and in particular, the victims.

Furthermore, future research could systematically investigate the number of air transport equipment used in natural and man-made disasters. Although the lack of a database making this information available is a substantial challenge to such research, it may provide a clearer trend regarding the equipment used in disasters throughout the years and/or in different areas.

Last but not least, there is also room for research in the cost-efficiency of the various means of transporting humanitarian aid. The means of sea, land, and air could be compared to determine which is the most cost-efficient and rapid way of delivering humanitarian assistance.

Much work is needed to improve humanitarian operations in times of crises. The hope is that the current work has contributed to this important task in some small way.

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Appendix A - Definitions

All definitions from em-dat.be (Accessed from http://www.emdat.be/Glossary on 28/07/2017)

Affected

People requiring immediate assistance during a period of emergency, i.e. requiring basic survival needs such as food, water, shelter, sanitation and immediate medical assistance.

Climatological hazard

A hazard caused by long-lived, meso- to macro-scale atmospheric processes ranging from intra-seasonal to multi-decadal climate variability.

Coastal flood

Higher-than-normal water levels along the coast caused by tidal changes or thunderstorms that result in flooding, which can last from days to weeks.

Cold wave

A period of abnormally cold weather. Typically, a cold wave lasts two or more days and may be aggravated by high winds. The exact temperature criteria for what constitutes a cold wave vary by location.

Disaster

Situation or event, which overwhelms local capacity, necessitating a request to national or international level for external assistance (definition considered in EM-DAT); An unforeseen and often sudden event that causes great damage, destruction and human suffering. Though often caused by nature, disasters can have human origins.

Disaster Event

A disaster meeting the EM-DAT criteria and which is recorded in EM-DAT. A disaster event can affect one country or several [see «Country-level disaster»]. In the case of the latter, the disaster event will result in several country-level disasters being entered into the database. A disaster event will always have a unique DISNO identifier.

Drought

An extended period of unusually low precipitation that produces a shortage of water for people, animals and plants. Drought is different from most other hazards in that it develops slowly, sometimes even over years, and its onset is generally difficult to detect. Drought is not solely a physical phenomenon because its impacts can be exacerbated by human activities and water supply demands. Drought is therefore often defined both conceptually and operationally. Operational definitions of drought, meaning the degree of precipitation reduction that constitutes a drought, vary by locality, climate and environmental sector.

Earthquake

Sudden movement of a block of the Earth's crust along a geological fault and associated ground shaking.

Estimated Damage

The amount of damage to property, crops, and livestock. In EM-DAT estimated damage are given in US$ ('000). For each disaster, the registered figure corresponds to the damage value at the moment of the event, i.e. the figures are shown true to the year of the event.

Extreme winter conditions

Damage caused by snow and ice. Winter damage refers to damage to buildings, infrastructure, traffic (esp. navigation) inflicted by snow and ice in form of snow pressure, freezing rain, frozen waterways etc.

Flash flood

Rapid inland floods due to intense rainfall A flash flood describes sudden flooding with short duration. In sloped terrain, the water flows rapidly with a high destruction potential. In flat terrain, the rainwater cannot infiltrate into the ground or run off (due to small slope) as quickly as it falls. Flash floods typically are associated with thunderstorms. A flash flood can occur at virtually any place.

Flood

A general term for the overflow of water from a stream channel onto normally dry land in the floodplain (riverine flooding), higher-than- normal levels along the coast and in lakes or reservoirs (coastal flooding) as well as ponding of water at or near the point where the rain fell (flash floods).

Fog

Water droplets that are suspended in the air near the Earth's surface. Fog is simply a cloud that is in contact with the ground.

Geophysical disasters

Events originating from solid earth.

Geophysical hazard

A hazard originating from solid earth. This term is used interchangeably with the term geological hazard.

Glacial lake outburst

Hazard

Threatening event, or probability of occurrence of a potentially damaging phenomenon within a given time period and area.

Heat wave

A period of abnormally hot and/or unusually humid weather. Typically, a heat wave lasts two or more days. The exact temperature criteria for what constitutes a heat wave vary by location.

Homeless

Number of people whose house is destroyed or heavily damaged and therefore need shelter after an event.

Hurricane

Large-scale closed circulation system in the atmosphere above the western Atlantic with low barometric pressure and strong winds that rotate clockwise in the southern hemisphere and counter-clockwise in the northern hemisphere. Maximum wind speed of 64 knots or more [See « cyclone » for the Indian Ocean and South Pacific and eastern Pacific and « typhoon » for the western Pacific].

Hydrological hazard

A hazard caused by the occurrence, movement, and distribution of surface and subsurface freshwater and saltwater.

Injured

People suffering from physical injuries, trauma or an illness requiring immediate medical assistance as a direct result of a disaster.

Meteorological disasters

Events caused by short-lived/small to mesoscale atmospheric processes (in the spectrum from minutes to days).

Rain

Water vapour condenses in the atmosphere to form water droplets that fall to the Earth.

Tornado

A violently rotating column of air that reaches the ground or open water (waterspout).

Total affected

In EM-DAT, it is the sum of the injured, affected and left homeless after a disaster.

Tropical storm

A tropical storm originates over tropical or subtropical waters. It is characterised by a warm-core, non-frontal synoptic-scale cyclone with a low pressure centre, spiral rain bands and strong winds. Depending on their location, tropical cyclones are referred to as hurricanes (Atlantic, Northeast Pacific), typhoons (Northwest Pacific), or cyclones (South Pacific and Indian Ocean).

Typhoon

Large-scale closed circulation system in the atmosphere above the western Pacific with low barometric pressure and strong winds that rotate clockwise in ther southern hemisphere and counter-clockwise in the northern hemisphere. Maximum wind speed of 64 knots or more [See « hurricane » for the western Atlantic and eastern Pacific and « cyclone » for the Indian Ocean and South Pacific].

Vulnerability

Degree of loss (from 0% to 100%) resulting from a potential damaging phenomenon.

Winter storm/Blizzard

A low pressure system in winter months with significant accumulations of snow, freezing rain, sleet or ice. A blizzard is a severe snow storm with winds exceeding 35 mph (56 km/h) for three or more hours, producing reduced visibility (less than 0.25 mile (400 m)).

Appendix B - Abbreviations

EU: European Union

GDP: Gross Domestic Product

GHG: Greenhouse Gas

ISIS: Islamic State of Iraq and Syria

NATO: North Atlantic Treaty Organization

OECD: Organisation for Economic Co-operation and Development

OFDA: Office of U.S. Foreign Disaster Assistance

UK: United Kingdom

UN: United Nations

UNISDR: United Nations Office for Disaster Risk Reduction

US: United States

WFP: World Food Program