PROJECT REPORT

NATURAL DISASTERS INTENSITY ANALYSIS AND CLASSIFICATION USING ARTIFICIAL INTELLIGENCE

TEAM ID : PNT2022TMID10415

HINDUSTHAN INSTITUTE OF TECHNOLOGY

PONDURI MANOGNA - 720819104085

YELLAVULA KUMAR RAO - 720819104127

LOKESH MPT - 720819104062

VENGADESH J - 720819104123

CHILLAKURU DEEKSHITHA - 720819104023

UNDER THE GUIDANCE OF

INDUSTRY MENTOR NAME: SWATHI

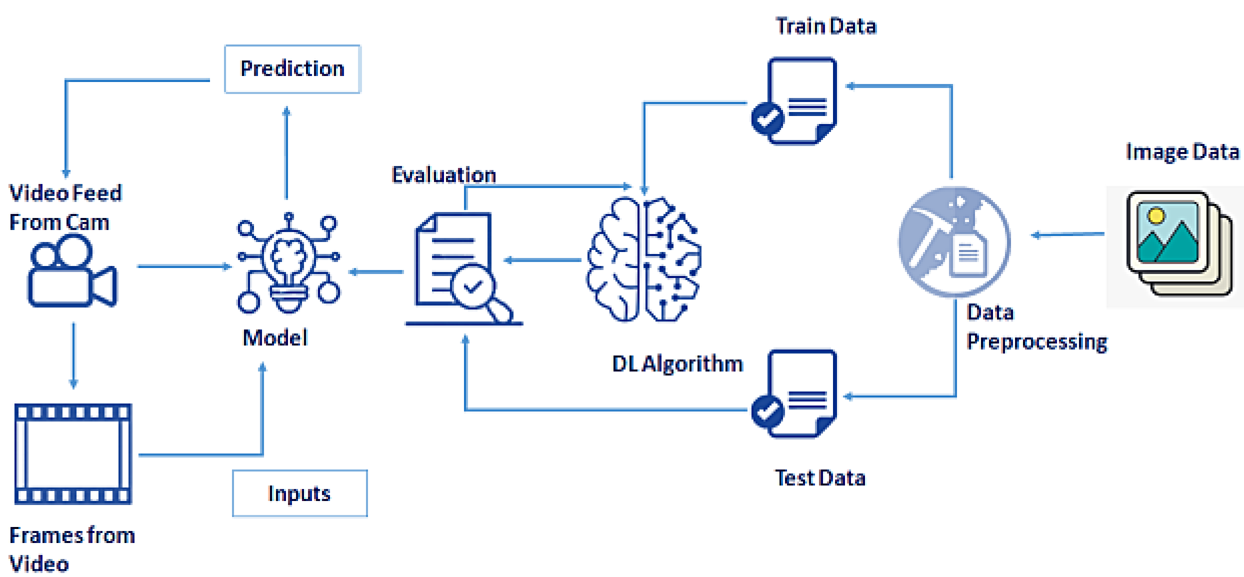
FACULTY MENTOR NAME: SENTHIL KUMAR

INTRODUCTION

PROJECT DESCRIPTION:

Natural disasters not only disturb the human ecological system but also destroy the properties and critical infrastructures of human societies and even lead to permanent change in the ecosystem. Disaster can be caused by naturally occurring events such as earthquakes, cyclones, floods, and wildfires. Many deep learning techniques have been applied by various researchers to detect and classify natural disasters to overcome losses in ecosystems, but detection of natural disasters still faces issues due to the complex and imbalanced structures of images. To tackle this problem, we developed a multilayered deep convolutional neural network model that classifies the natural disaster and tells the intensity of disaster of natural The model uses an integrated webcam to capture the video frame and the video frame is compared with the Pre-trained model and the type of disaster is identified and showcased on the OpenCV window.

TECHNICAL ARCHITECTURE:



PURPOSE:

This algorithm is capable of providing a level of accuracy close to that of human analyses and of detecting a larger number of , particularly those of low intensity, which are usually not identified by traditional detection methods.

PROJECT OBJECTIVE:

A natural disaster is "the negative impact following an actual occurrence of natural hazard in the event that it significantly harms a community". A natural disaster can cause loss of life or damage property, and typically leaves some economic damage in its wake. The severity of the damage depends on the affected population's resilience and on the infrastructure available. Examples of natural hazards include: avalanche, coastal flooding, cold wave, drought, earthquake, hail, heat wave, hurricane (tropical cyclone), ice storm, landslide, lightning, riverine flooding, strong wind, tornado, typhoon, tsunami, volcanic activity, wildfire, winter weather. Global multihazard proportional economic loss by natural disasters as cyclones, droughts, earthquakes, floods, landslides and volcanoes In modern times, the divide between natural, man-made and man-accelerated disasters is quite difficult to draw. Human choices and activities like architecture, fire, resource management or even climate change potentially play a role in causing "natural disasters". In fact, the term "natural disaster" has been called a misnomer already in 1976. A disaster is a result of a natural or man-made hazard impacting a vulnerable community. It is the combination of the hazard along with exposure of a vulnerable society that results in a disaster. Natural disasters can be aggravated by inadequate building norms, marginalization of people, inequities, overexploitation of resources, extreme urban sprawl and climate change. The rapid growth of the world's population and its increased concentration often in hazardous environments has escalated both the frequency and severity of disasters. With the tropical climate and unstable landforms, coupled with deforestation, unplanned growth proliferation, non-engineered constructions make the disaster-prone areas more vulnerable. Developing countries suffer more or less chronically from natural disasters due to ineffective communication combined with insufficient budgetary allocation for disaster prevention and management. An adverse event will not rise to the level of a disaster if it occurs in an area without vulnerable population. In a vulnerable area, however, such as Nepal during the 2015 earthquake, an adverse event can have disastrous consequences and leave lasting damage, which can take years to repair. The disastrous consequences also affect the mental health of affected communities, often leading to post-traumatic symptoms. These increased emotional experiences can be supported through collective processing, leading to resilience and increased community engagement.

PROJECT FLOW:

• Aerial imagery captured via unmanned aerial vehicles (UAVs) is playing an increasingly important role in disaster response.

• Unlike satellite imagery, aerial imagery can be captured and processed within hours rather than days.

• In addition, the spatial resolution of aerial imagery is an order of magnitude higher than the imagery produced by the most sophisticated commercial satellites today.

• Both the United States Federal Emergency Management Agency (FEMA) and the European Commission's Joint Research Center (JRC) have noted that aerial imagery will inevitably present a big data challenge.

• The purpose of this article is to get ahead of this future challenge by proposing a hybrid crowd sourcing and real-time machine learning solution to rapidly process large volumes of aerial data for disaster response in a time-sensitive manner.

• Crowd sourcing can be used to annotate features of interest in aerial images (such as damaged shelters and roads blocked by debris).

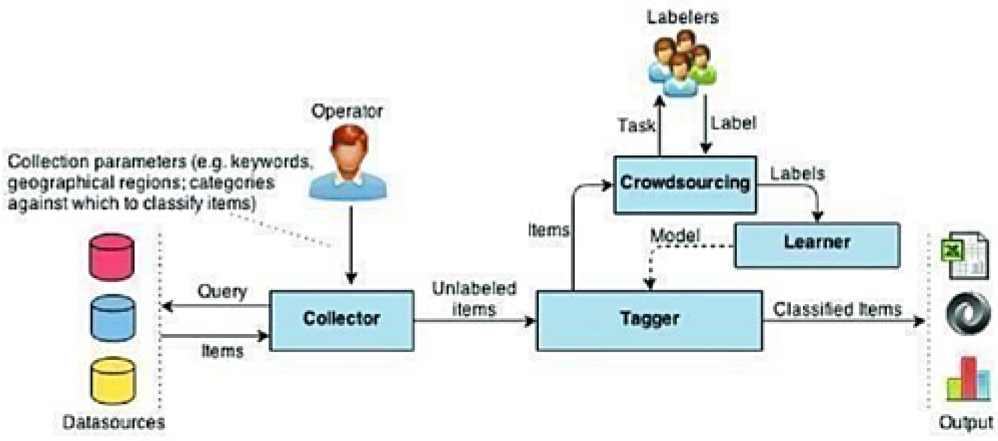
• These human-annotated features can then be used to train a supervised machine learning system to learn to recognize such features in new unseen images.

• In this article, we describe how this hybrid solution for image analysis can be implemented as a module (i.e., Aerial Clicker) to extend an existing platform called Artificial Intelligence for Disaster Response (AIDR), which has already been deployed to classify microblog messages during disasters using its Text Clicker module and in response to Cyclone Pam, a category5cyclone that devastated Vanuatu in March 2015.

• The hybrid solution we present can be applied to both aerial and satellite imagery and has applications beyond disaster response such as wildlife protection, human rights, and archeological exploration.

• As a proof of concept, we recently piloted this solution using very high-resolution aerial photographs of a wildlife reserve in Namibia to support rangers with their wildlife conservation efforts.

• The results suggest that the platform we have developed to combine crowd sourcing and machine learning to make sense of large volumes of aerial images can be used for disaster response.



PROJECT STRUCTURE:

1. Historical Disasters and Agricultural Losses

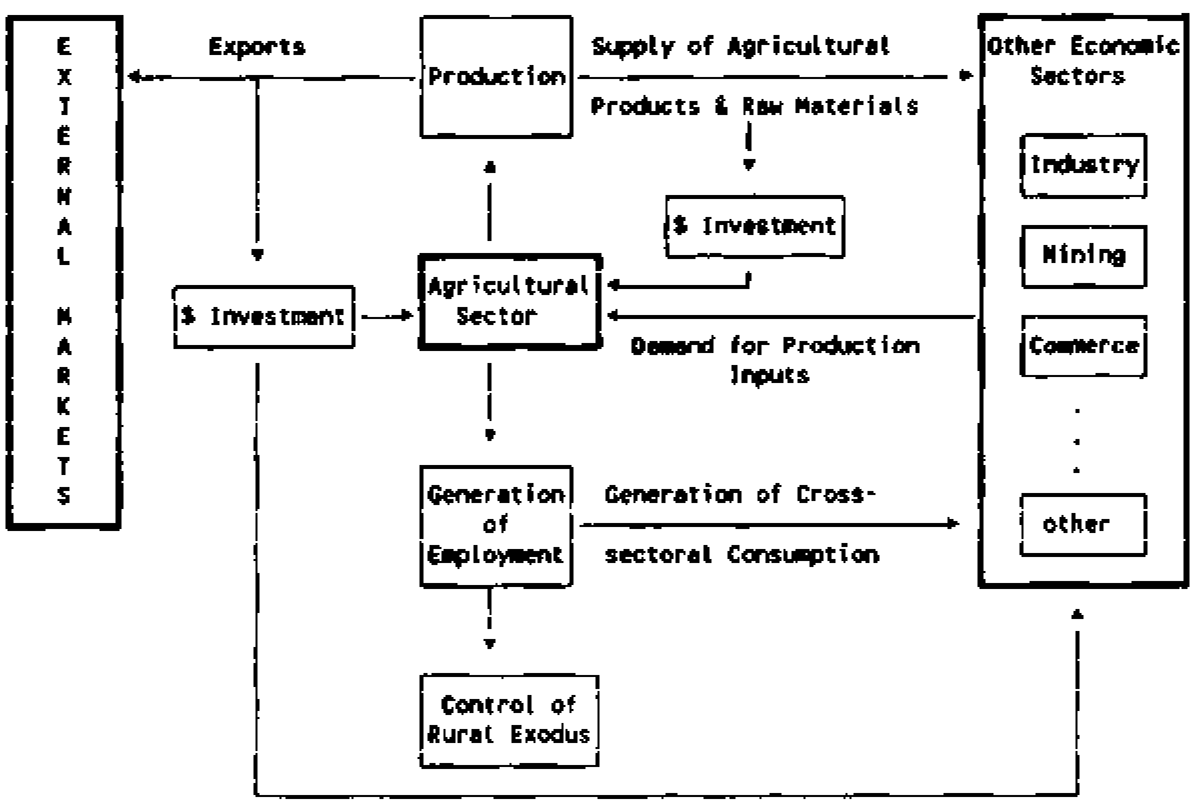
• Data from a variety of sources indicate that approximately 90 percent of all natural disasters worldwide occur in developing countries (Long, 1978). Recent Latin American and Caribbean examples illustrate the magnitude of the problem. When Hurricanes David and Frederick struck the Dominican Republic in 1979, they caused an estimated US$342 million in damage to the agricultural sector (UNDRO, 1980), destroying 80 percent of all crops and 100 percent of the banana crop. As a result, agricultural production fell 26 percent in 1979 and continued to be down 16 percent in 1980. Agriculture accounts for 37 percent of the country's gross domestic product and employs 40 percent of the labor force (USAID/OFDA, 1982). In 1984, the worst floods in Colombia in a decade caused an estimated US$400 million in damage to crops and livestock, while floods in Ecuador in 1982 and 1983 shrank the value of the banana crop by US$4.3 million (UN/ECLA, 1983).

• In short, from 1960 to 1989 natural disasters caused over US$54 billion in physical damage in Latin America and the Caribbean. While the information available on the amount of national and international funds committed to reconstruction in response to each disaster is limited, the need to redirect funds to post-disaster work curtailed the availability of funds otherwise targeted for new investment.

2. Economy-wide Effects of Disasters.

• Besides the indirect social and economic impacts on a given region or sector, disasters can affect employment, the balance of trade, foreign indebtedness, and competition for scarce development investment funds. It has even been said that "the effect of natural disasters in disaster prone developing countries tends to cancel out real growth in the countries" (Long, 1978).

• In simplified fashion, the impact natural disasters in the agricultural sector can have on the entire economy. Internally, farm products provide food for the urban population and primary inputs to industry. Externally, they are exported and earn foreign exchange. Earnings from internal and external markets provide capital for new investment in the economy. Furthermore, the sector's operation generates an important demand for products from other sectors (e.g., fertilizers, equipment, and machinery). Finally, agricultural employment generates an increased demand for consumption goods and services from urban sectors. Urban growth and rural exodus are important considerations in the management of natural hazards, since they result in overcrowding of peripheral urban areas and increase the probability of disasters in these areas as a result of floods, landslides, earthquakes, and other hazards.



3. Natural Hazards and Development Issues

• Not withstanding the term "natural," a natural hazard has an element of human involvement. A physical event, such as a volcanic eruption, that does not affect human being is a natural phenomenon but not a natural hazard. A natural phenomenon that occurs in a populated is a hazardous event. A hazardous event that causes unacceptably large numbers of fatalities and/or overwhelming property damage is a natural disaster. In areas where there are no human interests, natural phenomena do not constitute hazards nor do they result in disasters. This definition is thus at odds with the perception of natural hazards as unavoidable havoc wreaked by the unrestrained forces of nature. It shifts the burden of cause from purely natural processes to the concurrent presence of human activities and natural events.

• illustrates this approach incorporating another argument into the discussion: the relationship of human and economic losses to the severity of an event and the degree of vulnerability (or survival capability) of human and economic interests.

• The survival capability of projects depends on many factors. Losses from a severe event may be no worse or even less than those from a milder event if the former occurs in an area where both the population is adequately prepared to respond and the physical structures are designed and built to withstand its impact. One of the main differences between losses suffered by industrialized and less developed countries is the extent to which natural hazards and mitigation measures have been considered in the development planning.

• Planning systems and planners in developing countries cannot always be held fully responsible for the inadequacy of the natural hazard assessment and mitigation measures implemented (see Chapter 1). There are several reasons for this. First, much development is based on already existing hazard-prone scenarios. Second, planners depend on the availability of hazard information. And last, the planning process takes place within the prevailing economic, political, social, technological, and cultural parameters of a society. Mexico City's vulnerability to earthquakes is a good illustration. The sprawling city rests on precarious and deteriorating geological foundations. In spite of a well documented history of seismic activity, economic and technological constraints and complex political, social, cultural, and demographic elements impede the introduction of non-structural mitigation measures.

• On the other hand, planning systems and planners are responsible for some serious shortcomings of investment projects in hazard-prone areas. Irrigation systems, roads, reservoirs, dams, and other infrastructure facilities are prime examples. In these cases, where the system of constraints and parameters is less complex than in urban planning, planners should be able to incorporate more information and have greater control over decision-making. But even where sufficient hazard risk information was available, projects have been undertaken without minimum mitigation measures. It is not uncommon for an area periodically devastated by hurricanes or earthquakes to be rebuilt again and again in the same way. Other disasters occur routinely as a direct consequence of improper human intervention in areas with previously stable ecosystems. The following box lists the key elements for incorporating natural hazards into agricultural investment projects.

• Survival capability depends on many factors, and mitigation can make a substantial difference in minimizing the effects of disasters. While planners and planning systems are not responsible for some problems associated with natural hazards, they can exert influence in correcting some of the shortcomings. The following section discusses the process of integrating natural hazard information into the preparation of investment projects.

BASIC CONCEPTS:

NATURAL HAZARDS AND INVESTMENT PROJECT:

To facilitate the understanding of the subsequent sections, several key concepts are defined and explained below.

1. Probability

• Probability is the likelihood of occurrence of a particular event. This is often based on historical frequency. For example, the probability of a hurricane in any given year could be 0.1, or 10 percent, if hurricanes have struck in two of the past 20 years. For the purpose of decision-making, however, probabilities are rarely based strictly on historical information but are usually adjusted to take account of currently available information may be then referred to as subjective probabilities. For example, the observation that tropical storms have recently occurred in other parts of the world can result in the assignment of a higher subjective probability to a local storm than would be indicated by the historical frequency.

2. Risk

• Risk is generally defined as the probability of loss. In economic terms, this refers to a decline in income due to losses resulting from a natural hazard. Here risk will be used more generally to refer to uncertainty in the variables used in economic planning. For instance, in assessing the benefits and costs of a planned irrigation project, prices and yields of agricultural crops may fluctuate during the life of the project. These fluctuations can be caused by natural hazard events, but can also be caused by changing market conditions and weather cycles.

3. Risk Aversion

• Risk aversion refers to an individual's attitude toward risk. Most people are risk-averse; that is, they are willing to incur some cost to avoid risk. But there is a wide range in degrees of risk aversion (Binswanger, 1980, and Young, 1979). In other words, to avoid a given level of risk, some people will pay more than others.

4. Risk Assessment

• Risk assessment refers to the quantification of a risk. It requires a determination of both the consequences of an event and the likelihood of its occurrence. For example, a risk assessment of the potential economic effects of an earthquake on an agricultural project would require an estimate of its impact on farming activities and structural components, and of the probability of earthquakes in the region during the life of the project.

5. Risk Management

• Risk management refers to actions taken to reduce the consequences or probability of unfavorable events. Similarly, natural hazard management refers to activities undertaken to reduce the negative effects of natural hazards. For example, a farmer may choose to plant a windbreak along a field to reduce the chances that wind will damage his sugar crops. While this may reduce his average income if he has to remove land from production, he may still do it to mitigate against an uncertain but potentially damaging storm.

PREREQUISITES:

Plan Prerequisites:

• Information disaster planning is only effective when it is part of a comprehensive information and records management program. A plan to protect business records is ineffective and needlessly expensive if the majority of the protected records no longer have administrative, legal, fiscal, research or historical value. To reconstruct or salvage outdated or non-essential records is a waste of time and money. More frequently, the lack of approved retention authorizations or not following the retention authorization creates a large body of records that might not be essential or useful to a department. A major disaster is not the appropriate time to conduct a comprehensive review of your records retention authorizations and compliance.

Prerequisite 1: Information is Viewed as a Resource

• Departments that are committed to managing information throughout the total life cycle, from creation or inception, through its use, storage, retrieval, to its final disposition, are more likely to properly place disaster planning in their total management program.

Prerequisite 2: Adequate General Insurance

• An information disaster plan is a form of insurance. Disaster prevention planning is a form of risk assessment. The planning process presupposes that business insurance programs are in place to protect the University's assets and to provide adequate liability protection. Such programs should already be identified and provide protection against certain risks and dangers.

• Risk assessment is a management tool for determining the likelihood of a disaster and its financial impact on the University. A specific dollar amount is placed on each potential disaster by calculating an Annual Loss Expectancy (A.L.E.). The A.L.E. is determined by multiplying the frequency of occurrence by the expected dollar loss per occurrence.

• An information disaster plan complements existing insurance by scrutinizing the University from an information vantage point. The plan identifies specific risks such as building and equipment hazards that can result in flooding to records storage areas, dangerous storage practices that increase the risk of fire near irreplaceable research and development records, and periodic electric storms or tornados that endanger electronically generated vital records. High, medium or low disaster plans have a price tag, but an ounce of prevention is better than a pound of cure.

Prerequisite 3: A Vital Records Program

• In the event of a disaster, recovery can be very costly. It is important that protected, reconstructed, salvaged, and restored records contain information that is essential to the department's continued operation (vital records). The identification and protection of essential records represents the gray area where a vital records program and a disaster plan overlap.

Prerequisite 4: A Current Records Retention Schedule

• A vital records program is built upon a detailed records retention schedule -- a comprehensive list of records indicating the length of time each record is maintained in the office area, in the records center, or on electronic media devices and when and if it can be destroyed.

• The retention schedule must precede the vital records protection and disaster recovery plan. This schedule provides necessary information about the location of records, media upon which records are stored, methods of protection, and the value of individual records.

Prerequisite 5: A Sound Records Classification and Retrieval System

• Jumbled, poorly labeled records, whether stored in a bulging file folder, in a disorganized microfilm system, or on a poorly indexed electronic system, significantly increase the cost of disaster planning. The main difficulty is that records are not grouped into workable records series -- a group of identical or related records that are normally used and filed as a unit -- that can be evaluated as a unit for retention scheduling purposes.

Prerequisite 6: An Adequate Security Program

• A general security program for both facilities and information provides the necessary framework to develop an information disaster plan.

The following is just a few security elements found in an adequate program:

- Computer passwords/password protection
- Employee identification cards
- Security personnel
- Restricted access areas
- Fire vaults and safes
- Smoke detectors

PRIOR KNOWLEDGE:

INTODUCTION

Over the past 20 years, various disasters that have occurred in Indonesia have caused many losses. From the data of The Asia Pacific Disaster Report 2010 compiled by The Economic and Social Commission for Asia and the Pacific (ESCAP) and The UN International Strategy for Disaster Reduction (UNISDR) losses suffered by Indonesia at least US $ 22.5 billion. So Indonesia ranks second as a country that has death rates caused by floods in Asia-Pacific. According to Flood Disaster Management Agency West Sumatra Province in 2016, West Sumatra Province, especially the city of Padang is a city that has a medium to high potential for flooding. There are seven sub-districts in Padang that have the potential, including Koto Tangah, Lubuk Begalung, Nanggalo, Padang Selatan, Padang Barat, Teluk Kabung and Padang Timur is covering 14 villages. The cause of floods in the Padang City is, the recorded Padang City has 5 major rivers and 16 small rivers in the lowlands, has a tropical climate with rainfall almost every year with high enough bulk, drainage system is not good for ready to accommodate rain or water pairs, the lack of hygiene of the gutter and disappearance of green open spaces and water absorption as transformed into luxury housing complex and shopping centers/shops. So for that, several efforts need to be done to minimize the impact that will occur.

RESEARCH METHOD

This research is qualitative descriptive. Qualitative research methods are also called naturalistic methods because the research is done on natural conditions (natural settings) [11]. Began and Taylor define a qualitative methodology as a research procedure that produces descriptive data in the form of written or oral words of observable persons and behaviors [12]. Data collection method used is questionnaire method. Questionnaire used in the form of an open questionnaire, which is a questionnaire that asks the respondent to provide information in response to their understanding [13].

Survey was conducted in July 2018 at Public Senior High School 6 Padang. The population in this study is all students of class XI Public Senior High School 6 Padang consisting of 9 Classes. While the research sample taken by purposing random sampling technique, obtained class XI Natural Sciences 2 with the number of students 29 people as the sample research. The qualitative research procedure according is as follows: establishing focus of research, collecting data, processing data, analyzing data, and presenting data.

The first activities to do tostart of qualitative research is to determine the research question. Research question in this research is referred to as the focus of research on the things to be sought from the research. The research method used in data retrieval is by using non test. In this no test technique are used question are sheets students' knowledge for the data needed to determine the level of students' knowledge. Techniques of data analysis consist of two namely.

(a) Qualitative data analysis techniques. The results of questionnaires quality of instruments, knowledge floods, qualitative data. Qualitative data in the form of categorized value, namely SB (Very Good), B (Good), C (Simply), K (Less) [11].

(b) Quantitative data analysis techniques that are categories that are converted into quantitative data. Quantitative data from questionnaires are measurement instruments, is SB: 4, B: 3, C: 2, K: 1. Questionnaire prior knowledge consists of 4 indicators outlined in 14 Questions.

Score analysis can be done by dividing the score obtained with the ideal score then multiplied 100%. So it can be expressed in the equation 1:

$$P = A/B * 100 \%$$

Information:
P = Percentage
A = scores obtainedB = ideal score

Classification categories of this analysis can be seen in Table 1.

Table 1. Criteria Assessment Prior Knowledge Students

Interval Score	Criteria
(75-100) %	Very Good
(50-74,99) %	Good
(25-49,99) %	Simply
(0-24,99) %	Less

RESULTS AND DISCUSSION

Results of this study is data of the prior knowledge of students the flood disaster that will be implemented in the development of teaching materials of Senior High School Physics. Based on data analysis Flood Disaster Management Agency West Sumatra 2016, one of the areas in Padang City that has medium to high potential for flood disasters is the District of South Padang. Public Senior High School 6 Padang is a school located in the District of South Padang. The Location of the school on the hillside resulted in the school often flooded when it rained with high and long-lasting rainfall. From the results of interviews with several students, floods will inundate schools and the classroom floor, especially in the eastern part of the school that do have low ground. This will certainly disrupt the learning activities in the classroom. For that, students need to have prior knowledge about the flood disaster, so students can know and do to reduce the impact of flooding, things to do when the flood occurs and the action to be done after the flood. Based on the prior knowledge questionnaire filled with students, where the questionnaire consists of 4 indicator questions and consists of 14 question variables. These 4 indicators include (A) knowledge of flood disasters, (B) flood disaster classification, (C) flood disaster risk, and (D) flood disaster mitigation.

Graph Analysis of Students' Prior Knowledge from each Indicator

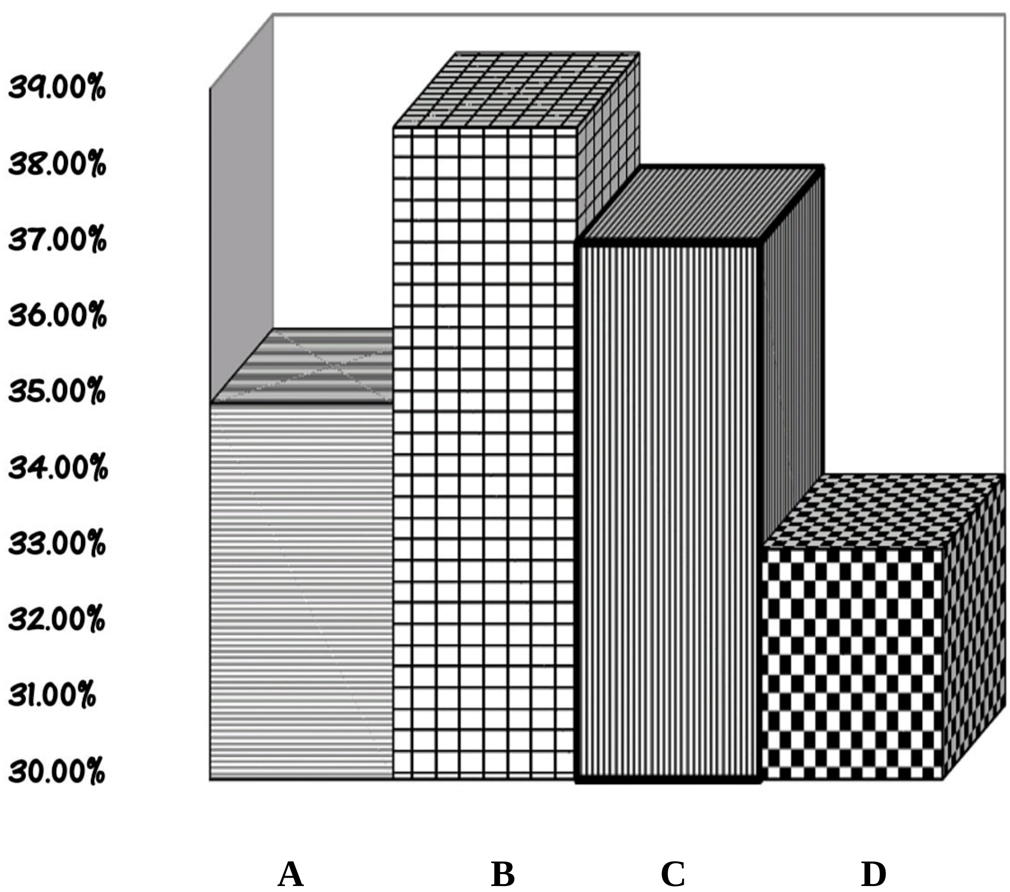


Figure 1. Graph of Results of Disaster Prior Knowledge Analysis of Each Indicator

Graph Analysis Prior knowledge of each Category

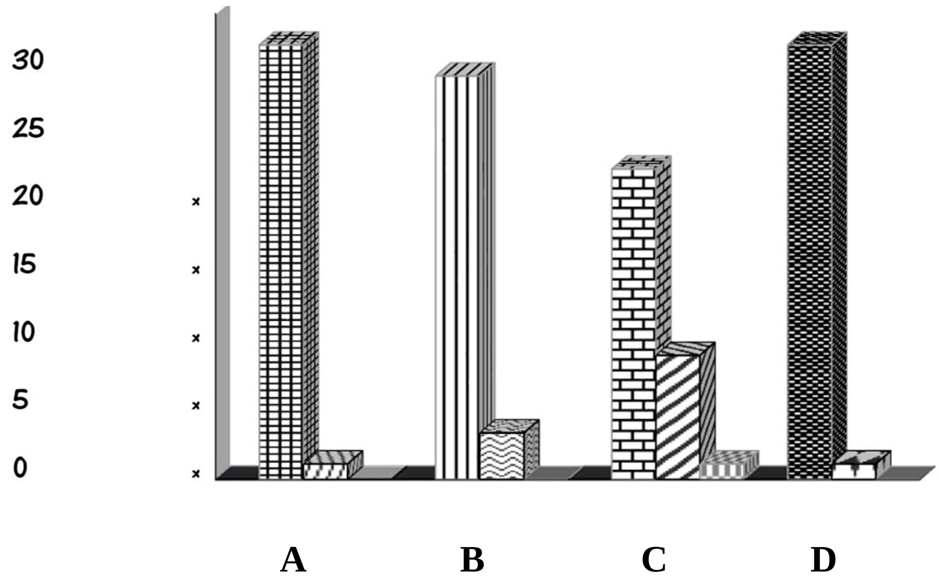


Figure 2. Graph of Results of Disaster Prior Knowledge Analysis of each Category

IMAGE PREPROCESSING:

APPLY IMAGE DATA GENERATOR FUNCTIONALITY TO TRAINSET AND TESTSET:

Performing data augmentation to train data

```
x_train = train_datagen.flow_from_directory('train_set', target_size = (64,64),
```

batch_size = 5, color_mode = 'rgb', class_mode = 'categorical')

```
FileNotFoundError                         Traceback (most recent call last)

Input In [11], in ()

----> 1 x_train = train_datagen.flow_from_directory('train_set', target_size

= (64,64), batch_size = 5, color_mode = 'rgb', class_mode = 'categorical')

File ~\anaconda3\envs\tf_env\lib\site- packages\keras\preprocessing\image.py:1650, in
ImageDataGenerator.flow_from_directory(self, directory, target_size, color_mode, classes, class_mode,
batch_size, shuffle, seed, save_to_dir,save_prefix, save_format, follow_links, subset, interpolation,
keep_aspect_ratio)

   1564    def flow_from_directory(

   1565    self,

   1566    directory,

   (...)
   1580    keep_aspect_ratio=False,

   1581    ):

   1582        """Takes the path to a directory & generates batches ofaugmented data.

   1583

   1584    Args:

   (...)
   1648    and `y` is a numpy array of corresponding labels.

   1649    """
```

```
->   1650 return DirectoryIterator(
     1651     directory,
     1652   self,
     1653   target_size=target_size,
     1654   color_mode=color_mode,
     1655   keep_aspect_ratio=keep_aspect_ratio,
     1656   classes=classes,
     1657   class_mode=class_mode,
     1658   data_format=self.data_format,
     1659   batch_size=batch_size,
     1660  shuffle=shuffle,
     1661   seed=seed,
     1662   save_to_dir=save_to_dir,
     1663  save_prefix=save_prefix,
     1664   save_format=save_format,
     1665   follow_links=follow_links,
     1666   subset=subset,
     1667   interpolation=interpolation,
     1668   dtype=self.dtype,
     1669   )
```

File **~\anaconda3\envs\tf_env\lib\site-packages\keras\preprocessing\image.py:563**, in DirectoryIterator. init **(self, directory, image_data_generator,**

target_size, color_mode, classes, class_mode, batch_size, shuffle, seed, data_format, save_to_dir, save_prefix, save_format, follow_links, subset,interpolation, keep_aspect_ratio, dtype)

```
    561 if not classes:
    562     classes = []
--> 563     for subdir in sorted(os.listdir(directory)):
    564         if os.path.isdir(os.path.join(directory, subdir)):
    565             classes.append(subdir)
```

FileNotFoundError: [WinError 3] The system cannot find the path specified:

'train_set'

Performing data augmentation to test data

```
x_test = test_datagen.flow_from_directory('test_set', target_size = (64,64), batch_size = 5,
color_mode = 'rgb', class_mode = 'categorical')
```

Found 198 images belonging to 4 classes.

CONFIGURE IMAGE DATA GENERATOR CLASS:

Image Data Augmentation

Configuring image Data Generator Class

Setting Parameter for Image Augmentation for training data

```
train_datagen = ImageDataGenerator(rescale = 1./255, shear_range = 0.2, zoom_range =
0.2, horizontal_flip = True)
```

Image Data Augmentation for testing data

```
test_datagen = ImageDataGenerator(rescale = 1./255)
```

MODEL BUILDING:

TRAIN TEST AND SAVE MODEL:

• In this tutorial, you will learn how to automatically detect natural disasters (earthquakes, floods, wildfires, cyclones/hurricanes) with up to 95% accuracy using Keras, Computer Vision, and Deep Learning. I remember the first time I ever experienced a natural disaster — I was just a kid in kindergarten, no more than 6-7 years old.

• We were outside for recess, playing on the jungle gym, running around like the wild animals that young children are. Rain was in the forecast. It was cloudy. And very humid. My mother had given me a coat to wear outside, but I was hot and uncomfortable — the humidity made the cotton/polyester blend stick to my skin. The coat, just like the air around me, was suffocating. All of a sudden the sky changed from “normal rain clouds” to an ominous green.

• The recess monitor reached into her pocket, grabbed her whistle, and blew it, indicating it was time for us to settle our wild animal antics and come inside for schooling.

• After recess we would typically sit in a circle around the teacher’s desk for show-and-tell. But not this time. We were immediately rushed into the hallway and were told to cover our heads with our hands — a tornado had just touched down near our school.

• Just the thought of a tornado is enough to scare a kid. But to actually experience one? That’s something else entirely.

• The wind picked up dramatically, an angry tempest howling and berating our school with tree branches, rocks, and whatever loose debris was not tied down.

• The entire ordeal couldn’t have lasted more than 5-10 minutes — but it felt like a terrifying eternity.

• It turned out that we were safe the entire time. After the tornado had touched down it started carving a path through the cornfields away from our school, not toward it. We were lucky. It’s interesting how experiences as a young kid, especially the ones that scare you, shape you and mold you after you grow up. A few days after the event my mom took me to the local library. I picked out every book on tornados and hurricanes that I could find. Even though I only had a basic reading level at the time, I devoured them, studying the pictures intently until I could recreate them in my mind — imagining what it would be like to be inside one of those storms. Later, in graduate school, I experienced the historic June 29th, 2012 derecho that delivered 60+ MPH sustained winds and gusts of over 100 MPH, knocking down power lines and toppling large trees.

• That storm killed 29 people, injured hundreds of others, and caused loss of electricity and power in parts of the United States east coast for over 6 days, an unprecedented amount of time in the modern-day United States.

• Natural disasters cannot be prevented — but they can be detected, giving people precious time to get to safety. In this tutorial, you’ll learn how we can use Computer Vision and Deep Learning to help detect natural disasters. To learn how to detect natural disasters with Keras, Computer Vision, and Deep Learning, just keep reading! Looking for the source code to this post? JUMP RIGHT TO THE DOWNLOADS SECTION Detecting Natural Disasters with Keras and Deep Learning In the first part of this tutorial, we’ll discuss how computer vision and deep learning algorithms can be used to automatically detect natural disasters in images and video streams. From there we’ll review our natural disaster dataset which consists of four classes:

- Cyclone/hurricane
- Earthquake
- Flood
- Wildfire

We’ll then design a set of experiments that will:

- Help us fine-tune VGG16 (pre-trained on ImageNet) on our dataset.
- Find optimal learning rates.
- Train our model and obtain > 95% accuracy! Let’s get started! How can computer vision and deep learning detect natural disasters?

Figure 1: We can detect natural disasters with Keras and Deep Learning using a dataset of natural disaster images. (image source) Natural disasters cannot be prevented — but they can be detected. All around the world we use sensors to monitor for natural disasters:

- Seismic sensors (seismometers) and vibration sensors (seismoscopes) are used to monitor for earthquakes (and downstream tsunamis).
- Radar maps are used to detect the signature “hook echo” of a tornado (i.e., a hook that extends from the radar echo).
- Flood sensors are used to measure moisture levels while water level sensors monitor the height of water along a river, stream, etc.
- Wildfire sensors are still in their infancy but hopefully will be able to detect trace amounts of smoke and fire. Each of these sensors is highly specialized to the task at hand — detect a natural disaster early, alert people, and allow them to get to safety.
- Using computer vision we can augment existing sensors, thereby increasing the accuracy of natural disaster detectors, and most importantly, allow people to take precautions, stay safe, and prevent/reduce the number of deaths and injuries that happen due to these disasters. Our natural disasters image dataset Figure 2: A dataset of natural disaster images. We’ll use this dataset to train a natural disaster detector with Keras and Deep Learning. The

dataset we are using here today was curated by PyImageSearch reader, Gautam Kumar. Gautam used Google Images to gather a total of 4,428 images belonging to four separate classes:

- Cyclone/Hurricane: 928 images
- Earthquake: 1,350
- Flood: 1,073
- Wildfire: 1,077
- He then trained a Convolutional Neural Network to recognize each of the natural disaster cases.
- Gautam shared his work on his LinkedIn profile, gathering the attention of many deep learning practitioners (myself included). I asked him if he would be willing to share his dataset with the PyImageSearch community and allow me to write a tutorial using the dataset. Gautam agreed, and here we are today!

APPLICATION BUILDING:

BUILD HTML CODE:

```
<!DOCTYPE html>

<html lang="en">

<title>Home - Natural Disasters Database</title>

<meta charset="UTF-8">

<meta name="viewport" content="width=device-width, initial-scale=1">

<link rel="stylesheet" href="https://www.w3schools.com/w3css/4/w3.css">

<link rel="stylesheet" href="https://fonts.googleapis.com/css?family=Lato">

<link rel="stylesheet" href="https://fonts.googleapis.com/css?family=Montserrat">

<link rel="stylesheet" href="https://cdnjs.cloudflare.com/ajax/libs/font-
awesome/4.7.0/css/fontawesome.min.css">
```

```
<style>

body,h1,h2,h3,h4,h5,h6 {font-family: "Lato", sans-serif}

.w3-bar,h1,button {font-family: "Montserrat", sans-serif}

.fa-anchor,.fa-coffee {font-size:200px}

</style>

<body>

<!-- Navbar -->

<div class="w3-top">

 <div class="w3-bar w3-black w3-card w3-left-align w3-large">

 <a class="w3-bar-item w3-button w3-hide-medium w3-hide-large w3-right w3-padding-large w3-

hover-white w3-large w3-red" href="javascript:void(0);" onclick="myFunction()" title="Toggle Navigation

Menu"><i class="fa fa-bars"></i></a>

 <a href="{% url 'home' %}" class="w3-bar-item w3-button w3-hide-small w3-padding-large w3-hoverwhite">Home</a>

 <a class="w3-bar-item w3-button w3-padding-large w3-white">Earthquake</a>

 <a href="{%url 'tsunami'%}" class="w3-bar-item w3-button w3-hide-small w3-padding-large w3-hover-white">Tsunami</a>

<a href="{%url 'tornado'%}" class="w3-bar-item w3-button w3-hide-small w3-padding-large w3-hoverwhite">Tornado</a>

 <a href="{%url 'volcano'%}" class="w3-bar-item w3-button w3-hide-small w3-padding-large w3-hoverwhite">Volcanic Activity</a>

 </div>
```

```
 <!-- Navbar on small screens -->

 <div id="navDemo" class="w3-bar-block w3-white w3-hide w3-hide-large w3-hide-medium
w3-large">

 <a href="#" class="w3-bar-item w3-button w3-padding-large">Earthquake</a>

 <a href="#" class="w3-bar-item w3-button w3-padding-large">Tsunami</a>

 <a href="#" class="w3-bar-item w3-button w3-padding-large">Tornado</a>

 <a href="#" class="w3-bar-item w3-button w3-padding-large">Volcanic Activity</a>

 </div>

</div>

<!-- Header -->

<header class="w3-container w3-grey w3-center" style="padding:128px 16px">

 <h1 class="w3-margin w3-jumbo">Earthquakes</h1>

 <p class="w3-xlarge">Natural Disasters Database</p>

</header>

<div class="w3-container">

 <h2>Earthquakes</h2>

 <table class="w3-table-all">

 <tr>

 <th>Earthquake_id</th>

 <th>Intensity</th>

 <th>Date</th>

 <th>Country</th>
```

```
 <th>Place</th>
 <th>Latitude</th>
 <th>Longitude</th>
 {% for quake in all_quakes %}
 <tr>
 <td>{{quake.earthquake_id}}</td>
 <td>{{quake.intensity}}</td>
 <td>{{quake.date}}</td>
 <td>{{quake.country}}</td>
 <td>{{quake.place}}</td>
 <td>{{quake.latitude}}</td>
 <td>{{quake.longitude}}</td>
 </tr>
 {% endfor %}
 </table>
</div>
<div class="w3-container">
 <h2>Damage caused by the quakes</h2>
 <table class="w3-table-all">
 <tr>
 <th>Earthquake_id</th>
 <th>Amount (in million)</th>
```

```
 <th>Deaths (in thousands)</th>

 <th>House_destroyed (in thousands)</th>

 </tr>

 {% for d in damage %}

 <tr>

 <td>{{d.earthquake_id}}</td>

 <td>{{d.amount}}</td>

 <td>{{d.deaths}}</td>

 <td>{{d.house_destroyed}}</td>

 </tr>

 {% endfor %}

 </table>

</div>

<div class="w3-container w3-black w3-center w3-opacity w3-padding-50">

 <h1 class="w3-margin w3-xlarge">Thanks for visiting the website</h1>

</div>

<!-- Footer -->

<footer class="w3-container w3-padding-40 w3-center w3-opacity">

 <div class="w3-xlarge w3-padding-20">

 <h1>A Database project </h1>

</footer>

<script>
```

// Used to toggle the menu on small screens when clicking on the menu button

```
function myFunction() {
 var x = document.getElementById("navDemo");
 if (x.className.indexOf("w3-show") == -1) {
 x.className += " w3-show";
 } else {
 x.className = x.className.replace(" w3-show", "");
 }
}
</script>
</body>
</html>
```

HTML CODE FOR NATURAL DISATSTER:

```
<!doctype html>
<html>
<head>
<meta name="viewport" content="width=device-width, initial- scale=1"/>
<title>Natural Disasters - Our World in Data</title>
<meta name="description" content="Where and from which disasters do people die? What can we do to prevent deaths from natural disasters?"/>
<link rel="canonical" href="https://ourworldindata.org/natural-disasters"/>
<link rel="alternate" type="application/atom+xml" href="/atom.xml"/><link rel="apple-touch-icon" sizes="180x180" href="/apple-touch-icon.png"/>
<meta property="fb:app_id" content="1149943818390250"/>
<meta property="og:url" content="https://ourworldindata.org/natural-disasters"/>
<meta property="og:title" content="Natural Disasters"/>
```

<meta property="og:description" content="Where and from which disasters do people die? What can we do to prevent deaths from natural disasters?"/>
<meta property="og:image" content="https://ourworldindata.org/uploads/2019/11/Annual-deaths-by-natural-disaster- 768x459.png"/>
<meta property="og:site_name" content="Our World in Data"/>
<meta name="twitter:card" content="summary_large_image"/>
<meta name="twitter:site" content="@OurWorldInData"/>
<meta name="twitter:creator" content="@OurWorldInData"/><meta name="twitter:title" content="Natural Disasters"/><meta name="twitter:description" content="Where and from which disasters do people die? What can we do to prevent deaths from natural disasters?"/><meta name="twitter:image" content="https://ourworldindata.org/uploads/2019/11/Annual-deaths-by-natural-disaster-768x459.png"/><link href="https://fonts.googleapis.com/css?family=Lato:300,400,400i,700,700i|Playfair+Display:400,600,70 0&display=swap" rel="stylesheet"/><link rel="stylesheet" href="https://ourworldindata.org/assets/commons.css"/><link rel="stylesheet" href="https://ourworldindata.org/assets/owid.css"/><meta name="citation_title" content="Natural Disasters"/><meta name="citation_fulltext_html_url" content="https://ourworldindata.org/natural- disasters"/><meta name="citation_fulltext_world_readable" content=""/><meta name="citation_publication_date" content="2014/06/03"/><meta name="citation_journal_title" content="Our World in Data"/><meta name="citation_journal_abbrev" content="Our World in Data"/><meta name="citation_author" content="Hannah Ritchie"/><meta name="citation_author" content="Max Roser"/></head><body class=""><header class="site-header"><div class="wrapper site- navigation-bar"><div class="site-logo">Our World
 in Data</div><nav class="site- navigation"><div class="topics-button-wrapper"><div class="label">Articles
by topic</div><div class="icon"><svg width="12" height="6"><path d="M0,0 L12,0 L6,6 Z" fill="currentColor"></path></svg></div></div><div><div class="site-primary-navigation"><form class="HeaderSearch" action="/search" method="GET"><input type="search" name="q" placeholder="Search..."/><div class="icon"><svg aria-hidden="true" focusable="false" data-prefix="fas" data-icon="magnifying-glass" class="svg-inline--fa fa-magnifying- glass " role="img" xmlns="http://www.w3.org/2000/svg" viewBox="0 0 512 512"><path fill="currentColor" d="M416 208c0 45.9-14.9 88.3-40 122.7L502.6 457.4c12.5 12.5 12.5 32.8 0 45.3s-

32.8 12.5-45.3 0L330.7 376c-34.4 25.2-76.8 40-122.7 40C93.1 416 0 322.9 0 208S93.1 0 208 0S416 93.1
416 208zM208 352c79.5 0 144-64.5 144-144s-64.5-144-144-144S64 128.5 64 208s64.5 144 144
144z"></path></svg></div></form><ul class="site-primary-links">
Latest
About
Donate
</div><div class="site-secondary-navigation"><ul class="site- secondary-links">
All charts
Sustainable Development Goals Tracker
</div></div></nav><div class="header-logos-wrapper"></div><div class="mobile-site-navigation"><button data-track-note="mobile-search-button"><svg aria- hidden="true" focusable="false" data-prefix="fas" data-icon="magnifying-glass" class="svg-inline--fa fa-magnifying-glass " role="img" xmlns="http://www.w3.org/2000/svg" viewBox="0 0 512 512"><path fill="currentColor" d="M416 208c0 45.9-14.9 88.3-40 122.7L502.6 457.4c12.5 12.5 12.5 32.8 0 45.3s-
32.8 12.5-45.3 0L330.7 376c-34.4 25.2-76.8 40-122.7 40C93.1 416 0 322.9 0 208S93.1 0 208 0S416 93.1
416 208zM208 352c79.5 0 144-64.5 144-144s-64.5-144-144-144S64 128.5 64 208s64.5 144 144
144z"></path></svg></button><button data-track-note="mobile-newsletter-button"><svg aria- hidden="true" focusable="false" data-prefix="fas" data-icon="envelope-open-text" class="svg-inline--fa fa-envelope-open-text " role="img" xmlns="http://www.w3.org/2000/svg" viewBox="0 0 512 512"><path fill="currentColor" d="M215.4 96H144 107.8 96v8.8V144v40.4 89L.2 202.5c1.6-18.1 10.9-
34.9 25.7-45.8L48 140.3V96c0-26.5 21.5-48 48-48h76.6l49.9-36.9C232.2 3.9 243.9 0 256 0s23.8 3.9 33.5
11L339.4 48H416c26.5 0 48 21.5 48 48v44.3l22.1 16.4c14.8 10.9 24.1 27.7 25.7 45.8L416 273.4v-89V144
104.8 96H404.2 368 296.6 215.4zM0 448V242.1L217.6 403.3c11.1 8.2 24.6 12.7 38.4 12.7s27.3-4.4 38.4-
12.7L512 242.1V448v0c0 35.3-28.7 64-64 64H64c-35.3 0-64-28.7-64-64v0zM176

160H336c8.8 0 16 7.2

16 16s-7.2 16-16 16H176c-8.8 0-16-7.2-16-16s7.2-16 16-16zm0 64H336c8.8 0 16 7.2 16 16s-7.2 16-16

16H176c-8.8 0-16-7.2-16-16s7.2-16 16-16z"></path></svg></button><button data-track-note="mobile-hamburger-button"><svg aria-hidden="true" focusable="false" data-prefix="fas" data-icon="bars" class="svg-inline--fa fa-bars " role="img" xmlns="http://www.w3.org/2000/svg" viewBox="0 0 448 512"><path fill="currentColor" d="M0 96C0 78.3 14.3 64 32 64H416c17.7 0 32 14.3 32 32s-14.3 32-32 32H32C14.3 128 0 113.7 0 96zM0 256c0-17.7 14.3-32 32-32H416c17.7 0 32 14.3 32 32s-14.3 32-32

32H32c-17.7 0-32-14.3-32-32zM448 416c0 17.7-14.3 32-32 32H32c-17.7 0-32-14.3-32-32s14.3-32 32-

32H416c17.7 0 32 14.3 32 32z"></path></svg></button></div></div></header><div class="alert- banner"><div class="content"><div class="text">COVID-19 vaccinations, cases, excess mortality, and much more</div>Explore our COVID-19 data</div></div><main><article class="page with-sidebar large-banner"><div class="offset-header"><header class="article-header"><div class="article-titles"><h1 class="entry-title">Natural Disasters</h1></div><div class="authors- byline">by Hannah Ritchie and Max Roser</div><div class="blog-info">This article was first published in 2014. It was last updated in November 2021.</div><div class="tools"><a

href="#licence"><svg aria-hidden="true" focusable="false" data-prefix="fab" data-icon="creative- commons" class="svg-inline--fa fa-creative-commons " role="img" xmlns="http://www.w3.org/2000/svg" viewBox="0 0 496 512"><path fill="currentColor" d="M245.83 214.87l-33.22 17.28c-9.43-19.58-25.24-19.93-27.46-19.93-22.13 0-33.22 14.61-33.22 43.84 0 23.57 9.21

43.84 33.22 43.84 14.47 0 24.65-7.09 30.57-21.26l30.55 15.5c-6.17 11.51-25.69 38.98-65.1 38.98-22.6 0-

73.96-10.32-73.96-77.05 0-58.69 43-77.06 72.63-77.06 30.72-.01 52.7 11.95 65.99 35.86zm143.05 0l-

32.78 17.28c-9.5-19.77-25.72-19.93-27.9-19.93-22.14 0-33.22 14.61-33.22 43.84 0 23.55 9.23 43.84

33.22 43.84 14.45 0 24.65-7.09 30.54-21.26l31 15.5c-2.1 3.75-21.39 38.98-65.09 38.98-22.69 0-73.96-

9.87-73.96-77.05 0-58.67 42.97-77.06 72.63-77.06 30.71-.01 52.58 11.95 65.56 35.86zM247.56 8.05C104.74 8.05 0 123.11 0 256.05c0 138.49 113.6 248 247.56 248 129.93 0 248.44-100.87 248.44-248
0-137.87-106.62-248-248.44-248zm.87 450.81c-112.54 0-203.7-93.04-203.7-202.81 0-105.42 85.43-
203.27 203.72-203.27 112.53 0 202.82 89.46 202.82 203.26-.01 121.69-99.68 202.82-202.84 202.82z"></path></svg>Reuse our work freely<svg aria-hidden="true" focusable="false" data-prefix="fas" data-icon="book" class="svg-inline--fa fa-book " role="img" xmlns="http://www.w3.org/2000/svg" viewBox="0 0 448 512"><path fill="currentColor" d="M96 0C43 0
0 43 0 96V416c0 53 43 96 96 96H384h32c17.7 0 32-14.3 32-32s-14.3-32-32-32V384c17.7 0 32-14.3 32-
32V32c0-17.7-14.3-32-32-32H384 96zm0 384H352v64H96c-17.7 0-32-14.3-32-32s14.3-32 32-32zm32-
240c0-8.8 7.2-16 16-16H336c8.8 0 16 7.2 16 16s-7.2 16-16 16H144c-8.8 0-16-7.2-16-16zm16 48H336c8.8 0 16 7.2 16 16s-7.2 16-16 16H144c-8.8 0-16-7.2-16-16s7.2-16 16-16z"></path></svg>Cite
this research</div></header></div><div class="content-wrapper"><div class="toc-wrapper"><aside class="entry-sidebar"><nav class="entry-toc">
Natural Disasters
<li class="section">Summary
<li class="section">Natural disasters kill tens of thousands each year
<li class="section">What share of deaths are from natural disasters?
<li class="section">Number of deaths from natural disasters
<li class="subsection">Annual deaths from natural disasters
<li class="subsection">Average number of deaths by decade
<li class="subsection">Number of deaths by type of natural disaster
<li class="section">Injuries and displacement from disasters
<li class="section">Natural disasters by type
<li class="subsection">Earthquakes
<li class="subsection"><a href="#volcanoes" data-

track-note="toc-link">Volcanoes
<li class="subsection">Landslides
<li class="subsection">Famines & Droughts
<li class="subsection">Hurricanes, Tornados, and Cyclones
<li class="subsection">Extreme precipitation and flooding
<li class="subsection"><a href="#extreme-temperature-heat-cold"

data-track-note="toc-link">Extreme Temperature (Heat & Cold)
<li class="subsection">Wildfires
<li class="subsection">Lightning
<li class="section">Economic costs
<li class="subsection">Global disaster costs
<li class="subsection">Disaster costs by country
<li class="section">Not all deaths are equal: How many deaths make a natural disaster newsworthy?
<li class="section">Link between poverty and deaths from natural disasters
<li class="section">Definitions & Metrics
<li class="section">Data Quality
<li class="section">Data Sources
<li class="section">Endnotes
<li class="section">Licence
<li class="section">Citation
</nav><div class="toggle-toc"><button data-track-note="page-toggle-toc" aria-label="Open table of contents"><svg aria-hidden="true" focusable="false" data-prefix="fas" data- icon="bars" class="svg-inline--fa fa-bars " role="img" xmlns="http://www.w3.org/2000/svg" viewBox="00 448 512"><path fill="currentColor" d="M0 96C0 78.3 14.3 64 32 64H416c17.7 0 32 14.3 32 32s-14.3 32-32 32H32C14.3 128 0 113.7 0 96zM0 256c0-17.7 14.3-32 32-32H416c17.7 0 32 14.3 32 32s-14.3 32-
32 32H32c-17.7 0-32-14.3-32-32zM448 416c0 17.7-14.3 32-32 32H32c-17.7 0-32-14.3-32-32s14.3-32 32-
32H416c17.7 0 32 14.3 32 32z"></path></svg>Contents</button></div></aside></div><div class="offset-content"><div class="content-and-footnotes"><div class="article-content"><section><figure

data-explorer- src="https://ourworldindata.org/explorers/natural-disasters?facet=none&Disaster+Type=All+disasters&Impact=Deaths&Timespan=Decadal

+average&Per+capita=false&country=~OWID_WRL" class="wp-block-full-content-width" style="width: 100%; min-height: 740px; max-height: 950px; height: 100vh; border: 0px none

!important;"><div class="loading-indicator"></div></figure><div class="wp-block-columns is-style-sticky-right"><div class="wp-block-column"><p>→ Open the Data Explorer in a new tab.</p><hr class="wp-block-separator"><div class="wp-block-owid-summary">
<h2 id="summary">Summary</h2>

Natural disasters kill on average 45,000 people per year, globally.
<a href="https://ourworldindata.org/natural-disasters#what-share-of-deaths-are-from-natural-

disasters">Globally, disasters were responsible for 0.1% of deaths over the past decade. This was highly variable, ranging from 0.01% to 0.4%.
Deaths from natural disasters have seen a large decline over the past century – from, in some years, millions of deaths per year to an average of 60,000 over the past decade.
Historically, droughts and floods were the most fatal disaster events. Deaths from these events are now very low – the most deadly events today tend to be earthquakes.
Disasters affect those in poverty most heavily: high death tolls tend to be centered in low-to-middle income countries without the infrastructure to protect and respond to events.

</div></div><div class="wp-block-column"><div class="wp-sticky-container"></div></div></div><div class="block-wrapper" data-reactroot=""><div data-variation="full- width" data-default-open="false" class="wp-block-owid-additional-information"><h3 class="additional-information_heading" data-track-note="additional-information-toggle"><svg aria-hidden="true" focusable="false" data-prefix="fas" data-icon="angle-right" class="svg-inline--fa fa-angle-right " role="img" xmlns="http://www.w3.org/2000/svg" viewBox="0 0 320 512"><path fill="currentColor" d="M278.6 233.4c12.5 12.5 12.5 32.8 0 45.3l-160 160c-12.5 12.5-32.8 12.5-45.3 0s-12.5-

32.8 0-
45.3L210.7 256 73.4 118.6c-12.5-12.5-12.5-32.8 0-45.3s32.8-12.5 45.3 0l160
160z"></path></svg>All
our interactive charts on Natural Disasters</h3><div aria-hidden="true" class="rah-static rah-static-- height-zero " style="height:0;overflow:hidden"><div style="transition:opacity 250ms ease 0ms;-webkit-transition:opacity 250ms ease 0ms;opacity:0"><div class="content">

<div class="wp-block-full-content-width"><div class="related-charts"><div class="wp-block- columns is-style-sticky-right"><div class="wp-block-column">
<li class="active"><img src="https://ourworldindata.org/grapher/exports/ace-north-atlantic-hurricanes.svg" loading="lazy" data-no-lightbox="true" data-no-img-formatting="true" width="850" height="600">Accumulated cyclone energy of North Atlantic hurricanes
<li class=""><img src="https://ourworldindata.org/grapher/exports/countries-with- legislative-regulatory-provisions-for-managing-disaster-risk.svg" loading="lazy" data-no-lightbox="true" data-no-img-formatting="true" width="850" height="600">Adoption and implementation of policies to reduce disaster risk
<li class=""><img src="https://ourworldindata.org/grapher/exports/heat-wave-index-usa.svg" loading="lazy" data-no- lightbox="true" data-no-img-formatting="true" width="850" height="600">Annual Heat Wave Index in the United States
<li class=""><a

href="https://ourworldindata.org/grapher/acres-burned-per-wildfire-usa"><img src="https://ourworldindata.org/grapher/exports/acres-burned-per-wildfire-usa.svg" loading="lazy" data-no-lightbox="true" data-no-img-formatting="true" width="850" height="600">Average acres burned per wildfire in the United States
<li class=""><img src="https://ourworldindata.org/grapher/exports/death-rates-from-disasters.svg" loading="lazy" data- no-lightbox="true" data-no-img-formatting="true" width="850" height="600">Death rate from natural disasters
<li class=""><img src="https://ourworldindata.org/grapher/exports/death-rates-natural- disasters.svg" loading="lazy" data-no-lightbox="true" data-no-img-formatting="true" width="850" height="600">Death rates from natural disasters
<li class=""><a

href="https://ourworldindata.org/grapher/earthquake-deaths"><img
src="https://ourworldindata.org/grapher/exports/earthquake-deaths.svg" loading="lazy" data-
no- lightbox="true" data-no-img-formatting="true" width="850" height="600">Deaths
from earthquakes
<li class=""><a
href="https://ourworldindata.org/grapher/share-deaths- from-natural-disasters"><img
src="https://ourworldindata.org/grapher/exports/share-deaths-from- natural-disasters.svg"
loading="lazy" data-no-lightbox="true" data-no-img-formatting="true" width="850"
height="600">Deaths from natural disasters as a share of total
deaths
<li class=""><a href="https://ourworldindata.org/grapher/number-of-
deaths- from-natural-disasters"><img
src="https://ourworldindata.org/grapher/exports/number-of-deaths- from-natural-disasters.svg"
loading="lazy" data-no-lightbox="true" data-no-img-formatting="true" width="850"
height="600">Deaths from natural disasters by type
<li class=""><a
href="https://ourworldindata.org/grapher/decadal-average-death-rates-from-natural-
disasters"><img src="https://ourworldindata.org/grapher/exports/decadal-average-death-rates-
from-natural- disasters.svg" loading="lazy" data-no-lightbox="true" data-no-img-
formatting="true" width="850" height="600">Decadal average: Death rates from
natural disasters
<li class=""><a
href="https://ourworldindata.org/grapher/decadal-deaths-disasters-type"><img
src="https://ourworldindata.org/grapher/exports/decadal-deaths-disasters-type.svg"
loading="lazy" data-no-lightbox="true" data-no-img-formatting="true" width="850"
height="600">Decadal average: Number of deaths from natural
disasters
<li class=""><a href="https://ourworldindata.org/grapher/direct-
disaster-economic-loss"><img src="https://ourworldindata.org/grapher/exports/direct-disaster-
economic-loss.svg" loading="lazy" data-no-lightbox="true" data-no-img-formatting="true"
width="850" height="600">Direct disaster economic loss
<li
class=""><a href="https://ourworldindata.org/grapher/direct-disaster-loss-as-a-share-of-
gdp"><img src="https://ourworldindata.org/grapher/exports/direct-disaster- loss-as-a-share-of-
gdp.svg" loading="lazy" data-no-lightbox="true" data-no-img-formatting="true" width="850"
height="600">Direct disaster economic loss as a share of GDP
<li
class=""><a href="https://ourworldindata.org/grapher/direct-economic-loss-attributed-to-
disasters"><img src="https://ourworldindata.org/grapher/exports/direct-economic-loss-
attributed-to- disasters.svg" loading="lazy" data-no-lightbox="true" data-no-img-
formatting="true" width="850" height="600">Direct economic loss attributed to
disasters
<li class=""><a href="https://ourworldindata.org/grapher/disaster-
risk-reduction-progress"><img

src="https://ourworldindata.org/grapher/exports/disaster-risk-reduction-progress.svg" loading="lazy" data-no-lightbox="true" data-no-img-formatting="true" width="850" height="600">Disaster risk reduction progress score
<li class=""><img src="https://ourworldindata.org/grapher/exports/drought-severity-index-us.svg" loading="lazy" data- no-lightbox="true" data-no-img-formatting="true" width="850" height="600">Drought severity index
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<li class=""><img src="https://ourworldindata.org/grapher/exports/fatality-rates-due-to-lightning-in-the-us.svg" loading="lazy" data-no-lightbox="true" data-no-img-formatting="true" width="850" height="600">Fatality rates due to lightning in the US
<li class=""><img src="https://ourworldindata.org/grapher/exports/fatality-rates-in-the-us-due-to-weather-events.svg" loading="lazy" data-no-lightbox="true" data-no-img-formatting="true" width="850" height="600">Fatality rates in the US due to weather events
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GDP
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<li class=""><img src="https://ourworldindata.org/grapher/exports/how-many-deaths-does-it-take-for-a-disaster-to- receive-news-coverage.svg" loading="lazy" data-no-lightbox="true" data-no-img-formatting="true" width="850" height="600">How many deaths does it take for a disaster to receive news coverage?
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<li class=""><img src="https://ourworldindata.org/grapher/exports/news-coverage-of-disasters-by-continent.svg" loading="lazy" data-no-lightbox="true" data-no-img-formatting="true" width="850" height="600">News coverage of disasters, by continent
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disasterrisk
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precipitation
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usa"><img src="https://ourworldindata.org/grapher/exports/acres-burned-usa.svg" loading="lazy" data-no-lightbox="true" data-no-img-formatting="true" width="850" height="600">Wildfire acres burned in the United States
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128c12.5 12.5 32.8 12.5 45.3 0s12.5-32.8 0-45.3L109.3 288z"></path></svg></button><div
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288z"></path></svg></button></div></div></div></div></div>
</div></div></div></div></div></sec<section><div class="section-heading"><div

class="wrapper"><div><h2 id="natural-disasters-kill-tens-of-thousands-each-year">Natural disasters kill tens of thousands each year</h2></div></div></div><div class="wp-block-columns is-style-sticky-right"><div class="wp- block-column"><p>The number of deaths from natural disasters can be highly variable from year-to- year; some years pass with very few deaths before a large disaster event claims many lives.

If we look at the average over the past decade, approximately 45,000 people globally died from natural disasters each year. This represents around 0.1% of global deaths.</p><p>In the visualizations shown here we see the annual variability in the number and share of deaths from natural disasters in recent decades.</p><p>What we see is that in many years, the number of deaths can be very low – often less than 10,000, and accounting for as low as 0.01% of total deaths. But we also see the devastating impact of shock events: the 1983-85 famine and drought in Ethiopia; the 2004 Indian Ocean earthquake and tsunami; Cyclone Nargis which struck Myanmar in 2008; and the 2010 Port-au-Prince earthquake in Haiti. All of these events pushed global disasters deaths over 200,000 – more than 0.4% of deaths in these years.</p><p>Low-frequency, high-impact events such as earthquakes and tsunamis are not preventable, but such high losses of human life are. We know from historical data that the world has seen a significant reduction in disaster deaths through earlier prediction, more resilient infrastructure, emergency preparedness, and response systems.

Those at low incomes are often the most vulnerable to disaster events: improving living standards, infrastructure and response systems in these regions will be key to preventing deaths from natural disasters in the coming decades.</p></div><div

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</svg>

Click to open interactive version

</div>

</figure></div></div></div></section>

<section><div class="section-heading"><div class="wrapper"><div><h2 id="what-share-of-deaths-are-from-natural-disasters">What share of deaths are from natural disasters?</h2></div></div></div><div class="wp- block-columns is-style-sticky-right"><div class="wp-block-column"><p>Globally, over the past decade, natural disasters accounted for an average of 0.1% of total deaths. This was, however, highly variable tohigh-impact events and ranged from 0.01% to 0.4% of total deaths.</p><p>In the map shown here you can explore these trends by country over the past few decades. Using the timeline on the chart you can observe changes across the world over time, or by clicking on a country you can see its individual trend.</p><p>What we observe is that for most countries the share of deaths from natural disasters arevery low in most years. Often it can be zero – with no loss of life to disasters – or well below 0.01%. But we also see clearly the effects of low-frequency but high-impact events: in 2010, more than 70% of deaths in Haiti were the result of the Port-au-Prince earthquake. </p></div><div class="wp-block-column"><div class="wp-sticky-container"><figure data-

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Click to open interactive version

</div>

</figure></div></div></div></section>

<section><div class="section-heading"><div class="wrapper"><div><h2 id="number-of-deaths-from-natural-disasters">Number of deaths from natural disasters</h2></div><div class="in-this-section"><div class="label">In

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64c0-17.7-14.3-32-32-32s-32 14.3-32 32l0 306.7L54.6 265.4c-12.5-12.5-32.8-12.5-45.3 0s-12.5 32.8 0
45.3l160 160z"></path></svg>Number of deaths by type of natural
disaster
</div></div><h3 id="annual-deaths-from-natural-disasters">Annual
deaths from natural disasters<a class="deep-link" href="#annual-deaths-from-natural-
disasters"></h3><div class="wp-block-columns is-style-sticky-right"><div class="wp-block-
column"><p>In the visualization shown here we see the long-term global trend in natural disaster
deaths. This shows the estimated annual number of deaths from disasters from 1900 onwards from
the
EMDAT International Disaster Database.<a id="ref-1"
class="ref"href="#note-1">¹</p><p>What we see is that in the early-to-mid 20th
century, the annual death toll from disasters was high, often reaching over one million per year. In
recent decades we have seen a substantial decline in deaths. In most years fewer than 20,000 die (and
in the most

recent decade, this has often been less than 10,000). Even in peak years with high-impact events, the
death toll has not exceeded 500,000 since the mid-1960s. </p><p>This decline is even more
impressive when we consider the rate of <a href="https://ourworldindata.org/world-population-
growth">population growth over this period. When we correct for population – showing this data
interms of death rates (measured per 100,000 people) – we see an even greater decline over the past
century. This chart can be viewed <a href="https://ourworldindata.org/explorers/natural-
disasters?facet=none&Disaster+Type=All+disasters&Impact=Deaths&Timespan=Annual&
amp;Per+capita=true&country=~OWID_WRL">here.</p><p>The annual number of
deaths from natural disasters is also available by country since 1990. This can be explored in the
interactive map.</p></div><div class="wp-block-column"><div class="wp-sticky-container"><figure

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This declineis even more impressive when we consider the rate of population growth over this period. When we correct for population – showingthis data in terms of death rates (measured per 100,000 people) – then we see a more than 10-fold decline over the past century. This chart can be viewed here.</p></div><div class="wp-block-column"><div class="wp-sticky-container"><figure data-grapher-src="https://ourworldindata.org/grapher/decadal-deaths-disasters-type?country=OWID_WRL~" class="grapherPreview">

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container"></div></div></div><div class="wp-block-columns is-style-sticky-right"><div class="wp-
block-column"><p>This chart shows the declining death rate due to lightning strikes in the
US.<br><br>In the first decade of the 20th century the average annual rate of deaths was 4.5 per
million people in the US. In the first 15 years of the 21st century the death rate had declined to an
average of 0.12 deaths per million. This is a 37-fold reduction in the likelihood of being killed by
lightning in the US.</p></div><div class="wp-block-column"><div class="wp-sticky-container"><figure
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76,64,142.76,142.76a142.17,142.17,0,0,1-24.13,79.43A27.47,27.47,0,0,1,239.76,234.78Z" transform="translate(0 -0.41)"></path>

</svg>

Click to open interactive version

</div>

</figure></div></div></div><div class="wp-block-columns is-style-sticky-right"><div class="wp-block-column"><h4 id="lightning-strikes-across-the-world">Lightning strikes across the world</h4></div><div class="wp-block- column"><div class="wp-sticky-container"></div></div></div><div class="wp-block-columns is-style- sticky-right"><div class="wp-block-column"><p>The map here shows the distribution of lightning strikesacross the world. This is given as the lightning strike density – the average strikes per square kilometer each year.

In particular we see the high frequency of strikes across the Equatorial regions, especially across central Africa.</p></div><div class="wp-block-column"><div class="wp-sticky- container"><div class="wp-block-image"><figure class="aligncenter"><img loading="lazy" width="750" height="465" src="https://ourworldindata.org/uploads/2014/06/ourworldindata_world-map-of- frequency-of-lightning-strikes-–-wikipedia-nasa-data0-750x465.png" alt="World Map of Frequency of lightning strikes – Wikipedia [NASA data]0" class="wp-image-4334" srcset="https://ourworldindata.org/uploads/2014/06/ourworldindata_world-map-of-frequency-of-lightning-strikes-–-wikipedia-nasa-data0-750x465.png 750w,

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https://ourworldindata.org/uploads/2014/06/ourworldindata_world-map-of-frequency-of-lightning-strikes-–-wikipedia-nasa-data0.png 1290w" sizes="(max-width: 750px) 100vw, 750px" data-high-res-src="https://ourworldindata.org/uploads/2014/06/ourworldindata_world-map-of-frequency-of-lightning-strikes-–-wikipedia-nasa-data0.png"><figcaption>World map of frequency of lightning strikes –Wikipedia (NASA data)⁸</figcaption></figure></div></div></div <section><div class="section-heading"><div class="wrapper"><div><h2 id="economic-costs">Economic costs</h2></div><div class="in-this-section"><div class="label">In this section</div><div class="border"></div></div><ul class="subheadings">
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<svg aria-hidden="true" focusable="false" data-prefix="fas" data-icon="arrow-down" class="svg-inline--fa fa-arrow-down " role="img" xmlns="http://www.w3.org/2000/svg" viewBox="0 0 384 512"><path fill="currentColor" d="M169.4 470.6c12.5 12.5 32.8 12.5 45.3 0l160-160c12.5-12.5 12.5-32.8 0-45.3s-32.8-12.5-45.3 0L224
370.8 224 64c0-17.7-14.3-32-32-32s-32 14.3-32 32l0 306.7L54.6 265.4c-12.5-12.5-32.8-12.5-45.3 0s-12.5 32.8 0 45.3l160 160z"></path></svg>Disaster costs by country
</div></div><h3 id="global-disaster-costs">Global disaster costs</h3><div class="wp-block-columns is-style-sticky- right"><div class="wp-block-column"><p>Natural disasters not only have devastating impacts in terms of the loss of human life, but can also cause severe destruction with economic costs.

When we look at global economic costs over time in absolute terms we tend to see rising costs. But, importantly, the world – and most countries – have also gotten richer. Global gross domestic product has increased more than four-fold since 1970. We might therefore expect that for any given disaster, the absolute economic costs could be higher than in the past. </p><p>A more appropriate metric to compare economic costs over time is to look at them in relation to GDP. This is the
indicator adopted by all countries as part of the UN Sustainable Development Goals to monitor progress on resilience to disaster costs.

In the chart shown here we see global direct disaster losses given as a share of GDP. There is notable year-to-year variability in costs – ranging from 0.15% to 0.5% of global GDP. In recent decades there has been

no clear trending increase in damages when we take account of economic growth over this period.</p><p>This is also true when we look at damages specifically for weather-related disasters. This trend in damages relative to global GDP is also shown in the interactive chart. </p></div><div class="wp-

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Click to open interactive version

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Click to open interactive version

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decline in global deaths from natural disasters – this is despite the fact that the human population has increased rapidly over this period.</p><p>Behind this improvement has been the improvement in living standards;access to and development of resilient infrastructure; and effective response systems. These factors have been driven by an increase in incomes across the world.</p><p>What remains true today is that populations in low-income countries – those where a large percentage of the population still live in extreme poverty, or score low on the Human Development Index – are more vulnerable to the effects of natural disasters. </p><p>We see this effect in the visualization shown. This chart shows the death rates from natural disasters – the number of deaths per 100,000 population – of countries grouped by their socio-demographic index (SDI). SDI is a metric of development, where low-SDI denotes countries with lowstandards of living.</p><p>What we see is that the large spikes in death rates occur almost exclusively for countries with a low or low-middle SDI. Highly developed countries are much more resilient to disaster events and therefore have a consistently low death rate from natural disasters.</p><p>Note that this does not mean low-income countries have high death tolls from disasters year-to-year: the data here shows that in most years they also have very low death rates. But when low-frequency, high- impact events do occur they are particularly vulnerable to its effects.</p><p>Overall development, poverty alleviation, and knowledge-sharing of how to increase resilience to natural disasters will therefore be key to reducing the toll of disasters in the decades to come.</p></div><div class="wp- block-column"><div class="wp-sticky-container"><figure data-grapher- src="https://ourworldindata.org/grapher/death-rates-natural-disasters" class="grapherPreview">

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Click to open interactive version

</div>

</figure></div></div></div></section> <section><div class="section-heading"><div class="wrapper"><div><h2 id="definitions-metrics">Definitions & Metrics</h2></div></div></div><div class="wp-block-columns is-style-sticky- right"><div class="wp-block-column"><h4 id="hurricanes-cyclones-typhoons">Hurricanes, cyclones & typhoons</h4></div><div class="wp-block-column"><div class="wp-sticky-container"></div></div></div><div class="wp-block- columns is-style-sticky-right"><div class="wp-block-column"><p>There are multiple terms used to describe extreme weather events: hurricanes, typhoons, cyclones and tornadoes. What is the differencebetween these terms, and how are they defined?</p><p>The terms hurricane, cyclone and typhoon all refer to the same thing; they can be used interchangeably. Hurricanes and typhoons are both described as the weather phenomenon ‘tropical cyclone’. A

tropical cyclone is a weather event which originates over tropical or subtropical waters and results in a rotating, organized system of clouds and thunderstorms. Its circulation patterns should be closed and low-level.</p><p>The choice of terminology is location-specific and depends on where the storm originates. The term hurricane is used to describe a tropical cyclone which originates in the North Atlantic, central North Pacific, and eastern North Pacific. When it originates in the Northwest Pacific, we call it typhoon. In the South Pacific and Indian Ocean the general term tropical cyclone is used.</p><p>In other words, the only difference between a hurricane and typhoon is where it occurs.</p></div><divclass="wp-block-column"><div class="wp-sticky-container"></div></div></div><div class="wp-block- columns is-style-sticky-right"><div class="wp-block-column"><h4 id="when-does-a-storm-become-a- hurricane">When does a storm become a hurricane?</h4></div><div class="wp-block-column"><div class="wp-sticky-

container"></div></div></div><div class="wp-block-columns is-style-sticky-right"><div class="wp-block- column"><p>The characteristics of a hurricane are described in detail at the NASA website.</p><p>A hurricane evolves from a tropical disturbance or storm based on a threshold of wind speed.</p><p>A tropical disturbance arises over warm ocean waters. It can grow into a tropical depression which is an area of rotating thunderstorms with winds up to 62 kilometres (38 miles) per hour. From there, a depression evolves into a tropical storm if its wind speed reaches 63 km/hr (39 mph).</p><p>Finally a hurricane is formed when a tropical storm reaches a wind speed of 119 km/hr (74 mph).</p></div><div class="wp-block- column"><div class="wp-sticky-container"></div></div></div><div class="wp-block-columns is-style- sticky-right"><div class="wp-block-column"><h4 id="difference-between-hurricanes-and-tornadoes">Difference between hurricanes and tornadoes</h4></div><div class="wp-block-column"><div class="wp-sticky-container"></div></div></div><div class="wp-block-columns is-style-sticky-right"><div class="wp-block-column"><p>But, hurricanes/typhoons/cyclones are distinctly different from tornadoes.</p><p>Whilst hurricanes and tornadoes have a characteristic circulatory wind patterns, theyare very different weather systems. The main difference between the systems is scale (tornadoes are small-scale circulatory systems; hurricanes are large- scale). These differences are highlighted in the table below:</p></div><div class="wp-block- column"><div class="wp-sticky-container"><div class="tableContainer"><table id="tablepress-99" class="tablepress tablepress-id-99">

<thead>

<tr class="row-1 odd">

<th class="column-1"> </th><th class="column-2">Hurricanes/typhoons</th><th class="column-3">Tornadoes</th>

</tr>

</thead>

<tbody class="row-hover">

<tr class="row-2 even">

<td class="column-1">Diameter</td><td class="column-2">60 to 1000smiles</td><td class="column-3">Up to 1 - 1.5 miles (usually less)</td>

</tr>

<tr class="row-3 odd">

<td class="column-1">Wind speed</td><td class="column-2">74 to 200mph</td><td class="column-3">40 to 300 mph</td>

</tr>

<tr class="row-4 even">

<td class="column-1">Lifetime</td><td class="column-2">Long (usuallydays)</td><td class="column-3">Very short (usually minutes)</td>

</tr>

<tr class="row-5 odd">

<td class="column-1">Travel distance</td><td class="column-2">Long (100metres to 100 miles)</td><td class="column-3">Short distances</td>

</tr>

<tr class="row-6 even">

<td class="column-1">Environmental impact</td><td class="column-2">Canhave impact on wider environment and atmospheric patterns.</td><td class="column-3">Local (although can be very high impact). Little wider impact on atmospheric systems or environment.</td>

</tr>

</tbody>

</table></div></div></div></div><div class="wp-block-columns is-style-sticky-right"><div class="wp-block-column"><h4 id="volcanic-explosivity-index-vei">Volcanic Explosivity Index (VEI)</h4></div><div class="wp-block-column"><div class="wp-sticky-container"></div></div></div><div class="wp-block-columns is-style-sticky-right"><div

class="wp-block-column"><p>The intensity or size of volcanic eruptions are most commonly defined by a metric termed the 'volcanic explosivity index (VEI)'. The VEI is derived based on the erupted mass or deposit of an eruption. The scale for VEI was outlined by Newhall & Self (1982), but is now commonly adopted in geophysical reporting.¹⁴</p><p>The table below provides a summary (from the NOAA's National GeophysicalData Center) of the characteristics of eruptions of different VEI values. A 'Significant

Volcanic
Eruption’ is often defined as an eruption with a VEI value of 6 or greater. Historic eruptions thatwere definitely explosive, but carry no other descriptive information are assigned a default VEI of 2.</p></div><div class="wp-block-column"><div class="wp-sticky-container"><div class="tableContainer"><table id="tablepress-98" class="tablepress tablepress-id-98">

<thead>

<tr class="row-1 odd">

<th class="column-1">Volcanic Explosivity Index (VEI)</th><th class="column-2">General description</th><th class="column-3">Cloud Column Height (km)</th><th class="column-4">Volume (m^3)</th><th class="column-5">Qualititative Description</th><th class="column-6">Classification</th><th class="column-7">How frequent?</th><th class="column-8">Example</th>

</tr>

</thead>

<tbody class="row-hover">

<tr class="row-2 even">

<td class="column-1">0</td><td class="column-2">Non-explosive</td><td class="column-3">< 0.1 km</td><td class="column-4">$1x10^4$</td><td class="column-5">Gentle</td><td class="column-6">Hawaiian</td><td class="column-7">daily</td><td class="column-8">Kilauea</td>

</tr>

<tr class="row-3 odd">

<td class="column-1">1</td><td class="column-2">Small</td><td class="column-3">0.1 - 1km</td><td class="column-4">$1x10^6$</td><td class="column-5">Effusive</td><td class="column- 6">Haw/Strombolian</td><td class="column-7">daily</td><td class="column-8">Stromboli</td>

</tr>

<tr class="row-4 even">

<td class="column-1">2</td><td class="column-2">Moderate</td><td class="column-3">1 - 5km</td><td class="column-4">$1x10^7$</td><td class="column-5">Explosive</td><td class="column-6">Strom/Vulcanian</td><td class="column-7">weekly</td><td class="column-8">Galeras, 1992</td>

</tr>

<tr class="row-5 odd">

<td class="column-1">3</td><td class="column-2">Moderate-Large</td><td class="column-3">3 - 15 km</td><td class="column-4">1x10^{8}</td><td class="column-5">Explosive</td><td class="column-6">Vulcanian</td><td class="column-7">annually</td><td class="column-8">Ruiz, 1985</td>

</tr>

<tr class="row-6 even">

<td class="column-1">4</td><td class="column-2">Large</td><td class="column-3">10 - 25km</td><td class="column-4">1x10^{9}</td><td class="column-5">Explosive</td><td class="column- 6">Vulc/Plinian</td><td class="column-7">10's of years</td><td class="column-8">Galunggung, 1982</td>

</tr>

<tr class="row-7 odd">

<td class="column-1">5</td><td class="column-2">Very Large</td><td class="column-3">> 25 km</td><td class="column-4">1x10^{10}</td><td class="column-5">Cataclysmic</td><td class="column-6">Plinian</td><td class="column-7">100's of years</td><td class="column-8">St. Helens, 1981</td>

</tr>

<tr class="row-8 even">

<td class="column-1">6</td><td class="column-2"></td><td class="column-3">> 25 km</td><td class="column-4">1x10^{11}</td><td class="column-5">Paroxysmal</td><td class="column-6">Plin/Ultra-Plinian</td><td class="column-7">100's of years</td><td class="column-8">Krakatau, 1883</td>

</tr>

<tr class="row-9 odd">

<td class="column-1">7</td><td class="column-2"></td><td class="column-3">> 25 km</td><td class="column-4">1x10^{12}</td><td class="column-5">Colossal</td><td class="column-

6">Ultra-Plinian</td><td class="column-7">1000's of years</td><td class="column-

8">Tambora,1815</td>

</tr>

<tr class="row-10 even">

<td class="column-1">8</td><td class="column-2"></td><td class="column-3">> 25 km</td><td class="column-4">>1x10^{12}</td><td class="column-5">Colossal</td><td class="column-6">Ultra-Plinian</td><td class="column-7">10,000's of years</td><td class="column-8">Yellowstone, 2Ma</td>

</tr>

</tbody>

</table></div></div></div></div></<section><div class="section-heading"><div class="wrapper"><div><h2 id="data-quality">Data Quality</h2></div></div></div><div class="wp-block-columns is-style-sticky-right"><div class="wp-block-column"><h4 id="number-of-reported-disaster-events">Number of reported disaster events</h4></div><div class="wp-block-column"><div class="wp-sticky-container"></div></div></div><div class="wp-block-columns is-style-sticky-right"><div class="wp-block-column"><p>A key issue of data quality is the consistency of even reporting over time. For long-term trends in natural disaster events we know that reporting and recording of events today is much more advanced and complete than in the past. This canlead to significant underreporting or uncertainty of events in the distant past.

In the chart here we show data on the number of reported natural disasters over time.

This change over time can be influenced by a number of factors, namely the increased coverage of reporting over time. The increase over time is therefore not directly reflective of the actual trend in disaster events.</p></div><div class="wp-block-column"><div class="wp-sticky-container"><figure data-grapher-src="https://ourworldindata.org/grapher/number-of-natural-disaster-events" class="grapherPreview">

<div><img src="https://ourworldindata.org/exports/number-of-natural-disaster-events_v5_850x600.svg" width="850" height="600" loading="lazy" data-no-lightbox="" alt="Number ofnatural disaster events v5 850x600"></div>

<div class="interactionNotice">

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<path fill="currentColor" d="M448,344.59v96a40.36,40.36,0,0,1-1.06,9.16l-32,136A40,40,0,0,1,376,616.59H168a40,40,0,0,1-32.35-16.47l-128-176a40,40,0,0,1,64.7-47.06L104,420.58v-276a40,40,0,0,1,80,0v200h8v-40a40,40,0,1,1,80,0v40h8v-24a40,40,0,1,1,80,0v24h8a40,40,0,1,1,80,0Zm-256,80h-8v96h8Zm88,0h-8v96h8Zm88,0h-8v96h8Z" transform="translate(0 -0.41)"></path>

<path fill="currentColor" opacity="0.6" d="M239.76,234.78A27.5,27.5,0,0,1,217,192a87.76,87.76,0,1,0-145.9,0A27.5,27.5,0,1,1,25.37,222.6,142.17,142.17,0,0,1,1.24,143.17C1.24,64.45,65.28.41,144,.41s142.76,64,142.76,142.76a142.17,142.17,0,0,1-24.13,79.43A27.47,27.47,0,0,1,239.76,234.78Z" transform="translate(0 -0.41)"></path>

</svg>

Click to open interactive version

</div>

</figure></div></div></div><div class="wp-block-columns is-style-sticky-right"><div class="wp-block-column"><h4 id="number-of-reported-disasters-by-type">Number of reported disasters by type<aclass="deep-link" href="#number-of-reported-disasters-by-type"></h4></div><div class="wp-block-column"><div class="wp-sticky-container"></div></div></div><div class="wp-block-columns is-style- sticky-right"><div class="wp-block-column"><p>This same data is shown here as the number of reported disaster events by type. Again, the incompleteness of historical data can lead to significant underreporting in the past. The increase over time is therefore not directly reflective of the actual trend in disaster events.</p></div><div class="wp-block-column"><div class="wp- sticky-container"><figure data-grapher-src="https://ourworldindata.org/grapher/natural-disasters-by-type" class="grapherPreview">

<div><img src="https://ourworldindata.org/exports/natural-disasters-by-type_v10_850x600.svg" width="850" height="600" loading="lazy" data-no-lightbox="" alt="Naturaldisasters by type v10 850x600"></div>

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xmlns="http://www.w3.org/2000/svg" viewBox="0 0 448 617">

<path fill="currentColor" d="M448,344.59v96a40.36,40.36,0,0,1-1.06,9.16l-32,136A40,40,0,0,1,376,616.59H168a40,40,0,0,1-32.35-16.47l-128-176a40,40,0,0,1,64.7-

47.06L104,420.58v-276a40,40,0,0,1,80,0v200h8v-40a40,40,0,1,1,80,0v40h8v-24a40,40,0,1,1,80,0v24h8a40,40,0,1,1,80,0Zm-256,80h-8v96h8Zm88,0h-8v96h8Zm88,0h-8v96h8Z" transform="translate(0 -0.41)"></path>

<path fill="currentColor" opacity="0.6" d="M239.76,234.78A27.5,27.5,0,0,1,217,192a87.76,87.76,0,1,0-145.9,0A27.5,27.5,0,1,1,25.37,222.6,142.17,142.17,0,0,1,1.24,143.17C1.24,64.45,65.28.41,144,.41s142.76,64,142.76,142.76a142.17,142.17,0,0,1-24.13,79.43A27.47,27.47,0,0,1,239.76,234.78Z" transform="translate(0 -0.41)"></path>

</svg>

Click to open interactive version

</div>

</figure></div></div></div<section><div class="section-heading"><div class="wrapper"><div><h2 id="data-sources">Data Sources</h2></div></div></div><div class="wp-block-columns is-style-sticky-right"><div class="wp-block-column"><p>Wikipedia has several lists of disasters, and an overview of these lists can be found at List of Disasters.</p></div><div class="wp-block-column"><div class="wp-sticky-container"></div></div></div><div class="wp-block-columns is-style-sticky-right"><div class="wp-block-column"><h4 id="deaths-from-natural-disasters">Deaths from natural disasters</h4></div><div class="wp-block-column"><div class="wp- sticky-container"></div></div></div><div class="wp-block-columns is-style-sticky-right"><div class="wp-block-column"><h5>Institute for Health Metrics and Evaluation (IHME), Global Burden of Disease</h5>
Data: IHME provides data on deaths and death rates fromnatural disasters
Geographical coverage: Global – country and regional level
Time span: 1990 onwards
Available at: IHME, GBD
</div><div class="wp- block-column"><div class="wp-sticky-container"></div></div></div><div class="wp-block-columns is- style-sticky-right"><div class="wp-block-column"><h4 id="multiple-types-of-disasters">Multiple Types of Disasters</h4></div><div class="wp-block-column"><div class="wp-sticky-container"></div></div></div><div class="wp-block-columns is-

style-sticky-right"><div class="wp-block-column"><h5>EM-DAT – The International Disaster Database</h5>
Data: EM-DAT is a catalogue of disasters listing detailed information on natural disasters: droughts (famines), earthquakes, epidemics, extreme temperatures, floods, insect infestations, mass movement (dry & wet), storms, volcanos, and wildfires. There is also a data section on technological disasters.
Geographical coverage: Global – country and regional level (primarily cross-country data set, but also contains the name of the sub-national regions affected by disasters)
Time

span: 1900 onwards
Available at: EM-DAT
Raw data has to be requested but the section on disaster trends encompasses a number of visualizations (time series and maps).
EM-DAT is maintained by the Center for Research on the Epidemiology of Disasters (CRED)
EM-DAT data on the annual number of deaths and number of affected by drought, epidemics, earthquakes, extreme temperature, flood, storm, tsunami, plane crash by country is available at Gapminder. <a href="http://www.gapminder.org/world/#$majorMode=chart$is;shi=t;ly=2003;lb=f;il=t;fs=11;al=30;stl=t
;st=t;nsl=t;se=t$wst;tts=C$ts;sp=5.35870967741936;ti=2008$zpv;v=0$inc_x;mmid=XCOORDS;iid=phA
wc
NAVuyj1jiMAkmq1iMg;by=ind$inc_y;mmid=YCOORDS;iid=rvbbs7uxQc7swJ4RR2BcQfA;by=ind$inc_s;u
ni
Value=8.21;iid=phAwcNAVuyj0XOoBL_n5tAQ;by=ind$inc_c;uniValue=255;gid=CATID0;by=grp$map_x;
sc
ale=log;dataMin=282;dataMax=119849$map_y;scale=lin;dataMin=0;dataMax=242000$map_s;sma=49
;s mi=2.65$cd;bd=0$inds=i239_t001980,,,,;i44_t001980,,,,">Here is the data on the number of peoplekilled in earthquakes during a year.
<h5>Earth Observatory by NASA – Natural Hazards</h5>
Data: Up to date information and satellite images on fires, storms, floods, volcanoes, earthquakes, and droughts
Geographical coverage: Global
Time span: Recent years – very up to date
Available at: earthobservatory.nasa.gov/NaturalHazards<
/a>
<h5>Natural Hazards Data – U.S. National Oceanic and Atmospheric Administration's National Geophysical Data Center (NGDC)</h5>
Data: Data and maps on many natural hazards including cyclones, tsunamis, earthquakes, volcanoes, and wildfires. It includes the 'Global Significant Earthquake Database, 2150 B.C. to present' (5500 events) and 'The Significant Volcanic Eruption Database' and 'Global Historical Tsunami Events and Runups' among many other datasets.
Geographical coverage: Global – exact location
Time span: Millennia
Available at: Online here
<li class="no-bullet">Download maps as pdf or ArcIMS interactive maps, and data in tab-delimited data files or html.
<h5>Global Risk Data Platform</h5>
Data: Spatial data on tropical cyclones and related stormsurges, drought, earthquakes, biomass fires, floods,

landslides, tsunamis and volcanic eruptions.
Geographical coverage:
Global
Time span: Recent past
Available at: The
website can be found here.
<li class="no-
bullet">Users can visualize, download or extract data on past hazardous events, human &
economical hazard exposure and riskfrom natural hazards.
<h5>Socioeconomic Data
and Applications Center (SEDAC) – by NASA</h5>
Data: Maps of natural
hazards
Geographical coverage: Global
Time span:
Recent years
Available at: Online <a
href="http://sedac.ciesin.columbia.edu/data/sets/browse?facets=theme:hazards">here at the SEDAC

website at Colombia University
<h5>Center for Hazards & Risk
Research at Columbia University</h5>
Hotspots: Risk levels calculated by
combining hazard exposure with historical vulnerability for two indicators of elements at risk—gridded
population and Gross Domestic Product (GDP) per unit area—for six major natural hazards:
earthquakes,volcanoes, landslides, floods, drought, and cyclones
Natural disaster
profiles: Profiles for 13 countries provide information on sub-national areas at risk from
natural hazards includingcyclones, droughts, earthquakes, volcanoes, floods, and
landslides.
Geographical coverage: Global for hotspots
data
Time span: Recent past
Available at: Online
<a
href="http://www.ldeo.columbia.edu/chrr/research/profiles/">here
<
/ul></div><div class="wp-block-column"><div class="wp-sticky-container"></div></div></div><div
class="wp-block-columns is-style-sticky-right"><div class="wp-block-column"><h4 id="data-sources-
earthquakes"> Earthquakes<a class="deep-link" href="#data-sources-
earthquakes"></h4></div><div class="wp-block-column"><div class="wp-sticky-
container"></div></div></div><div class="wp-block-columns is-style-sticky-right"><div class="wp-
block- column"><h5>Global Earthquake Model (GEM)</h5>
Data: GEM
Global Historical Earthquake Catalogue (1000-1900) and the ISC-GEM Global Instrumental Earthquake
Catalogue (1900-2009)
Geographical coverage:Global
Time
span: 1000 onwards
Available at: Online <a
href="http://web.archive.org/web/20130106062157/http://www.globalquakemodel.org:80/risk-
global- components/exposure-database">here
</div><div
class="wp- block-column"><div class="wp-sticky-container"></div></div></div><div class="wp-block-
columns is- style-sticky-right"><div class="wp-block-column"><h4 id="fire">Fire<a class="deep-link"
href="#fire"></h4></div><div class="wp-block-column"><div class="wp-sticky-
container"></div></div></div><div class="wp-block-columns is-style-sticky-right"><div class="wp-
block- column"><h5>ATSR World Fire Atlas – by the European Space Agency
(ESA)</h5>
Data: Monthly global fire maps
Geographical
coverage: Global
Time span: 1995
onwards
Available at: Online at the website of ESA
<a
href="http://due.esrin.esa.int/page_wfa.php">here
</div><div
class="wp-block-column"><div class="wp-sticky-container"></div></div></div><div class="wp-block-
columns is-style-sticky-right"><div class="wp-block-column"><h4 id="tsunami">Tsunami<a
class="deep-link" href="#tsunami"></h4></div><div class="wp-block-column"><div class="wp-

sticky- container"></div></div></div><div class="wp-block-columns is-style-sticky-right"><div class="wp-block-column"><p>The Center for International Earth Science Information Network at the Earth Institute at Columbia University publishes data on the Population Affected by the Indian Ocean Tsunami (December 2004).</p></div><div class="wp-block-column"><div class="wp-sticky-container"></div></div></div><div class="wp-block-columns is-style-sticky-right"><div class="wp-block-column"><h4 id="floods">Floods</h4></div><div class="wp-block-column"><div class="wp-sticky-container"></div></div></div><div class="wp-block- columns is-style-sticky-right"><div class="wp-block-column"><p>Wikipedia has a <a

href="http://en.wikipedia.org/wiki/List_of_deadliest_floods">List of Deadliest Floods and a List of Floods.</p></div><div class="wp-block- column"><div class="wp-sticky-container"></div></div></div><div class="wp-block-columns is-style- sticky-right"><div class="wp-block-column"><h4 id="hurricanes">Hurricanes</h4></div><div class="wp-block-column"><div class="wp-sticky-container"></div></div></div><div class="wp-block-columns is-style-sticky-right"><div class="wp-block-column"><h5>Unisys Data on Hurricanes</h5>
Data: Data on the track of the storm plus a text-based table of tracking information. The table includes position in latitude and longitude, maximum sustained winds in knots, and central pressure in millibars.
Geographical coverage: Atlantic, East Pacific, West Pacific, South Pacific, South Indian, and North Indian
Time span: 1851 until now
Available at: Online here
<li class="no-bullet"> This data set was used by Dean Yang (2008) – Coping with Disaster: The Impact of Hurricanes on International Financial Flows, 1970-2002. The B.E. Journal of Economic Analysis & Policy. Volume 8,Issue 1, ISSN (Online) 1935-1682, DOI: 10.2202/1935-1682.1903, June 2008. Online here.
<h5>National Climatic Data Center (NOAA)</h5>
Data: Data on the track of storms
Geographical coverage: Global
Time span: 1848 until now
Available at: Online at NOAA here
</div><div class="wp-block-column"><div class="wp-sticky-container"></div></div></div><div class="wp-block-columns is-style-sticky-right"><div class="wp-block-column"><h4 id="data-sources-volcanoes">Volcanoes</h4></div><div class="wp-block-column"><div class="wp-sticky-container"></div></div></div><div class="wp-block-columns is-style-sticky-right"><div class="wp-block-column"><h5>National Geophysical Data Center (NGDC)</h5>
Data: Global listing of over 500 significant eruptions which includes information on the latitude, longitude, elevation, type of volcano, and last known eruption.
Geographical coverage: Global
Time span: 1750BC onwards
Available at: Online at the Significant Volcanic Eruption Database.
<h5>Smithsonian

Institution’s Global Volcanism Program (GVP)</h5>
Data: Complete list of current and past activity for all volcanoes on the planet active during the last 10,000 years. Data includes eruption type, maximum Volcanic Explosivity Index, start and end dates (when known), and thetype of evidence for the eruption.
Geographical coverage: Global
Time span: Past 10,000 years to present day
Available at: Online at the Volcanoes of the World Database
Full reference: Global Volcanism Program, 2013.

Volcanoes of the World, v. 4.7.3. Venzke, E (ed.). Smithsonian Institution. https://doi.org/10.5479/si.GVP.VOTW4-2013
</div><div class="wp-block-column"><div class="wp-sticky-container"></div></div></div><div class="wp-block-columns is-style-sticky-right"><div class="wp-block-column"><h4 id="data-sources-lightning">Lightning</h4></div><div class="wp-block-column"><div class="wp-sticky-container"></div></div></div><div class="wp-block-columns is-style-sticky-right"><div class="wp-block- column"><h5>Lightning Maps</h5>
Data: Real-time tracking of lightning strikes
Geographical coverage: Global
Time span: Real-time
Available at: Online here
</div><div class="wp-block-column"><div class="wp-sticky-container"></div></div></div></</div><footer class="article-footer"><div class="wp-block-columns"><div class="wp-block-column"><h3 id="endnotes"class="h3-bold">Endnotes</h3><ol class="endnotes"><li id="note-1"><p>EMDAT (2019): OFDA/CRED International Disaster Database, Université catholique de Louvain – Brussels – Belgium</p>
<li id="note-2"><p>EM-DAT, CRED / UCLouvain, Brussels, Belgium – www.emdat.be (D. Guha-Sapir)</p>
<li id="note-3"><p>Since two events are ranked equally in 8th place, a total of 11 are included.</p>
<li id="note-4"><p>National Geophysical Data Center / World Data Service (NGDC/WDS): Significant Earthquake Database. National Geophysical Data Center, NOAA. Available at: https://www.ngdc.noaa.gov/nndc/struts/form?t=101650&s=1&d=1.</p >
<li id="note-5"><p>The death toll of the Haitian earthquake is still disputed. Here we present the adopted figure by the NGDC of the NOAA (for consistency with other earthquakes); this is the figure reported by the Haitian government. Some sources suggest a lower figure of 220,000. In the latter case, this event would fall to 7th place in the above rankings.</p>
<li id="note-6"><p>This data is sourcedfrom the The Significant Volcanic Eruption Database is a global listing of over 500 significant eruptions.</p>
<li id="note-7"><p>
 This is from the NASA Socioeconomic Data And Applications Center (SEDAC) hosted by the Center for International Earth Science Information Network (CIESIN) at Columbia University. This map is online at their website here.
 This document is licensed under a Creative Commons 3.0 Attribution License.</p>
<li id="note-8"><p>
 This map is taken from Wikipedia here.
 This fileis licensed under the Creative Commons Attribution-Share Alike 3.0 Unreported license.</p>
<li id="note-9"><p>Eisensee, T., & Strömberg, D. (2007). News droughts, news floods, and US disasterrelief. The Quarterly Journal of Economics, 122(2), 693-728. Online here: http://perseus.iies.su.se/~dstro/wpdisasters.pdf</p>
<li id="note-10"><p>As is mentioned below in more detail, this figure is controlled for other factors (i.e. country, year, month,

and number of people affected).</p>
<li id="note-11"><p>The study used a database compiled by the Centre for Research on the Epidemiology of Disasters, where an event qualifies as a disaster if at least one of the following criteria are fulfilled: ten or more people are reported, killed; 100 or more people are reported affected, injured, and/or homeless; there has been a declaration of a state of emergency; or there has been a call for international assistance.</p>
<li id="note-12"><p>Eisensee, T., & Strömberg, D. (2007). News droughts, news floods, and US disaster relief. The Quarterly Journal of Economics, 122(2), 693-728. Online here: http://perseus.iies.su.se/~dstro/wpdisasters.pdf</p>
<li id="note-13"><p>Based on the study’s analysis of data compiled by the Centre for Research on the Epidemiology of Disasters.</p>
<li id="note-14"><p>Newhall, C.G. and Self, S (1982). The volcanic explosivity index(VEI): an estimate of explosive magnitude for historical volcanism.Jour Geophys Res (Oceans & Atmospheres), 87:1231-1238. Available at: https://agupubs.on linelibrary.wiley.com/doi/abs/10.1029/JC087iC02p01231.</p>
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IDEATION PHASE:

LITERATURE SURVEY:

Abstract:

Natural disasters often result in fatalities, injuries, diseases and other negative physical and mental health effects. Indirectly, disasters can result in social grievances and resource scarcities which can trigger social conflicts. Despite the many natural disaster studies, however, little attention has been devoted to the study of conflicts following a natural disaster. Through a systematic literature review from 1986 to 2013, this paper examines social conflicts resulting from natural disasters. In this paper, a three-dimensional analysis, Description-Theme-Mechanism, is used to combine and analyze the current state of research, with the ultimate goal of clarifying the concept of social conflicts arising from natural disasters, summarizing existing research on the links between natural disasters and social conflicts, determining any significant rules and trends, and providing recommendations and directions for future research.

INTRODUCTION:

Natural disasters are catastrophic events with atmospheric, geological, and hydrological origins (e.g., droughts, earthquakes, floods, hurricanes, landslides) that can cause fatalities, property damage and social environmental disruption [1]. After a severe natural disaster, roads, communication and power sources are often damaged, so there are immediate localized resource shortages, and disordered and chaotic economic, political and social environments [2]. Natural disasters have been previously related to consequent social conflicts and a further entrenchment of existing poverty levels and inequalities [3], [4]. In this study, we adopted a classic definition for social conflict; a controversial interaction among social actors to realize scarce or incompatible aims and prevent the opponent from attaining them [5]. Social conflicts have existed since the beginning of human society and have exerted a significant influence on social evolution [6]. Conflict theory holds that conflicts are a basic state in society, and can function to encourage social integration and improve and/or stabilize social order [7].

In disaster research, there has been significantly more emphasis placed on disaster impact, risk management, and post-disaster recovery and reconstruction than on the social consequences arising from the disaster [8]. Sorokin [1] first identified the polarizing effects of disasters in his work “Man and Society in Calamity” [1], and Cuny [9] noted that natural disasters can act as triggers for social structural change [9]. Natural disasters can also cause political unrest [10] and some studies have explored how the occurrence of natural disasters can significantly increase the risk of violent civil conflict in both the short and medium term [11], [12], [8].

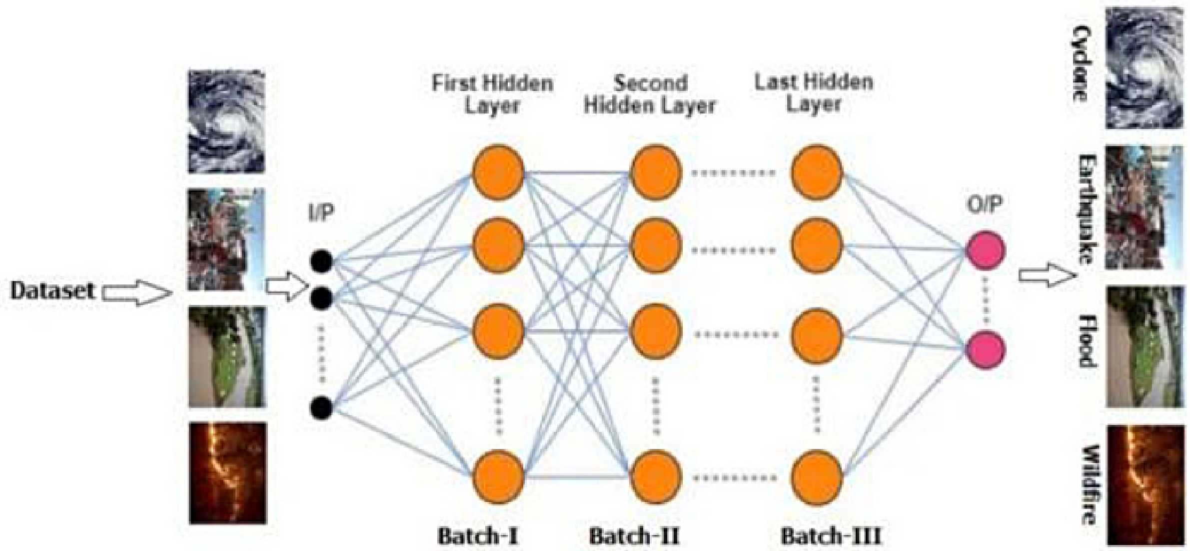
Some investigations into the causal relationship between natural disasters and conflict have been undertaken [3], [4], [13], [14]. In addition, some research has examined the conflict-inducing consequences of climate change, causing a heated debate in academic and open communities [15], [16], [17], [18], [19]. Despite this wide body of research, however, there has been a lack of systematic evaluative studies on the correlation between natural disasters and disaster-based conflicts. In this study, we discuss and analyze the mechanism behind natural disaster caused social conflict through a systematic literature review. The goals of this study are as follows: (1)

to analyze and summarize the significant rules and trends from previous studies into natural disasters and social conflict explore the mechanisms connecting natural disasters and socialconflict; (3) to provide recommendations and directions for future research.

Beck believed that today's society is constantly changing from industrial society to the risk-based society [20]. Risk society is a transformation of society from industrial to post-industrial [21]. The main feature of risk society is filled with uncertainties and conflicts in economy, politics, environment [20]. As Beck first proposed the notion of the risk society in 1986 and the research for this paper commenced in 2014, this study used this time frame (1986–2013) to build a literature database from the Web of Science Core Collection and Google Scholar based on the Emergency Events Database (EM-DAT), a global database on natural and technological disasters. For a natural disaster to be entered into the database, at least one of the following criteria must be met: (1) 10 or more people have been reported as killed; (2) 100 or more people have been reported as affected; (3) there has been a declaration of a state of emergency; (4) there has been a call for international assistance. Using knowledge management software, we analyzed the literature database and summarized the significant relationships between natural disasters and social co

The remainder of this paper is organized as follows. Section 2 presents the systematic literature review method used for the combing and analysis of research from a global perspective. Section 3 presents the literature analysis results. In this section, we identify the past and present research foci and give guidance as to possible avenues for future research. Some related special themes and mechanisms are discussed in detail and the relationships between those themes and achievements are analyzed. In Section 4, some findings and recommendations for future research are given. Finally, Section 5 concludes the study with a summary of the research and findings.

EMPATHY MAP:



IDEATION:

1. What is Natural Disaster?

2. Types of Natural Disasters

Geological Disasters

Meteorological Disasters

Hydrological Disasters

Biological Disasters

What is Natural Disaster?

A natural disaster can be defined as “A major event caused by Earth’s natural processes that leads to significant environmental degradation and loss of life.” A natural disaster is frequently preceded by a natural hazard. The Gujarat Earthquake, for example, which struck on January 26,2001, was a natural calamity. The natural danger lives underneath the active fault lines that run through Gujarat.

Anthropogenic causes, on the other hand, can cause or affect some natural dangers. Deforestation, mining, and agricultural activities, for example, can all cause landslides. Natural disasters frequently result in widespread damage. Natural disasters, such as wildfires, destroy animal habitats while also causing property damage and loss of life

Types of Natural Disasters

Geological Disasters, Hydrological Disasters, Meteorological Disasters, and Biological Disasters are the four broad types of natural hazards.

Geological Disasters

Geological hazards, or dangers caused by geological (i.e., Earth) processes, such as plate tectonics, are a type of risk. Earthquakes and volcanic eruptions are examples of this. In general, geological extreme events are beyond human control, however, humans have a significant

impact on the events' consequences.

Meteorological Disasters

Hazards caused by meteorological (i.e., weather) phenomena, particularly those related to temperature and wind, are known as meteorological hazards. Heat waves, cold waves, cyclones, hurricanes, and freezing rain are all examples of this. In the Atlantic, cyclones are known as hurricanes, while in the Pacific, they are known as typhoons.

Hydrological Disasters

Hazards caused by hydrological (water) processes are known as hydrological hazards. Floods, droughts, mudslides, and tsunamis are examples of natural disasters. Floods and droughts may cause havoc on agriculture and are one of the leading causes of famine. The 1931 Central China floods killed three or four million people, making it the greatest natural disaster in history (excluding pandemics).

Biological Disasters

Biological dangers are those that arise as a result of biological processes. This comprises a widerange of diseases, including infectious diseases that move from person to person and pose a significant threat to vast populations of people. Biological hazards are often left out of discussions about natural hazards, instead of falling under the purview of medicine and public health.

Geological Disasters	Meteorological Disasters	Hydrological Disasters	Biological Disaster
– Sinkholes – Landslides – Volcanic Eruption – Earthquakes – Avalanche	– Limnic Eruption – Flood – Tsunami	– Cyclonic – Storm – Blizzard – Cold waves – Drought – Hailstorms – Tornadoes	– AIDS – Tuberculosis – Hepatitis A – Hepatitis B – Hepatitis C

Now that we have studied the classification of Natural Disasters let us look into some Natural Disastersin depth.

Tornadoes are rotating, funnel-shaped clouds that form as a result of intense thunderstorms.With powerful winds averaging 30 miles per hour, they extend from a thunderstorm to the ground. They can also go from being stationary to 70 miles per hour in a matter of seconds.

Tornadoes can strike with little or no notice, giving those in affected areas only seconds to seekshelter. People often endure emotional anguish as a result of the unexpected nature of tornadoes and severe storms. Overwhelming anxiety, difficulty sleeping, and other depression-like symptoms are common reactions to natural disasters.

Hurricane

Tropical storms that originate in the southern Atlantic Ocean, Caribbean Sea, Gulf of Mexico, and the eastern Pacific Ocean are known as hurricanes. Every year, hurricanes harm millions of people living along the Atlantic and Gulf coasts. Hurricanes are known to cause mental sufferingin their victims. Before, during, and after these types of storms, people commonly experience intense anxiety, continual worrying, difficulty sleeping, and other depression-like symptoms. Other symptoms of hurricane-related emotional distress include:

Fearing that forecasted storms could turn into hurricanes, even if the chances of this happeningare slim, yelling or fighting with family and friends on a regular basis Having storm-related thoughts, memories, or dreams that you can’t seem to get out of your head.

Floods

Floods happen when water overflows from an area that is ordinarily dry. Floods are caused by avariety of factors, including hurricanes and tropical storms, broken dams or levees, and flash floods that happen within minutes or hours of heavy rain. Although floods are more common around the shore, especially during hurricane season, they can happen anywhere and vary in magnitude and length. Even little streams, gullies, and creeks that appear to be unaffected in dry weather might become flooded. Here are some symptoms of emotional discomfort caused by floods:

If you’re feeling hopeless or helpless, Fearing that anticipated storms would turn into hurricanes, even if the chances of this happening are slim, yelling or fighting with family andfriends on a regular basis.

Earthquake

An earthquake occurs when the Earth’s plates shift, causing a violent shaking of the ground thatcan last anywhere from a few seconds to several minutes. Mild initial shaking might quickly intensify and become violent. Earthquakes are quite common, and they happen every day somewhere in the world. Even mild earthquakes that cause minor damage and destruction can induce emotional discomfort in people (especially in areas not accustomed to these events). Aftershocks can occur for months after an earthquake, and they can be just as distressing. Hereare some symptoms of emotional distress caused by earthquakes:

Being easily startled, having trouble sleeping or sleeping too much, and having thoughts and memories of the earthquake that you can’t shake

Drought

A drought is a common, recurring meteorological occurrence that varies in intensity and duration depending on the region of the country and even within a state. Drought occurs when precipitation is below average for an extended period of time, usually a season or more. Drought can also be caused by a delay in the rainy season or rain timing in relation to crop development. Some symptoms of drought-related emotional discomfort include:

Feelings of overwhelming anxiety, continual worrying, difficulty sleeping, and other depressive-like symptoms, disagreements between people over limited water supplies, health issues connected to dust, insufficient water flow, or poor water and air quality, and financial problems due to crop failures

Examples of Natural Disasters

Here given below are the some examples of natural disasters-

Geological Disasters

Avalanche: An earthquake triggered an avalanche in Peru, killing nearly 20,000 people in 1970.

Landslides: An entire village was wiped away in the Pithoragarh district of Uttarakhand in 1998.

Earthquakes: An earthquake which registered 7.9 on the Richter scale, ripped through Gujarat, killing over 1,00,000 people in 2001.

Sinkholes: A sinkhole over a 100 meters deep formed suddenly. The event resulted in the death of five people and evacuation of thousands in 2007.

Volcanic Eruption: Mount Vesuvius – the deadliest volcano to ever erupt. It released 100,000 times the thermal energy of the Hiroshima-Nagasaki bombings. It was speculated that around 2,000 people died as a direct result in

79 AD.

Hydrological Disasters

Flood: A series of floods devastated China in 1931. It was also called one of the deadliest floodsin history, with the death toll estimated to be between 3.7 million to 4 million.

Tsunami: A 9.0 magnitude earthquake caused a 33 feet high tsunami to strike in 2011. It resulted in the deaths of over 18,500 individuals. The tsunami also caused the nuclear meltdownof the Fukushima Nuclear Power Plant.

Limnic Eruption: A limnic eruption is a rare kind of natural disaster in 1986. Because of its invisible nature, only two instances of this disaster have been ever observed. The deadliest among the two was the Lake Nyos limnic eruption. 1746 people and 3500 cattles were killed inthis event.

Meteorological Disasters

Cyclonic Storm: Cyclone Amphan caused widespread damage in Eastern India, while CycloneNisarga wreaked havoc on the West Coast of India in 1920.

Blizzard: In 1972, a blizzard dropped nearly 26 feet of snow, completely covering 200 villages inIran. It was the deadliest in recorded history, causing the death of 4,000 individuals.

Cold waves: In February 2020, Baghdad experienced the very first snowfall since the 1910s.

Drought: Cape Town, in South Africa faced a major water crisis between mid 2017 to 2018. This crisis had an extensive impact on public health and the nation’s economy.

Tornadoes: The Daulatpur-Saturia tornado was the deadliest tornado to

occur in recordedhistory. It killed approximately 1,300 people and injured
an estimated 12,000 people

Other Disasters

Forest fires: The 2019-20 Australian Bushfires resulted in 34 deaths, destruction of 5,900 buildings, andan estimated 46 million acres were burnt.

PROJECT DESIGN PHASE – I:

PROPOSED SOLUTION:

Nature-based solutions to disasters

Climate change is increasing the frequency, intensity and magnitude of disasters, leading to a higher number of deaths,injuries and increased economic losses.
Nature-based solutions, such as conserving forests, wetlands and coral reefs, can help communities prepare for, cope with, and recover from disasters, including slow-onset events such asdrought.
Nature can be a cost-effective and no-regret solution to reducing risks from disasters, complementing conventional engineering measures such as sea walls and storm channels. However, **investment in 'natural infrastructure' isunderexplored in policies aimed at reducing risk**
There is an urgent need to invest in nature-based solutions todisaster risk reduction in order to minimise our vulnerability to future events.

What is the issue?

According to the Emergency Events Database, in the last ten years, over 730,000 people have lost their lives, over 1.9 million have been injured, andaround 15 million have been made homeless as a result of disasters.

A 2017 analysis by Munich Re revealed total economic losses from natural disaster events in 2016 reached US$ 175 billion – compared to US$ 103 billion in2015. This was caused by natural catastrophes, such as forest fires in Canada and widespread flooding in the USA, Europe and Asia.

Climate change is increasing the frequency, intensity and magnitude of disasters,leading to a higher number of deaths and injuries, as well as increased property and economic losses. In the past 20 years, **90% of major disasters have been**

caused by weather-related events such as heatwaves, storms, floods anddroughts, according to the UN Office for Disaster Risk Reduction (UNISDR).

Nature can provide cost-effective, no-regret solutions to disasters, complementing conventional engineering measures such as sea walls and stormchannels.

However, despite its value in reducing the risk of disasters and building communities' resilience to climate change, investment in 'natural infrastructure'has been underexplored in disaster risk reduction policies.

Why is it important?

Nature-based solutions, such as conserving forests, wetlands and coral reefs,can help communities prepare for, cope with, and recover from disasters, including slow-onset events such as drought. They can also reduce the secondary impacts from non-climate-related disasters such as landslides following an earthquake.

Forests and other vegetation help stabilise slopes and therefore reduce the risk of landslides. Wetlands can help regulate floods. Coastal vegetation and natural features such as sand dunes and mangroves can provide protection from storm surges, strong winds and cyclones. Healthy coral reefs can reduce wave energyduring coastal storms.

In 2013, when Typhoon Haiyan hit the Philippine province of Leyte, 5,500 peopledied from storm surges along exposed coastlines. However, several communitiesin the same area remained relatively unaffected, and credited the presence of mangroves with saving their lives and properties. Following Hurricane Katrina, the US Congress in 2013 approved US$ 500 million to restore and reconnect ecosystems around the Gulf Islands and in the Jean Lafitte National Park on the New Orleans coast. These green spaces will help prevent economic damage andloss of lives from future extreme events. (Murti, R. and Buyck, C. (ed.) (2014). *Safe Havens*.)

Nature-based solutions also generate local employment and economic opportunities, reducing the need to import technical expertise and labour as in the case of engineering and construction. Investment in these solutions to reducerisk can therefore be included in public-sector stimulus packages and social development programmes.

What can be done?

There is an urgent need to invest in disaster risk reduction to minimise our vulnerability to future events. To date, much of the focus has been on reactive measures to address sudden onset events such as storms and landslides, including humanitarian aid relief and preparedness. However, climate change is also responsible for slow onset disasters such as drought. While emergency measures are critical in times of disasters and require continued efforts, as a global community we must move from reactive to proactive risk reduction. Proactive investments in risk reduction can help countries prepare for this type ofdisaster that may be 'invisible' until a crisis point is reached, when more resources may be required to reverse the damage.

Failing to address risk factors now means failure to secure investments in longer-term climate change mitigation and adaptation efforts. Investing in ecosystem management pays off in terms of longer-term resilience to climate change.

Better information sharing amongst the humanitarian aid sector, the environmental community and climate change policy makers, and the fostering ofmutually beneficial partnerships and collaborations are key to better recognising nature as an effective solution for disaster risk reduction.

The scientific basis of nature-based solutions to disaster risk reduction alsoneeds to be strengthened to enhance the understanding of how natural infrastructure can complement engineered infrastructure.

Improved coherence amongst disaster management, conservation and climate change policy mechanisms is also needed for nature-based solutions to be takeninto account in global policy and decision-making processes.

In some countries, nature-based solutions are already established as cost-effective ways to reduce disaster risk:

Following Typhoon Haiyan, the Philippine Government in 2015 pledged about US$ 22 million to restore mangrove and natural beach forests.

Switzerland invests up to CHF 150 million a year in forest management, as this is 5-10 times less expensive than engineered structures for reducing risks from landslides, rock falls and avalanches.

Instead of increasing the height of sea walls following the 2011 Great East Japan Earthquake and Tsunami, Japan declared the expansion of its coastal forest nationalpark in the form of Sanriku Fukko Reconstruction Park, with an estimated saving of more than JPY 2.5 billion.

IUCN provides technical support on integrating nature-based solutions into land-use planning for sustainable development. In applying nature-based solutions todisasters, IUCN is helping communities to understand their vulnerabilities and seek locally relevant nature-based solutions. It also promotes gender equality, reduces vulnerabilities of the poorest and the most marginalised, and promotes social equity from local to global levels.

PROBLEM SOLUTION FIT:

PROBLEM SOLUTION FIT OF NATURAL DISASTER

If you have experienced a natural disaster (such as a tornado or hurricane), it is very important to learnways of coping with the impact these events can have.

Natural disasters have the potential to produce high levels of stress, anxiety, and anger in those who areaffected. They are considered to be traumatic events and can potentially trigger post-traumatic stress disorder (PTSD) in survivors.

Unlike other traumatic events, natural disasters can result in tremendous destruction of property andfinancial loss, which further contributes to stress levels and disrupts coping efforts.

For example, a tornado or hurricane can destroy and disperse an entire community, thwarting theirattempts to connect with social support.

Ways to Cope With Natural Disasters

Though the effects of natural disasters can be severe and far-reaching, there are steps you can take tocope. Here are some ways you may be able to reduce the trauma of a natural disaster.

Seek out and connect with . Research has consistently found that early intervention, resources, and support from others can be a major factor in helping people overcome the negative effects of a traumatic event. Given that a natural disaster can impact an entire community, your support system may be weakened by a natural disaster. However, even connecting with one person can make a difference.

Identify local support groups or available crisis counselors to talk to. After a natural disaster, crisis counselors may be brought in to offer support and help you come up with ways of coping with the impact of a natural disaster. Take advantage of these opportunities.

Try to establish a schedule. For example, set regular times for meals, waking up in the morning, or talking with family and friends. A natural disaster can greatly disrupt your regularschedule increasing the extent to which your life feels chaotic and out of control. Coming up with a daily, structured schedule can help you establish a sense of predictability and control.

Talk about the effect of the natural disaster. Share your feelings with others, or at the very least, find some way to express your emotions. A natural disaster can result in strong feelings of anger, anxiety, and sadness. These emotions need to be expressed. If you i, they mayget more intense.

Focus on self-care. A natural disaster can deplete you physically as well as emotionally. It is very important that you make time to care for yourself. Self-care is integral to emotional and physical health. Caring for your body, mind, and spirit can increase your ability to cope with trauma. Make sure you eat well, get enough sleep, and exercise. Mindfulness practice has also been shown to help survivors cope with PTSD.[4]

Practice healthy coping strategies. Following a natural disaster, you will experience a number of intense negative emotions. Therefore, it is very important to identify . Alcohol or substance use, excessive sleep, and seeking comfort in food can be effective short-term strategies for managing emotional distress, but in the long-term, these behaviors don't address the root issue and often increase distress.[5]

Try to limit other sources of stress in your life. Although you may have little controlover other sources of stress in your life, try to limit the extent to which you make major decisions or life changes. Your most important task following a natural disaster is getting your life and emotions back in order. Therefore, it is important to put yourself in a place where it is going to be easier to do this.

Find ways to help others. Helping others can provide you with a sense of agency, purpose, control, and empowerment.[6]

Symptoms of PTSD

It is important to recognize that it is very normal to experience PTSD-like symptoms in the aftermath ofa traumatic event.

You may experience intrusive thoughts or memories of the traumatic event, feel on edge, or have difficulty sleeping.[7] These symptoms are, in many ways, the body's natural reaction to being exposed to(and surviving) a highly stressful event.

Healthy Coping Strategies

Symptoms naturally dissipate over time for most people who experience a traumatic event such as a natural disaster. Coping in a healthy manner further increases the likelihood that these symptoms will improve.[8]

However, engaging in unhealthy coping strategies (for example, drinking alcohol or other methods of avoidance) can increase the possibility that these symptoms will linger and potentially get worse— eventually resulting in a

Healthy coping strategies are key to recovering from a natural disaster.

Getting Help

If you notice that your symptoms are not getting better and are with aspects of your day-to-day life, it may be time to get help.

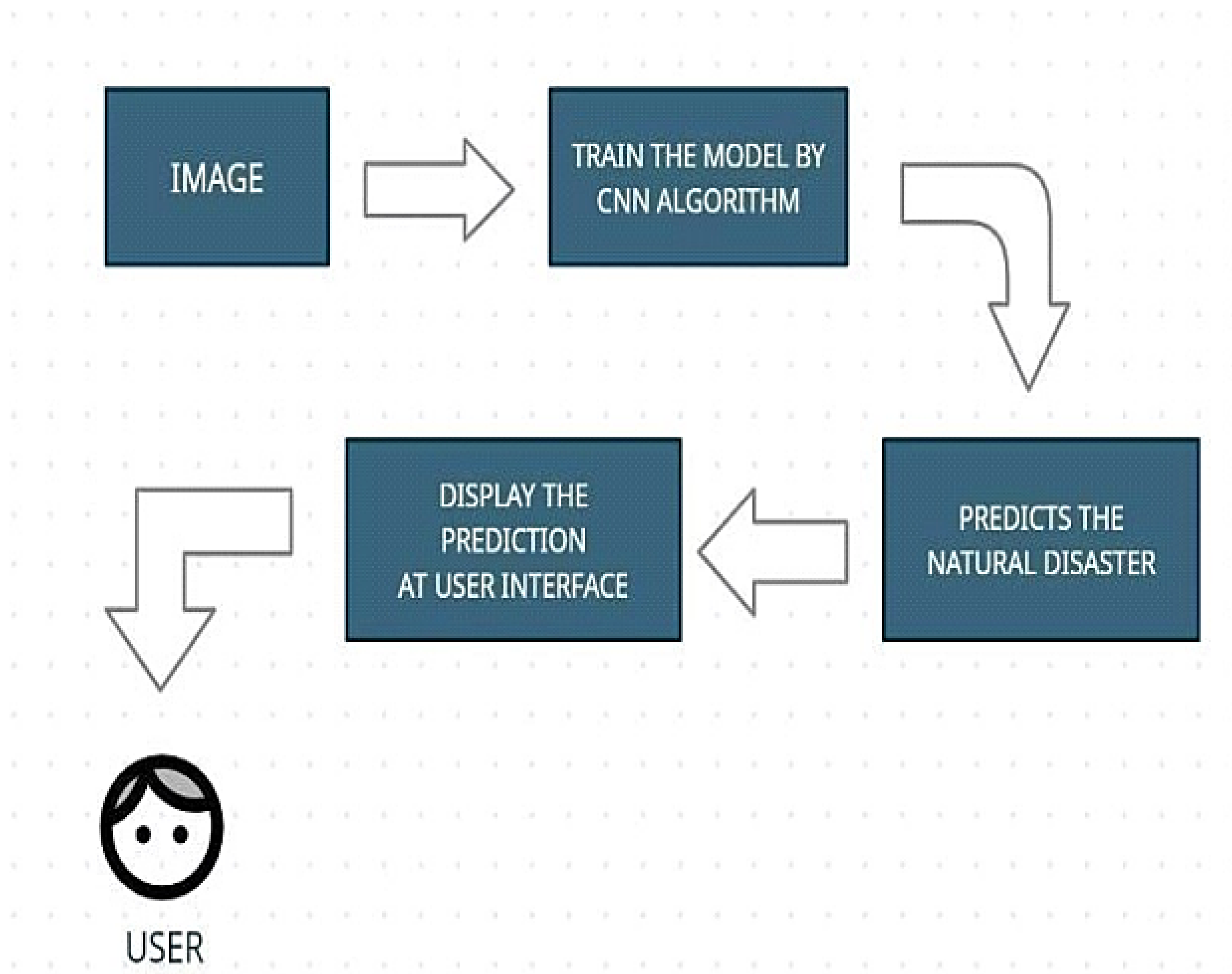
If you decide to start therapy, finding a qualified mental health provider can be an overwhelming and stressful task. Fortunately, there are websites with free search tools that can help you find in your area who are trained to treat PTSD.

Even if you don't feel as though your symptoms are interfering with your life, it can still be beneficial to talk with someone. A qualified and compassionate mental health professional can offer support and resources while you work through the stress of the aftermath of a natural disaster.

A therapist can also help you develop problem-solving skills to help you get your life back in order after the event, which takes some of the strain off you. The additional support and tools may prevent the development of PTSD or another trauma-related condition.

SOLUTION ARCHITECTURE

Natural Disasters Intensity Analysis AndClassificationUsingArtificial Intelligence



PROJECT DESIGN PHASE – II

CUSTOMER JOURNEY

Introduction

As natural disasters have become major threats to human life and the world economy, governm ents and international organizations are cooperating to promote global and regional risk manag ement, and to improve the capability to mitigate the effects of disasters. Early international disa ster reduction activities can be traced back to the International Decade for Natural Disaster Red uction (IDNDR 1990). It raised awareness of the significance of natural disaster reduction. In 199 4, the First World Conference on Disaster Reduction was held in Yokohama, Japan, establishing t he guiding principles for the Decade for Natural Disaster Reduction (ADRC 2006). In December 1 999, the UN General Assembly adopted the International Strategy for Disaster Reduction (ISDR) to implement follow-

up action for the achievements of the decade, and to promote the continuing development of di saster reduction around the world (Buckle 2007). Then, in 2005, the Second World Conference on Disaster Reduction was held in Hyogo Prefecture, Japan, and the Action 2005–

2015: Building the Resilience of Nations and Communities to Disasters, was adopted by the Conf erence and has become the international blueprint for disaster reduction. In December 2006, th e United Nations General Assembly agreed to establish the ‘United Nations Platform for Space- based Information for Disaster Management and Emergency Response-

UNSPIDER’ as a new United Nations program (CEOS 2005).

This UN platform is a gateway to space-

based information for disaster management support, serving as a bridge to connect disaster management and space communities, and by being a facilitator of capacity-
building and institutional strengthening for developing countries in particular. Along with such U N activities, some regional and international organizations have made efforts to encourage regio nal cooperation in natural disaster mitigation. One of the major European efforts is the Internati onal Charter ‘Space and Major Disasters’ initiated by the European Space Agency (ESA) and the F rench Space Agency (CNES) in 1999, which aims to provide a unified system of space data acquisition and to deliver these data sets to those affected by natural or man-

made disasters (CEOS 2005). Recently the Charter expanded into a world-

wide program and plays an important role in natural disaster mitigation activities.

In Asia, the most disaster-

prone continent, the Asian Disaster Reduction & Response Network (ADRRN) was formed in 200 2 following an agreement between the Asian Disaster Reduction Center (ADRC) in Kobe, Japan a nd the United Nations Office for Coordination of Humanitarian Affairs (UN OCHA). This brought t ogether more than 30 NGOs from regions all over Asia to work together for disaster reduction a nd response (IAP 2009).

In December 2004, nearly a quarter of a million people lost their lives and over 1.6 million were displaced from their homes in the devastating Indian Ocean tsunami. In the aftermath of this sh ocking event, the InterAcademy Panel (IAP) approved a proposal of natural disaster mitigation p roposed by the Chinese Academy of Sciences. Then an international study panel was established and produced a report. This paper introduces part of the results of the IAP report. Statistics hav e shown that the great natural disasters have resulted in a death toll of up to 2 million persons and economic losses up to US$1950 billion from 1950 to 2008 (IAP 2009). The most death toll and losses are from the three major natural disasters: storm; earthquake; and flood. So this paper m ainly deals with these three kinds of disaster.

Earthquake disasters

An earthquake is a sudden movement of the Earth's lithosphere (its crust and upper mantle), wh ich is caused by the release of built-

up stresses within rocks along geological faults, or by the movement of magma in volcanic areas. Smaller earthquakes occur frequently, but annually, only as many as 18–

20 reach a magnitude above Ms 7. Approximately 40 disastrous earthquakes have occurred sinc e the end of the twentieth century, and the total death toll is nearly 1.7 million. This number is a bout 50% of all victims of natural disasters. Most earthquakes (80%) occur in the oceans, mainly in the subduction zones. Earthquakes occurring in such regions have a frelatively large magnitud e and they are also deep. These earthquakes can cause tsunamis. Continental earthquakes are le ss frequent than those in the ocean and they occur mainly on the boundaries of continental plat es or the boundaries of active blocks (Johnston and Schweig 1996, China Earthquake Administration 2005).

Like other disasters, earthquakes and tsunamis can be sudden, seriously destructive, and create long-lasting social, environmental, and economic problems. However, compared with weather-related or biological disasters, damage from earthquakes is multiplied by the impossibility of acc urate and timely forecasting, and afterwards by difficulty in timely response and rescue efforts.

Earthquake disaster risk zonation is an important tool in earthquake disaster prevention. Most d eveloped countries have accurate and detailed earthquake disaster zoning and risk assessment maps. However, it is necessary to continue to evaluate the potential dangers of earthquakes by i mproving theory and methodology of risk assessment, based on seismic activity and active fault monitoring. It is also crucial to document disaster-caused changes, disaster degree, risk, and loss estimations (Long and Zelt 1991, Ma 2005, Liu 2007, Liu *et al*. 2007).

Engineering analysis for structural collapse prevention and deformation of buildings in the event of a major earthquake must be implemented everywhere. Related research must continue to b e carried out on the seismic structure of active faults, mechanisms of earthquake generation, assessment of potential earthquake activity, and potential losses.

The suddenness and destructiveness of earthquakes often result in rescue decisions being delay ed, chaotic, unplanned, and unscientific, thus resulting in even greater loss. It is critical to impro ve the means and methods of rescue in all countries. In order to improve the capabilities of eme rgency response and rescue, research should comprehensively review emergency rescue systems, rapid disaster-evaluation technologies, communications, and decision-making methods (Shen *et al*. 2003, Qu *et al*. 2004, Wang *et al*. 2008). There is also a great need for improved early warning systems. The lack of such a system resulted in the long-distance devastating damage following the Indian Ocean tsunami of 2004.

A systematic assessment of emergency and assistance needs before an earthquake would serve in determining the disaster extent, quantify assistance needed, and establish a disaster-planning database and disaster-needs forecast. The resulting disaster aid model could help to rapidly make decisions on the leve l of required assistance within 2–3 hours after large-scale earthquakes and an hour after middle-small-scale earthquakes. For example, the Ms 8.0 Wenchuan earthquake resulted in a large number of deaths and injuries as well as disruption of electricity, communications, transportation lines, an d water supplies. Figure 1 shows the appearance of Beichuan County Town before and after the earthquake. Major difficulties were encountered in the response time for rescue and disaster- relief operations because of the unknown situation on-site. The Chinese Academy of Sciences, in cooperation with other organizations, used remote-sensing techniques to immediately assist with disaster relief. Through acquiring, processing, interpreting, and analyzing remote-sensing data, a series of reports on disaster reduction were immediately submitted for earthqua ke assistance and disaster relief at all government levels. Additionally, digital earth technologies, such as using Google Earth immediately after the earthquake to acquire spatial information of t he disaster area, played a crucial role in assisting scientists to understand geological structures a nd plan for the subsequent further studies (Guo 2009, 2009a, 2009b, 2010a).

Tropical cyclones and storm surge disasters

Tropical cyclones are warm-core meteorological systems that develop over tropical and subtropical ocean waters, with a surface temperature of 26.5°C or more, and in areas of small changes in wind velocities with height.

There are, on average, around 90 tropical cyclones annually (including tropical storms, strong tropical storms, cyclonic storms, typhoons, hurricanes, and strong cyclonic storms). They occur in the northwest Pacific Ocean, the northeast Pacific Ocean, the southwest Indian Ocean, the Atlantic Ocean and Caribbean Sea, and the southwest Pacific Ocean. Storm surges are caused by tropical cyclones, which in turn are caused by strong winds and sudden decrease in atmospheric pressure near their centers. This change in pressure causes a sudden and sharp rise in coastal water levels (Henderson-Sellers *et al*. 1998, Knutson 2002, Emanuel 2005, The State Council of the People's Republic of China 2005, The Statement on Tropical Cyclones and Climate Change 2006, The Summary Statement on Tropical Cyclones and Climate Change 2006).

World Meteorological Organization (WMO) statistics show that tropical cyclones and the associated storm surges and torrential rains are the most destructive hazards in terms of deaths and material losses. According to the third assessment report on global climate change issued by the WMO and the Intergovernmental Panel on Climate Change (IPCC), since 1750, overall climate warming has been in part a result of human activities. The surface temperature of most tropical waters has already increased by 0.2–0.5°C (IPCC Third Assessment Report-Climate Change 2001). There are indications that in the future tropical cyclones may increase in intensity, although there are uncertainties regarding the overall frequency of tropical cyclones in a warming world. With increasing globalization, it can be inferred that disasters related to typhoons will have increasing socio-economic impact, particularly in developing countries.

In an attempt to reduce the effects of cyclones and storm surges, science and technology have developed surveillance systems and methodologies for disaster prediction and early-warning. These systems of spatial observation technology, supported by powerful computers and telecommunications facilities, have resulted in the development of numerical weather prediction techniques that permit significantly improved real time forecasts of weather-related hazardous phenomena. Some of the major advances of these sciences include: (1) the availability of an unprecedented amount of new non-traditional observations, in particular from earth observation (EO) satellites with onboard optical scanners and imaging radars; and (2) the considerable progress in the scientific understanding of dynamic and physical processes in the atmosphere and their interactions with the oceans.

Although over the past two decades several nations have made remarkable progress in typhoon surveillance, forecasting and alerts, there are still material predictive errors of the estimation of storm tracks and in the accuracy of predicting their intensity, path, wind, and associated precipit ation. Forecasting and early warning systems for storm surges have mainly been established in d eveloped countries, but Cuba and Bangladesh are examples of developing countries where new surveillance and forecasting systems have had very positive impact on disaster mitigation (The S tatement on Tropical Cyclones and Climate Change 2006, The Summary Statement on Tropical Cyclones and Climate Change 2006).

Flood and drought disasters

Floods and droughts have devastating consequences. According to the Asian Disaster Reduction Center, half the population world wide who suffered natural disasters was affected by floods an d one third by drought during the period from 1975 to 2005. The World Disaster Report, publish ed by the International Federation of Red Cross and the Red Crescent Societies, showed that over the past 20 years, deaths resulting from flood-related disasters, including floods, landslides, storm surges, and tsunamis, accounted for 83.7%,2.7%, 12.4%, 0.7%, and 0.5% of the total disaster-related fatalities in Asia, Africa, America, Europe, and Oceania, respectively. The statistics also in dicated that developing countries experienced more casualties when they were struck by natura l disasters (World Meteorological Organization & Global Water Partnership 2003, Lehner *et al*. 2006).

The increasing losses resulting from floods and droughts in both developed and developing coun tries indicate that disaster mitigation is not a simple matter related to economic development, b ut rather a more complex issue in which science and technology could play an important role (Fl owers 2003, Cheng 2006

The mainstream water-related management strategy in the twenty-first century has shifted from single-purpose engineering measures to comprehensive management for flood and drought preventio n. With the apparent direction of future climate change, extreme weather events are predicted t o occur more frequently. The probability that these events will cause greater damage has also in creased due to rapid population growth and construction in areas of high flood risk. Increased v ulnerability of life and property brings with it an increased demand for protection against the ele ments of nature. However, traditional methods of flood control and drought relief are becoming more complex as we face the deterioration in water distribution, intensification of soil erosion, degradation in aquatic ecology, and overall regional water shortages.

With existing and the future challenges related to floods and drought, there are several crucial is sues facing research scientists and governments. Under the premise that floods are inevitable, h ow can we reduce fatalities and property loss and improve our knowledge to take advantage of t he positive aspects of floods and thus transform negative relationships into beneficial interactio ns between humans and nature? In order to plan for management for the disasters, we need to select a risk-management model that fits local conditions.

Overall, we must exercise non-

engineering measures including laws, economics, administration, and education to enhance theintegrity and long-

term benefits of flood control engineering projects. Finally, we have to perfect the emergency response management system and operations for severe floods.

Earth observation (EO) for natural disaster mitigation

EO comprises *in situ* observations, which is direct observation carried out in close proximity to th e object or phenomenon of interest, and remote sensing or observation from a distance (CEOS 2005). There is an increasing use of EO technologies in post-disaster damage assessment.

Examples of EO at work today include the thousands of data buoys operating in the world's oceans, hundreds of thousands of land-

based environmental monitoring stations, tens of thousands of observations from aircraft platfo rms and over 50 environmental satellites orbiting the globe (Guo 2004, CEOS 2005, GEOSS 2006)

.

Earth observing technologies utilize information from spaceborne and airborne systems through a variety of active and passive sensors. From decades of work on disaster relief, it has been sho wn that EO can provide valuable information using optical and microwave technologies. Optical sensors have a long history and have continually improved both spatial and spectral resolution. Their technical advantages and familiarity give them an irreplaceable role in EO (as shown in Fig ure for extracting collapsed buildings in the Yushu earthquake which occurred in April 2010 in t he Qinghai Province of China). Microwave sensors are useful in situations where factors such as clouds or darkness impede the work of optical sensors. The most frequently used microwave se nsors are Synthetic Aperture Radar (SAR), microwave radiometers, scatterometers, and radar altimeters (GEOSS 2006, Guo 2010a).

Image/Map of spatial distribution of collapsed buildings interpreted from airborne optical remote-

sensing image overlaid with inducing factors generated in April 2010 for the Yushu earthquake area in western China (Guo *et al*. 2010b).

In terms of earthquake disaster mitigation and relief, EO is used for regional structural/tectonicmapping and other topographic and land-use base-

mapping for emergency relief logistics, estimation of settlement and structural vulnerability (e.g. building design) and exposure (e.g. proximity to active earthquake zones). EO also contributes t o damage assessment mapping using high-

resolution satellites, a primary need for relief agencies that need to locate victims and assess ris

k. SAR interferometry (InSAR) is increasingly being used for the mapping of seismic ground deformation. InSAR data provides information on pre-, co-, and post-

seismic deformation and therefore contributes to the mitigation phase by adding to the spatial u nderstanding of fault mechanics dynamics and strain. shows radar interferogram of the Yushu e arthquake, from which the spatial distribution of surface deformation field is clearly shown. Cos eismic deformation field within the image is about 82 km long and about 40 km wide along the f ault. From the distribution of interferometric fringes caused by Yushu seismic deformation field, we can see that the distribution of the coseismic deformation is centered around the Ganzi- Yushu fault zone. For more information on the results of interpreting the image, please refer to Guo *et al*. (2010c).

Coseismic deformation map from ALOS/PALSAR data of Yushu earthquake area in April 2010, wh ere (a) shows differential interferometric phase map; (b) differential interferometric phase of instrumental epicenter; and (c) differential interferometricphase of macro epicenter.

For floods, both optical and radar satellites have been widely used to quantify catchment basin c haracteristics, such as watershed boundaries, elevation and slope, land cover, as well as environ mental variables such as soil moisture, snow pack, temperature, vegetation indices, and evapotr anspiration. They have also been used operationally for flood and drought monitoring, mapping,early warning, and damage assessment. As a weather-

related disaster, the study of droughts has used a number of satellite-

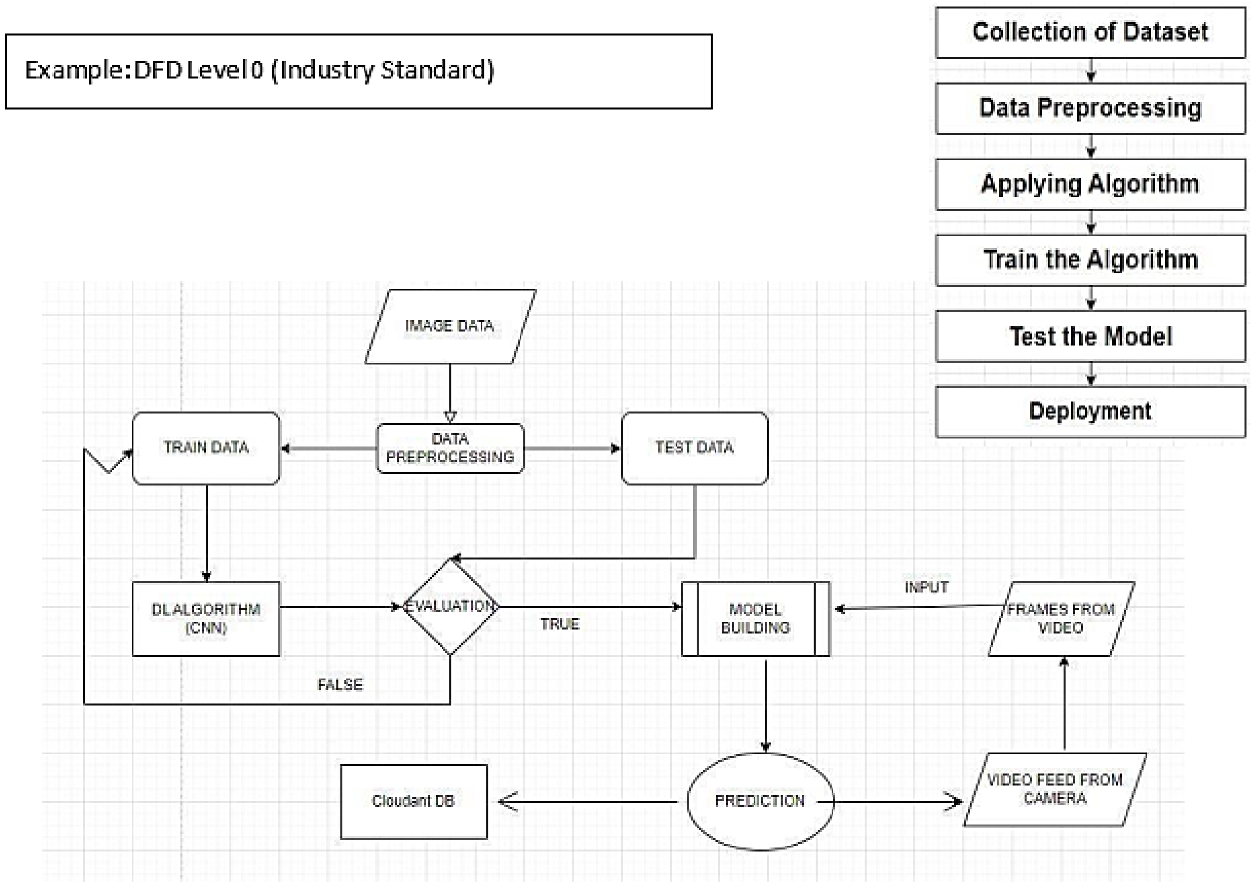
based programs and they are providing improved details relating to existing and projected resea rches. However, the potential contribution of existing satellites has still not yet been fully exploited (Scofield and Margottini 1999, Stancalie 2005).

Typhoons and hurricanes occur in the vast tropical ocean/seas where they are mainly monitored using E

O. Current research is focusing on improving EO for weather forecasting and also improving the timeline ss, quality, and long-term continuity of observations to help revise current forecasting.

Data Flow Diagrams:

A data flow diagram (DFD) is a visual representation of the information flow through a process or system. DFDs help you better understand process or system operation to discover potential problems, improve efficiency, and develop better



operation to discover potential problems, improve efficiency, and develop better processes.

USER STORIES:

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Customer (Mobile user)	LOGIN	USN-1	As a farmer, I canlogin by giving mobile number, gmail or google account and theirlocation.	I can prepare myself from cyclone and storing enough food and essentials	High	Sprint-1
Customer (Mobile user)	ALERT	USN-2	As a farmer, I can receive the alert message when thecyclone hits.	I can know about current climatic conditions andupcoming weather conditions	High	Sprint-2
Customer (Mobile user)	MONITORING	USN-3	As a farmer, I canview the continuous monitoring of cyclone and climatic changes.	I can know where the cyclone hits and how much impactsit may creates	High	Sprint-3
Customer (Mobile user)	REPORTS	USN-4	As a farmer, I cankeep the recordsof the previous cyclone and refernews from meteorologist for live updation	I can receivethe alert messages when the disaster occurs	High	Sprint-4

Customer (Mobile user)	END USERS (farmers)	USN-5	As a farmer, I canreceive the information fromthe database.	I should ensure thatany stored seeds or harvested crops are carefully protected from wind and flooding	High	Sprint-5

Technical Architecture:

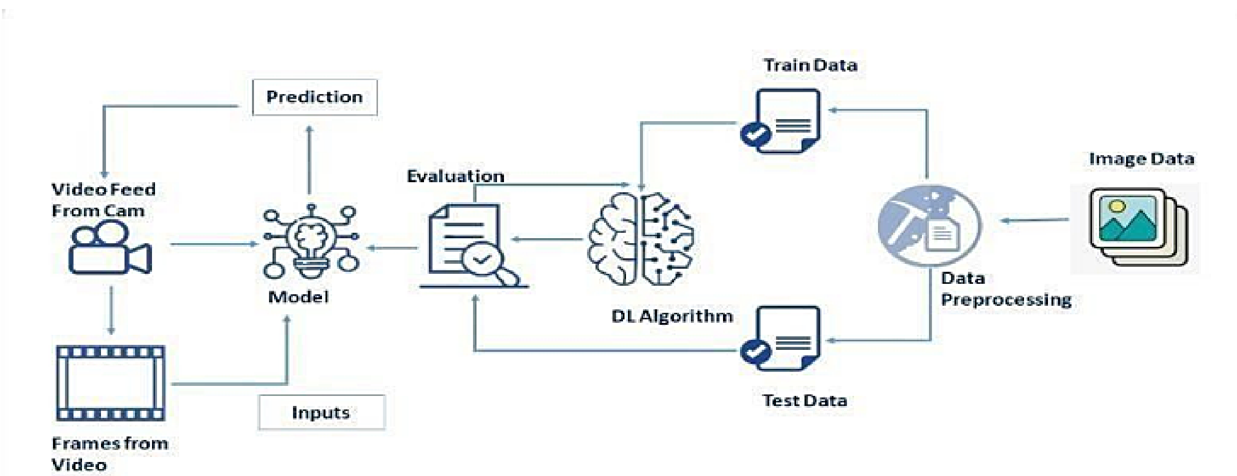


Table-1: Components & Technologies:

S. No	Component	Description	Technology
1.	User Interface	User interacts with application for the predictionof Any Natural disaster which will happen in future minutes.	HTML, CSS, JavaScript, Django,Pytho
2.	Feature Engineering Pipeline	Algorithms can't make sense of raw data. We have to select, transform, combine, and otherwise prepare our data so the algorithm canfind useful patterns.	Image processing, pattern extraction,etc
3.	Model Training kit	It learns patterns from the data. Then they usethese patterns to perform particular tasks.	Multiclass Classification Model,Regress Model, etc.
4.	Prediction unit	This function is used to predict outcomes from the new trained data to perform new tasks andsolve new problems.	Decision trees, Regression, Neuralnetw
5.	Evaluation system	It monitors that how Algorithm performs on dataas well as during training.	Chi-Square, Confusion Matrix, etc.
6.	Interactive services	To interact with our model and give it problems to solve. Usually this takes the form of an API, auser interface, or a command-line interface.	Application programming interface,etc.
7.	Data collection unit	Data is only useful if it's accessible, so it needs to be stored ideally in a consistent structure andconveniently in one place.	IBM Cloud, SQL Server.
8.	Data generation system	Every machine learning application lives off data.That data has to come from somewhere. Usually, it's generated by one of your core business functions.	Synthetic data gen
9.	Database management system	An organized collection of data stored in database, so that it can be easily accessed andmanaged.	MySQL, Dynamol

10.	IBM Cloud services	Processed data stored in cloud service which canbe access by the admin anywhere over the internet.	IBM Cloud etc.

<u>Table-2</u>: Application Characteristics:

S. No	Characteristics	Description	Technology
1.	Open-Source Frameworks	An open source framework is a template for software development that is designed by a social network of software developers. These frameworks are free for public use and providethe foundation for building a software application.	Keras, pensor flow.
2.	Authentication	This keeps our models secure and makes sureonly those who have permission can use them.	Encryption and Decryption (OTP).
3.	Application interface	Userusesmobileapplicationand web application to interact with model	Android and Web Development(Phon ReactNative, and NativeScript).
4.	Availability (both Online and Offlinework)	Its include both online and offline work. As goodinternet connection is need for online work to explore the software perfectly. Offline work includes the saved data to explore for later time.	Caching, backer

5.	Regular Updates	The truly excellent software product needs a continuous process of improvements and updates. Maintain your server and make sure that your content is always up-to-date. Regularly update an app and enrich it with new features.	Waterfall Appro Incremental ApproachSpiral Approach
6.	Personalization	Software has features like flexible fonts, backgrounds, settings, colour themes, etc. which make a software interface looks good andfunctional.	HubSpot Proof

PROJECT PLANNING

MILESTONE ACTIVITY LIST

Earthquake

To prepare for an earthquake, consider stashing some emergency supplies in advance, advises the Earthquake Country Alliance, a partnership of organizations and alliances focused on earthquake preparedness. Their site offers advice on stocking an "under-bed bag" and a "go bag." For example, the former may include shoes in a closedbag under the bed, to protect them (and your feet) from broken glass, while the latter would ideally contain enough supplies for three days in case of evacuation.

During an earthquake, the best guidance is to drop, cover, and hold on,Cotter says. If you feel an earthquake, drop to your hands and knees and crawl or move to cover underneath a sturdy piece of furniture — away from shelves and other things that could fall. "Hold on to the shelter to keep it protecting you, especially over your head and neck," he says. It's important not to start evacuating until after the shaking hasstopped. The vast majority of injuries in an earthquake, Cotter notes, happen when people try to run during the shaking and get hit by debris or fall down.

Cotter suggests practicing this routine — drop, cover, and hold on —with your family so it becomes second nature. Check out Great ShakeOut Earthquake Drills for more ideas on how to prepare for anearthquake with your family.

Hurricane

If you’re going to leave, leave early, Burdiss says. When a hurricane isapproaching, the people in its direct path are often all heading the opposite direction, which means the traffic to get out of town can be

extreme. Make sure you have enough fuel in your tank, he says, andget as much of a head start as you can.

If you don't have a car, make plans to carpool with friends or family, the Centers for Disease Control and Prevention (CDC) suggests. Or youcan call the authorities to get a ride, the agency recommends.

Cotter stresses that it’s crucial to heed all government warnings duringand in advance of a hurricane, especially evacuation guidance.

Explosion

Responding to an explosion is tricky when you don’t know its cause, Burdiss says. It’s best to assume there will be a secondary threat or hazard in the aftermath. For example, if a meth lab exploded, hazardousmaterials could be released; a natural gas leak explosion can create more threats, such as broken glass. First responders will assess these secondary risks, Burdiss says, so follow their guidance.

If you need to evacuate, he advises grabbing your emergency kit, along with important paperwork (like identification documents) and some cash,and using your communication plan to inform your friends and family of your destination.

Explosions are relatively uncommon in the United States, Cotter says; when they do happen, they’re often caused by gas leaks. If you detect the smell of gas, leave home immediately and call 911 and your naturalgas provider.

Cotter keeps combination gas and carbon monoxide detectors near hisgas oven range and gas washer and dryer, which will alert him if there are any leaks he might not smell immediately. Check the batteries regularly, he advises.

Fire

People often run to the bathroom when their home is on fire because they think its water supply will be helpful, says Wayne Struble, the director of emergency preparedness for the Florida-based hospital system Health First. But actually, it's common to get trapped inside there and not make it out. "You're better off going to a window," he says,and making sure you close every door as you move throughout the

space — it will help the fire take longer to reach you. If your window is aboveground, you need a means to climb down, like a collapsible ladder, as *The New York Times'* product review website The Wirecutterrecommended in July 2020.

There are some "neat new gadgets" for better fire evacuation, Cotter says. Some detectors include a guiding voice along with an audible alarm; that voice can help you and your family take faster action withoutneeding to determine what a plain alarm noise might mean, he says. One example is an Alexa-enabled smoke and carbon monoxide detector by First Alert, which costs under $200.

Cotter suggests practicing fire drills regularly. Ensure that all family members know to leave the house immediately without pausing to collect belongings, and be sure to have an agreed common meetingpoint, he says.

Of course, preventing a fire is better than having to respond to

one. FEMA encourages particular safety in regards to cooking, and useof portable space heaters, fireplaces, and wood stoves.

Flood

Preparing for a flood is similar to preparing for other emergencies, with one critical difference, Cotter says: flood insurance. Many common home and rental insurance policies do not cover flood damage, so check whether your plan has an exclusion. FEMA maintains flood maps nationwide, so you can see if your home has a high flood risk.

As with a hurricane, follow all evacuation guidance from local officialsand have a plan for a safe destination, along with several days of supplies.

Struble adds that, during a flood, it's best to seek refuge on a high floor,ideally near a window. Try to bring some water and food in case you need it, he says. If you live in a one-story home, he suggests stacking mattresses on top of a dining room table, which offers extra elevation in the event that water is rushing inside. But be careful about going inside an attic, says Struble:

You may find that you don’t have a way back out.

Terrorist Attack

Stay at home and shelter in place, Struble says. Keep your windows and doors closed, and “don’t be nosy, trying to go outside and see what’s going on.” Doing so could endanger you, he notes. Turn on thenews and listen for guidance from officials on what’s safe to do and when.

Burdiss says that in the event of a terrorist attack, it’s particularly important to avoid crowds. That’s his “stock advice to family andfriends.”

The Red Cross has compiled a terrorism safety checklist you can download, with details on preparing for the unexpected and how toshelter in place.

Tornado

Tornado alerts come in two forms: watches and warnings. Know the difference between the two, Cotter says. “A tornado watch means that conditions are favorable for severe weather like tornados, while a warning means that a tornado formation is likely or has already formed.” During a watch alert, review your shelter plan. If it's a warning, take shelter immediately. Always head for the lowest floor of your house — never go upstairs, Struble says. Many homes in Florida, where he lives,don’t have basements, so opt for an interior room with no windows. Bathrooms are a good choice, because if the house collapses, the sinks, shower, and toilet might create space for you to hide in, Struble says. And always keep a battery-powered radio with you to stay informed on official guidance. FEMA suggests tuning in to NOAA Weather Radio.

Severe Winter Weather

Winter weather like blizzards, extreme cold, high winds, and freezing rain, snow, and ice can all be serious enough to put your family’s emergency plan into action. According to FEMA, winter storms create ahigher risk of car accidents, hypothermia, frostbite, carbon monoxide poisoning, and heart attacks linked to overexertion. To help minimize your risk, they advise you stay off the roads, hole up indoors, dress warmly, prepare for power outages (but only use generators outdoors.

Sprint Prepares its Network and Emergency Response for Hurricane Sandy and Nor’easterConditions

OVERLAND PARK, Kan.--(BUSINESS WIRE)--As Hurricane Sandy continuesa path towards the East Coast and is projected to merge with a nor’easter in the Mid-Atlantic and Northeast regions, Sprint (NYSE:S) is preparing its network, mobilizing Network Disaster Recovery staff, and strategically staging Sprint Emergency Response Team (ERT) personnel and resources to serve customers and mitigate storm impact.

Sprint’s preparations include:

Actively monitoring the continued path of Hurricane Sandy and thenor’easter while instituting flood prevention measures at Sprint network facilities and retail stores.

Fully fueling all permanent generators and mobilizing portable generators into threatened areas to ensure they’re available to meet response needs based on the current track and intensity of Sandy andthe nor’easter.

Verifying operational readiness of generators and emergency equipment at all mobile switching centers and network Points of Presence (POP) – the facilities where traffic enters and leaves the company’s global IP network, which facilitate dedicated data services for Sprint’s corporate and government customers, as well asother critical communications.

Ensuring Sprint network strike teams are on standby and ready todeploy following Sandy’s landfall and the nor’easter’s impact.

Providing any local public safety agency in need of emergency communications assistance with 14 days of service free of charge for25 Sprint ERT wireless devices in states where an official “state of emergency” has been declared, including Connecticut Maryland, Massachusetts, New Jersey, New York, Pennsylvania, Virginia and Washington, D.C.

Preparing and mobilizing the Sprint Emergency Response Team’s SatCOLT (Satellite Cell on Light Truck) assets, mobile phone and broadband devices, reservist staff and other equipment at its Sterling,Va. hub to provide wireless communications service to local first responders, emergency command centers and other public safety officials in the field.

Additionally, throughout 2012, Sprint’s Network Disaster Recovery team conducted a series of exercises, workshops and drills in the Northeast focused on hurricane preparedness training, tactical planning, service restoration and incidentmanagement.

Sprint’s commitment to consumers, first responders andemergency medical officials

Created in 2002, the Sprint Emergency Response Team is a group of seasoned personnel with expertise in providing immediate restoration of wireless voice, data and IP service, Sprint Mobile Broadband devices, and fully charged SprintDirect Connect phones to facilitate coordination among disaster relief and emergency response agencies, public safety officials and medical personnel.

Sprint ERT maintains a 24-hour hotline, 365 days a year, to rapidly address client needs. Since its creation, Sprint ERT has conducted more than 5,200 deployments,and provided emergency wireless support for more than 1,250 events.

Wireless consumers residing in Sandy’s projected path are also encouraged to usethe following tips to prepare for a hurricane, severe flood or other natural disasters:

Keep your wireless phone and backup batteries fully charged, and beaware that an interruption of wireline and commercial power could affect wireless calls.

If possible, get extra batteries and charge them.

In times of commercial power outages, a car adapter for yourwireless phone should enable you to recharge the battery.

Keep phones and necessary accessories in a sealed plastic bag toavoid water damage.

Load family and emergency numbers into your wireless phone.

Use your Sprint camera phone to take digital pictures or video ofyour property and valuables before the storm hits, so you have "before" pictures in the event of any storm damage.

Wireless networks sometimes experience heavy traffic during emergency events, so rather than call, remember to use Sprint®Direct Connect® or send a text message.

For more information about Sprint’s hurricane preparation efforts, retail storeclosings, and to learn what you can do to prepare for a major storm, visit www.sprint.com/hurricaneinformation. Public safety officials seeking information about services from the Sprint Emergency Response Team shouldcall 1-888-639-0020,

email ERTRequests@sprint.com, or visit Sprint
ERT's Facebook page.

About Sprint Nextel

Sprint Nextel offers a comprehensive range of wireless and wireline communications services bringing the freedom of mobility to consumers,businesses and government users. Sprint Nextel served nearly 56 million customers at the end of the third quarter of 2012 and is widely recognized for developing, engineering and deploying innovative technologies, including the first wireless 4G service from a national carrier in the United States; offering

industry-leading mobile data services, leading prepaid brands including Virgin Mobile USA, Boost Mobile, and Assurance Wireless; instant national and international push-to-talk capabilities; and a global Tier 1 Internet backbone. The *American Customer Satisfaction Index* rated Sprint No. 1 among all nationalcarriers in customer satisfaction and most improved, across all 47 industries, during the last four years. *Newsweek* ranked Sprint No. 3 in its 2012 Green Rankings, listing it as one of the nation's greenest companies, the highest of any telecommunications company. You can learn more and visit Sprint
at www.sprint.com or www.facebook.com/sprint and www.twitter.com/sprint.

PROJECT DEVELOPMENT PHASE

PROJECT DEVELOPMENT OF SPRINT -1

protection SPRINT funds collaborative projects with many companies across the UK, the outcomes of many of these projects, and the missions of companies leading them, help to contribute to the UN's Sustainable Development Goals (SDGs). This was summarised in a previous report, that identified and summarised the most frequent Goals, directly and indirectly linked to SPRINT projects. The top 3 mostfrequent Goals were:

SDG#9 Industry, Innovation, and Infrastructure

SDG#12 Responsible Consumption and Production

SDG#13 Climate Action This report will summarise the SDG#13 and provides some examples of how SPRINT projects are supporting this Goal. Sustainable Development Goal SDG#13: Climate Action There is no country that is not experiencing the drastic effects of climate change. Its impacts upon the globe are ruthless and the recovery costs are countless. Due to changing weather patterns, sea levels are rising, weather events are becoming more extreme and greenhouse gas emissions are at their highest levels in history. As a result, flooding across India, Bangladesh and Nepal has affected 9.6 million people and 550 people died in 2020. Moreover, deforestation occurs simultaneously by anthropogenic activities and natural events, which release huge amounts of carbon dioxide that accelerates global warming. According to the United Nations Development Plan (UNDP), the annual average economic losses from climate-related disasters are in the hundreds of billions of dollars. This is not to mention the human impact of geo-physical disasters, which are 91 per cent climate-related, and which between 1998 and 2017 killed 1.3 million people and left 4.4 billion injured. Immediate action is required with efforts to integrate disaster risk measures, sustainable natural resource management and human security into national development strategies. Hence, these actions are possible through harnessing existing technologies, investments and collaborations of businesses. SPRINT Case Studies In the previous report about SPRINT and the SDGs, SDG#13: Climate Action appeared as the third most frequent Goal from the project lists contributing to strengthen resilience and adaptive capacity to climate related hazards and natural disasters, and mitigate the cost of climate action through sustainable management based on the Global Indicator Framework (GIF). Of the 87 projects investigated, a total of 21 projects were assessed to contribute directly or indirectly to SDG#13. Due to the space sector focus of the SPRINT programme, many of the funded collaborative projects are closely linked with harnessing innovative space technologies such as Earth Observation (EO), Sentinel 1 (Radar) and Sentinel 2 (Optical) which uses satellite imagery for a wide variety of applications such as forest change and land cover mapping. These technologies play a central role in climate change monitoring, weather forecasting, disaster management, and search and rescue operations. Ecometrica Ecometrica is the global leader in downstream space information solutions. The company signed up to the national SPRINT programme to have access to expertise from the University of Surrey, one of Britain’s top space research institutions. Ecometrica worked out to analyse satellite data for monitoring sustainable development goals and climate resilience. This project develops scalable methods to bring together Earth Observation data from different sources (both available Sentinel data and commercial products) to monitor vulnerability to, and recovery from natural disasters, specifically using the case of flooding in Mexico, and natural and man-made events in Brazil. Through this project, assessment on the risk of forest fires can be warned in advance to mitigate the impact of forest fire which is one of the main factors in forest degradation, and improve fire management regimes which is likely to be an essential component of climate change

resilience strategies. Moreover, tropical forests store large amounts of carbon dioxide which when mapping the details about the carbon storage capacity of tropical forest regeneration, will help tropicalforest partners to locate the areas where forest and planting will be most effective at sequestering carbon, thereby acting to reduce climate change. Figure 1 Data analysis based on Earth Observation by Ecometrica According to the Global Indicator Framework, Ecometrica covers the following indicators:

13.1 Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries 13.1.3 Proportion of local governments that adopt and implement local disaster risk reductionstrategies in line with national disaster risk reduction strategies 13.2 Integrate climate change measuresinto national policies, strategies and planning The outcomes of the Ecometrica project could also make direct and indirect contributions to achieving other SDGs, including:

Goal 1: No Poverty

Goal 3: Good Health and Well-being

Goal 4: Quality Education

Goal 5: Gender Equality

Goal 8: Decent Work and Economic Growth

Goal 10: Reduced Inequality

Goal 11: Sustainable Cities and Communities

Goal 12: Responsible Consumption and Production

Goal 15: Life on Land Previsico Flooding is the one of the extreme events caused by climate crisis. The importance of mitigation of its impacts and preparation for flooding is required for future resilience against natural disaster. The challenge with existing forecasting technologies is that because every stormis different, hourly changes in weather patterns can cause floods which are not detected using traditional forecasting approaches. However, Previsico has made a difference with a research project with SPRINT partner, the University of Leicester. Figure 2 Example of Previsico's flood forecasting programme Previsico is a global flooding forecasting company, which spun out of Loughborough University in 2019. The majority of its work is aimed at reducing the impact of flooding globally by delivering the absolute best flood forecasting technology to those who need it. Previsico signed up to the national SPRINT business support programme to further increase the accuracy of its flood modelling techniques and commercialise its comprehensive flood management solution. The collaboration with the University of Leicester has resulted in more accurate and validated flood forecasts to its international customers, enabling them to respond to flood events in a targeted and efficient manner. According to the Global Indicator Framework, Previsico covers the following indicators: 13.1 Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries 13.1.3 Proportion of local governments that adopt and implement local disaster risk reduction strategies in linewith national disaster risk reduction strategies 13.2 Integrate climate change measures into national policies, strategies and planning The outcomes of the Previsico project could also make direct and indirect contributions to achieving other SDGs, including:

Goal 1: No Poverty

Goal 3: Good Health and Well-being

Goal 8: Decent Work and Economic Growth

Goal 9: Industry, Innovation, and Infrastructure

Goal 10: Reduced Inequality

Goal 11: Sustainable Cities and Communities

Goal 15: Life on Land Conclusion The United Nations' Sustainable Development Goals are containing various issues around the world. In particular, SDG#13 was established to tackle global issues relating tothe climate crisis. As extreme weather events and natural disasters cause enormous costs in economic, social and environmental terms, the efforts to mitigate the impacts through innovative technology become critical. Therefore, the technological approach should be more emphasised and partnerships should be encouraged between businesses and Higher Education Institutions to accelerate the inventionof innovative technologies. Such technological support from SPRINT projects could allow sustainable solutions to become adapted from imagination to reality. Thus, people can be prepared for the disastersand living in more secure home environments.

ASSIST

The ASSIST research project (in Italian, ASSIST is the acronym of 'Ammodernamentodelle Strutture Sanitarie con il supporto di Indicatori Situazionali Tecnico-economici').The ASSIST research project aimed to assess the physical environment of existing hospital facilities of the Friuli Venezia Giulia region (North-East of Italy). The goal of the ASSIST

ARMONIA

The ARMONIA project aims to tighten collaboration between the civil protection institutions for risk prevention. Through the use of innovative methodologies, it developsa trans-frontier strategy in the management of natural disasters. The development of common protocols allows joint planning and implementation of harmonize actions to accelerate and facilitate.

PROJECT DEVELOPMENT OF SPRINT-3

Hazardous natural events are unfortunately becoming too frequently a “hot news” item in the media because of the extensive destruction and losses they cause. They are also coming to be associated with the bigphrase “climate change.”
Hazardous disaster events can happen anywhere in the world be it a developed or a developing country: the examples cited in this paper make it clear that the populations of all continents are vulnerable to natural disasters. However, for causes that will be discussed, disasters can have an even more dramatic impact (when talking about casualties) when they take place in poor countries with less infrastructure— transportation, electrical and water, medical facilities—to begin with. In this paper, we discuss the possible future impacts of climate change and recommend ways in which project managers can anticipate and mitigate the resulting risks.
Illustrating our paper with examples from recent natural or humanitarian emergencies on five continents, we will analyze how climate change has a relevant role in all these scenarios and how project management related to prevention protocols is a must that can no longer be postponed. We will propose specific statements and provide follow-on resources to address the impacts of climate change at project initiation to emphasize education, early warning systems, and preparedness.

Natural Hazards

Natural hazards have always been part of human life. However, in recent times, the number of people being affected by natural disasters is on the rise, with a majority of these people being vulnerable to multiple disasters as well. Given the fact that while a natural hazard such as a cyclone, a hurricane, or an earthquake cannot be avoided, measures can be adopted to mitigate the impact of the disaster, whether on human beings or on the infrastructures supporting their livelihoods.
But, what exactly is considered a natural disaster? This paper uses the natural disaster classification definitions of the EM-DAT, the world

database on disasters, maintained by the Centre for Research on the Epidemiology of Disasters (CRED), where disasters are classified as:

Hydrological – avalanches/landslides, droughts/famines, extreme temperatures, floods, forest/scrub fires, wind storms and other related disasters such as insect infestations and wave surges

Geological – earthquakes, tsunamis and volcanic eruptions

CRED data indicates a clear increase over the past two decades. The larger contributions to this increase come from weather-related disasters such as floods, wind storms, and related events. Disaster statistics show not only increasing frequency of disaster occurrence, but also impacts in larger areas. But perhaps more worrying, the greatest increase comes from small-scale disasters that when combined have major impacts on aid organization, strongly challenging their capability to respond to the populations' needs.
Therefore, it is critical to perform as much early analysis as possible so that governments and aid organizations can prepare for this trend.

The strongest population growth is in coastal areas (with greater exposure to floods, cyclones, and tidal waves) (ISDR, 2008). The International Strategy for Disaster Reduction (UNISDR) also pointed out based on CRED data that "much of the increase in the number of hazardous events reported is probably due to the significant improvements in information access and also to population growth, but the number of floods and cyclones being reported is still rising when compared to earthquakes" (ISDR, 2008).

Climate change threatens to cause the largest refugee crisis in human history. More than 200 million people, largely in Africa or Asia, might be forced to leave their homes to seek refuge in other places or countries over the course of the second half of the century, according to current climate science. But, we have already seen that several impacts and transformation are occurring at a much faster rate than envisaged by climate science, so the planning should start now, not when it might be too late for orderly and organized responses (Biermann & Boas, 2007).

Natural Disasters—Origins

When analysing natural disaster statistics, it is important to evaluate several important factors likely to increase the impacts of natural disasters, such as:

Increasing vulnerability of populations due to their location in vulnerable areas, often inhabiting cheap land that is prone to natural hazards, whetherurban or rural

Increasing deforestation and land-use change, often with severe impacts on ecosystems capability to deal with extreme events, whether floods or droughts

Diminished capacity to deal with disaster in areas that are constantly stricken and thus become increasingly vulnerable.

Recently, it has also become important to consider the impacts of the changing weather patterns. Not only an increasing occurrence of extreme weather events is likely to occur, but also, these changes are complicating the local population's ability to predict the best timings for agricultural purposes, especially in developing countries, a situation with significant impact on food security.

Envisaging an increasing need of disaster relief activities due to climate change, it is important to identify how the latter can impact human societies. “A changing climate means more work for humanitarian organizations.
Climate change is making our humanitarian work more difficult” (Red Cross/Red Crescent, 2007).

Climate Change Impacts

According to the latest Intergovernmental Panel on Climate Change (IPCC) reports, earth's climate is changing. At a global level, surface temperatures increased 0.74°C on average in the last 100 years, and the period of 1995–2006 encompasses 11 of the 12 warmest years (IPCC-WGI, 2007a).
These figures not only represent substantial increases, but also implicitly mean, by the natural processes occurring on earth, that the changes will be felt unequally in the various regions of the globe. In some of them the impacts will be dramatic, and this situation is more likely to occur in the already most vulnerable areas such as Africa andSoutheast Asia.
The IPCC AR4 reports a wide range of expected effects, among which of specific concern to this paper are:

Melting glaciers, increasing the risk of floods and reduced water supply in regions dependent on spring deglaciation

Increased frequency and intensity of heavy precipitation events, augmenting flood risk, especially in the heavily-populated mega-deltaregions in South, East, and Southeast Asia

Changed rainfall patterns (less rain in tropical and subtropical regions, and increases in temperate), with a likely detrimental impact on food security, since farmers will find difficulty in planting and harvesting their crops. Forced migrations in such situation can extend the reach of such a seriousproblem.

Droughts, heat waves and fires becoming more frequent. Drought-affected areas will likely increase in extent.

Tropical cyclone and hurricane increase in frequency and intensity, especially in the more destructive category 5 storms

Sea-level rise resulting from ocean thermal expansion and melting of Arctic, Greenland and West Antarctic ice sheets, likely to impact large cities situated near sea level, such as Los Angeles, New York, London, Mumbai, Shanghai, and Bangkok, and thousands of small settlements andsocieties, therefore impacting millions of people

Health impacts, such as increased deaths, disease and injury due to heat waves, floods, storms, fires and droughts, but also altered spatial distribution of some infectious disease vectors.

Presently there is large uncertainty about the likelihood of the possible effects, since they depend on temperature levels and other more complex factors that are currently of complex modelling and prediction, since they depend not only on greenhouse gas levels in the atmosphere but also on the concurrence of a multitude of feedback mechanisms, whose nature is not presently entirely known (IPCC-WGI, 2007b).
One of the uncertainties lies in the estimation of time when certain effects will occur, such as the melting of the Arctic ice sheets or Greenland glaciers, for example, which could cause significant sea level rise (Wikipedia, 2008a). It has been verified that the melting rate in the Arctic ice sheets is increasing at a higher rate than the one specified in the IPCC reports (Spratt, 2007). A question arises: Will sea levels rise ina few years, instead of a century from now?

But is it possible to avoid these effects? No, it is clear that even if extensive control is exercised on the anthropogenic greenhouse gas emissions, effects of past emissions will still continue to impact the carbon cycle for considerable time into the future. Therefore, the impact scenario should be seriously lookedat and planned for.

Again, citing the Red Cross/Red Crescent climate guide, “the whole field of disaster management—humanitarian action both before and after an event— may be changing rapidly.” The expected and also the unforeseen impacts of climate change may result in more complex disasters and subsequently, increasingly difficult and simultaneously occurring relief actions.

Recent Natural Disasters and Disaster Relief

In the following section, we summarize some of the most recent natural and humanitarian disasters that have hit each continent, further proof of how this phenomenon is not restricted to certain areas of the world and how it can, at any unexpected time, affect any corner of the planet.

Oceania: Cyclone and Tsunami

Two hazard occurrences will be presented to illustrate importantdifferences.

Australia—On 20 March 2006, Australia was hit by Cyclone Larry. It made landfall in the state of Queensland, south of the town of Innisfail, as category

Populations were warned and took procedures (evacuation and house preparation) to reduce personal and private risks. As a result of this preparation and other factors, no casualties were registered and the impacts were essentially roof and structural damage (about 10,000 buildings) and crop loss on the banana industry (about 80% of crops destroyed). After the hazard occurrence, several teams and resources were immediately deployed to the operations ground, with one central operations control. The recovery process was swift, and one year later the banana industry was back in business again. Both residents and responsible bodies were well prepared (Grigg, 2006).

It is important to remark that lessons learned from previous cyclones (Cyclone Althea [Townsville] in 1971 and Cyclone Tracy [Darwin] in 1974) were used to reinforce building standards in Australia to be further resilient to strong winds and construct an early cyclone warning system, both relevant factors in the preventive limitation of casualties and material damage.

Solomon Islands—On 2 April 2007, there was a magnitude 8.1 earthquake 10 km beneath the sea in the Solomon Islands, resulting in the generation of a large tsunami over the Solomon Islands, causing around 50 casualties and extensive destruction to homes, infrastructure and agricultural systems. There was no previous warning to populations, because only 20 minutes had passedbetween the detection of the earthquake and when the tsunami hit. In fact, the

tsunami was foreseen by the tsunami alert system in Australia, where authorities ordered an immediate evacuation of Pacific coast beaches (Picock, 2007). This system was, however, ineffective to reduce the vulnerability of Solomon Islanders. The limited loss of human life was due to ancestral tsunami awareness and knowledge to “run to high ground after an earthquake,” passed on to younger generations by survivors of a smaller 1952 tsunami, triggering an immediate spontaneous self-

The next weeks saw a wide range of relief agencies arrive to provide food, assistance for the injured, and emergency accommodation. But the characteristics of this archipelago and the geographic isolation of many of the affected areas resulted in a wide range of difficulties and delays in the assistance to all affected by the Tsunami. Probably acknowledging the lack of preparedness for such situations, the Prime Minister of the Solomon Islands promised to review their disaster preparedness plans (Brisbane Times, 2007).

Even though there were dramatic differences between Australia's and Solomon Islands' hazard reaction capacity due to the strength of each economy, disaster preparedness and prevention in Australia, followed by a centrally coordinated intervention, was undoubtedly a factor that accelerated the recovery from the damages. Unfortunately, the effects of the hazard in the Solomon Islands are still to be seen (ReliefWeb, 2008) on the ground.

Europe: Heat waves

The summer of 2003 witnessed a severe heat wave, where normal summer temperatures were found 20% to 30% higher than the seasonal average in central and western Europe. This extreme weather conditions took temperatures to maximums: UK with 38.1°C, France maintaining temperatures around 40 °C for almost two weeks, and in Switzerland, a record temperature of 41.5 °C. The result from this hazard was an estimated excess of 30,000 casualties. In France alone, 14,802 people reportedly died as a direct result of this event, mainly from dehydration, hypothermia, and heat stroke. The majority of these casualties were elderly.

Several factors may help explain this high death toll. Because France does not usually have very hot summers, most people didn't know how to react. Furthermore, most homes and retirement homes are not equipped with air conditioning. Heat waves were not considered a likelyhazard in France, so no hazard preparedness plans were in place for

such a situation. Lastly, health assistance capacity was diminished, because large numbers of doctors and emergency relief personnel were on vacation (this was in the month of August), leaving emergency levelsat low levels.

Several other failures contributed to the development of the situation.

Heat wave dangers result from the intricate association of natural and social factors: unusually high temperatures, as well as socio-economic vulnerability, along with social attenuation of hazards. In addition to age and gender, combinatorial factors included pre-existing disease, medication, urban residence, isolation, poverty, and, probably, air pollution (Poumadere, Mays, Le Mer, & Blong, 2005). The occurrence of this hazard gave evidence of the need to deploy a warning system and an emergency response plan to cope with such events (Grynszpan, 2003), as well as specifically addressing social factors, such as the living conditions of the elderly and the numbers of elderly, mentally ill, and other vulnerable people (WHO, 2003).

Contrasting with previous Australia case, France's economic strength did not mean it had a capacity to face and react to an extreme hazard. Lack of disaster preparedness (including an early warning system) andcentralized coordination were key to the high impacts verified.

America: Hurricane Katrina

Hurricane Katrina hit the Bahamas, Cuba, and the Gulf Coast of the United States during the last week of August, 2005, and ultimately caused the deaths of at least 1,836 people and estimated monetary costs of over 80 billion US dollars (Wikipedia, 2008b). Particularly hard-hit was the city of New Orleans, where the levee system maintained by the Army Corps of Engineers failed and the historic city of 450,000 was devastated by flooding of more than 80% of its area. It is estimated that after the hurricane, the city's population fell to 36% of its former level, as individuals voluntarily left or were evacuated. A year after the disaster, the city was still at less than half its former population (Infoplease, 2008).

The American Red Cross partnered with the Southern Baptist Convention to provide hot meals, emergency shelter, financial support, and health services to the many Hurricane Katrina survivors. These relief efforts continue more than two years after the event (American Red Cross, 2008). The Federal Emergency Management Agency (FEMA) has established the Gulf Coast Recovery Office and maintains

online status of all the rebuilding activities for public awareness (FEMA, 2008a). As of January 2008, there were tens of thousands of projects, including roads, detention centres, government and court administration buildings, hospitals and health care facilities, police and fire facilities, schools, and utilities and wastewater treatment plants. The City of New Orleans has set up a “One New Orleans Recovery and Resources Page,” yet key information on the Recovery Matrix, such as Orleans Parish New Business Licenses, has not been updated since September,2006 (City of New Orleans, 2008).

The National Response Framework was released by FEMA on January 22, 2008, as an effort to improve disaster response across all layers of government. The plan “focuses on preparedness and encourages a higher level of readiness across all jurisdictions” (FEMA, 2008c). However, there is little indication that the City of New Orleans, the State of Louisiana, or the federal government have taken specific steps to mitigate the continuing risk of rising sea levels and hurricanes with comprehensive efforts to protect the Louisiana Delta wetlands from further loss.

Asia: Boxing Day 2004 Tsunami

The 26 December 2004 tsunami generated by an underwater earthquake of magnitude about 9.2

on the Richter scale off the Indonesian coast impacted a dozen countries in the Indian Ocean region, killing some 240,000 people (UN-OCHA, 2008). The affected countries suffered varied degrees of damage and the recovery process has also been quite different in the various countries. The worst affected were Indonesia, Sri Lanka, and India in terms of losses of life, homes, and livelihoods. In India, 10,749 lives were reported lost, of which 7,983 were from the mainland state of Tamil Nadu (GOI, 2005). The impact of the tsunami was very high for a number of reasons:

No precedence—while tsunamis are known phenomena in the Pacific Ocean region, there has not been such a major event in recent memory.

Influx of seawater inland is well known in this region,

but always accompanied by bad weather; 26 December 2004 was a clear,sunny day.

Retreat of water from the shore was also a strange phenomenon that brought people flocking to the shore, and they were engulfed when thetsunami struck.

PROJECT DEVELOPMENT OF SPRINT-4

Introductio

Hazardous natural events are unfortunately becoming too frequently a “hot news” item in the media because of the extensive destruction and losses they cause. They are also coming to be associated with the bigphrase “climate change.”
Hazardous disaster events can happen anywhere in the world be it a developed or a developing country: the examples cited in this paper make it clear that the populations of all continents are vulnerable to natural disasters. However, for causes that will be discussed, disasters can have an even more dramatic impact (when talking about casualties)when they take place in poor countries with less infrastructure— transportation, electrical and water, medical facilities—to begin with. In this paper, we discuss the possible future impacts of climate change and recommend ways in which project managers can anticipate and mitigate the resulting risks. Illustrating our paper with examples from recent natural or humanitarianemergencies on five continents, we will analyze how climate change has a relevant role in all these scenarios and how project management related to prevention protocols is a must that can no longer be postponed. We will propose specific statements and provide follow-on resources to address the impacts of climate change at project initiation to emphasize education, early warning systems,

and preparedness.

Natural Hazards

Natural hazards have always been part of human life. However, in recent times, the number of people being affected by natural disasters ison the rise, with a majority of these people being vulnerable to multiple disasters as well. Given the fact that while a natural hazard such as a cyclone, a hurricane, or an earthquake cannot be avoided, measures can be adopted to mitigate the impact of the disaster, whether on human beings or on the infrastructures supporting their livelihoods.

But, what exactly is considered a natural disaster? This paper uses the naturaldisaster classification definitions of the EM-DAT, the world database on disasters, maintained by the Centre for Research on the Epidemiology of Disasters (CRED), where disasters are classified as:

Hydrological – avalanches/landslides, droughts/famines, extreme temperatures, floods, forest/scrub fires, wind storms and other relateddisasters such as insect infestations and wave surges

Geological – earthquakes, tsunamis and volcanic eruptions

CRED data indicates a clear increase over the past two decades. The larger contributions to this increase come from weather-related disasters such as floods, wind storms, and related events. Disaster statistics show not only increasing frequency of disaster occurrence, but also impacts in larger areas.But perhaps more worrying, the greatest increase comes from small-scale disasters that when combined have major impacts on aid organization, strongly challenging their capability to respond to the populations' needs.
Therefore, it is critical to perform as much early analysis as possible so thatgovernments and aid organizations can prepare for this trend.

The strongest population growth is in coastal areas (with greater exposure to floods, cyclones, and tidal waves) (ISDR, 2008). The International Strategy for Disaster Reduction (UNISDR) also pointed outbased on CRED data that “much of the increase in the number of hazardous events reported is probably due to the significant improvements in information access and also to population growth, but the number of floods and cyclones being reported is still rising when compared to earthquakes” (ISDR, 2008).
Climate change threatens to cause the largest refugee crisis in human history. More than 200

million people, largely in Africa or Asia, might beforced to leave their homes to seek refuge in other places or countries over the course of the second half of the century, according to current climate science. But, we have already seen that several impacts and transformation are occurring at a much faster rate than envisaged by climate science, so the planning should start now, not when it might betoo late for orderly and organized responses (Biermann & Boas, 2007).

Natural Disasters—Origins

When analysing natural disaster statistics, it is important to evaluate severalimportant factors likely to increase the impacts of natural disasters, such as:

Increasing vulnerability of populations due to their location in vulnerable areas, often inhabiting cheap land that is prone to natural hazards, whetherurban or rural

Increasing deforestation and land-use change, often with severe impactson ecosystems capability to deal with extreme events, whether floods or droughts

Diminished capacity to deal with disaster in areas that are constantlystricken and thus become increasingly vulnerable.

Recently, it has also become important to consider the impacts of the changing weather patterns. Not only an increasing occurrence of extreme weather events is likely to occur, but also, these changes are complicating the local population's ability to predict the best timings for agricultural purposes, especially in developing countries, a situation withsignificant impact on food security.

Envisaging an increasing need of disaster relief activities due to climate change, it is important to identify how the latter can impact human societies.“A changing climate means more work for humanitarian organizations.
Climate change is making our humanitarian work more difficult” (RedCross/Red Crescent, 2007).

Climate Change Impacts

According to the latest Intergovernmental Panel on Climate Change (IPCC) reports, earth's climate is changing. At a global level, surface temperatures increased 0.74°C on average in the last 100 years, andthe period of 1995–2006 encompasses 11 of the 12 warmest years (IPCC-WGI, 2007a).

These figures not only represent substantial increases, but also implicitly mean, by the natural processes occurring on earth, that the changes will be felt unequally in the various regions of the globe. In some of them the impacts will be dramatic, and this situation is more likely to occur in the already most vulnerable areas such as Africa andSoutheast Asia.

The IPCC AR4 reports a wide range of expected effects, among which ofspecific concern to this paper are:

Melting glaciers, increasing the risk of floods and reduced water supply inregions dependent on spring deglaciation

Increased frequency and intensity of heavy precipitation events, augmenting flood risk, especially in the heavily-populated mega-deltaregions in South, East, and Southeast Asia

Changed rainfall patterns (less rain in tropical and subtropical regions, andincreases in temperate), with a likely detrimental impact on food security, since farmers will find difficulty in planting and harvesting their crops. Forced migrations in such situation can extend the reach of such a seriousproblem.

Droughts, heat waves and fires becoming more frequent. Drought-affectedareas will likely increase in extent.

Tropical cyclone and hurricane increase in frequency and intensity,especially in the more destructive category 5 storms

Sea-level rise resulting from ocean thermal expansion and melting of Arctic, Greenland and West Antarctic ice sheets, likely to impact large cities situated near sea level, such as Los Angeles, New York, London, Mumbai, Shanghai, and Bangkok, and thousands of small settlements andsocieties, therefore impacting millions of people

Health impacts, such as increased deaths, disease and injury due to heatwaves, floods, storms, fires and droughts, but also altered spatial distribution of some infectious disease vectors.

Presently there is large uncertainty about the likelihood of the possible effects,since they depend on temperature levels and other more complex factors thatare currently of complex modelling and prediction, since they depend not onlyon greenhouse gas levels in the atmosphere but also on the concurrence of amultitude of feedback mechanisms, whose nature is not presently entirely known (IPCC-WGI, 2007b).

One of the uncertainties lies in the estimation of time when certain effects will occur, such as the melting of the Arctic ice sheets or Greenland glaciers, for example, which could cause significant sea levelrise (Wikipedia, 2008a). It has been verified that the melting rate in the Arctic ice sheets is increasing at a higher rate than the one specified in the IPCC reports (Spratt, 2007). A question arises: Will sea levels rise ina few years, instead of a century from now?

But is it possible to avoid these effects? No, it is clear that even if extensive control is exercised on the anthropogenic greenhouse gas emissions, effects of past emissions will still continue to impact the carbon cycle for considerabletime into the future. Therefore, the impact scenario should be seriously lookedat and planned for.

Again, citing the Red Cross/Red Crescent climate guide, “the whole field of disaster management—humanitarian action both before and after an event—

may be changing rapidly.” The expected and also the unforeseen impacts ofclimate change may result in more complex disasters and subsequently, increasingly difficult and simultaneously occurring relief actions.

Recent Natural Disasters and Disaster Relief

In the following section, we summarize some of the most recent natural and humanitarian disasters that have hit each continent, further proof of how this phenomenon is not restricted to certain areas of the world and how it can, at any unexpected time, affect any corner of the planet.

Oceania: Cyclone and Tsunami

Two hazard occurrences will be presented to illustrate importantdifferences.

Australia—On 20 March 2006, Australia was hit by Cyclone Larry. It made landfall in the state of Queensland, south of the town of Innisfail, as category

Populations were warned and took procedures (evacuation and house preparation) to reduce personal and private risks. As a result of this preparation and other factors, no casualties were registered and the impacts were essentially roof and structural damage (about 10,000 buildings) and croploss on the banana industry (about 80% of crops destroyed). After the hazard occurrence, several teams and resources were immediately deployed to the operations ground, with one central operations control. The recovery process was swift, and one year later the banana industry was back in business again.Both residents and responsible bodies were well prepared (Grigg, 2006).

It is important to remark that lessons learned from previous cyclones (Cyclone Althea [Townsville] in 1971 and Cyclone Tracy [Darwin] in 1974) were used to reinforce building standards in Australia to be further resilient to strong winds and construct an early cyclone warningsystem, both relevant factors in the preventive limitation of casualties and material damage.

Solomon Islands—On 2 April 2007, there was a magnitude 8.1 earthquake 10 km beneath the sea in the Solomon Islands, resulting in the generation of a large tsunami over the Solomon Islands, causing around 50 casualties and extensive destruction to homes, infrastructureand agricultural systems. There was no previous warning to populations, because only 20 minutes had passed between the detection of the earthquake and when the tsunami hit. In fact,

tsunami was foreseen by the tsunami alert system in Australia, whereauthorities ordered an immediate evacuation of Pacific coast beaches(Picock, 2007). This system was, however, ineffective to reduce the vulnerability of Solomon Islanders. The limited loss of human life was due to ancestral tsunami awareness and knowledge to “run to high ground after an earthquake,” passed on to younger generations by survivors of a smaller 1952 tsunami, triggering an immediate spontaneous self-evacuation (Fritz, 2008).
The next weeks saw a wide range of relief agencies arrive to provide food, assistance for the injured, and emergency accommodation. But the characteristics of this archipelago and the geographic isolation of many of the affected areas resulted in a wide range of difficulties and delays in the assistance to all affected by the Tsunami. Probably acknowledging the lack of preparedness for such situations, the PrimeMinister of the Solomon Islands promised to review their disaster preparedness plans (Brisbane Times, 2007).

Even though there were dramatic differences between Australia's andSolomon Islands' hazard reaction capacity due to the strength of eacheconomy, disaster preparedness and prevention in Australia, followedby a centrally coordinated intervention, was undoubtedly a factor that accelerated the recovery from the damages. Unfortunately, the effectsof the hazard in the Solomon Islands are still to be seen (ReliefWeb, 2008) on the ground.

Europe: Heat waves

The summer of 2003 witnessed a severe heat wave, where normal summer temperatures were found 20% to 30% higher than the seasonalaverage in central and western Europe. This extreme weather conditions took temperatures to maximums: UK with 38.1°C, France maintaining temperatures around 40 °C for almost two weeks, and in Switzerland, a record temperature of 41.5 °C. The result from this hazard was an estimated excess of 30,000 casualties. In France alone, 14,802 people reportedly died as a direct result of this event, mainly from dehydration, hypothermia, and heat stroke. The majority of these casualties were elderly.

Several factors may help explain this high death toll. Because France does not usually have very hot summers, most people didn't know how to react. Furthermore, most homes and retirement homes are not equipped with air conditioning. Heat waves were not considered a likelyhazard in France, so no hazard preparedness plans were in place for such a situation. Lastly, health assistance capacity was diminished, because large numbers of doctors and emergency relief personnel wereon vacation (this was in the month of August), leaving emergency levelsat low levels.

Several other failures contributed to the development of the situation.

Heat wave dangers result from the intricate association of natural and social factors: unusually high temperatures, as well as socio-economic vulnerability, along with social attenuation of hazards. In addition to age and gender, combinatorial factors included pre-existing disease, medication, urban residence, isolation, poverty, and, probably, air pollution (Poumadere, Mays, Le Mer, & Blong, 2005). The occurrence ofthis hazard gave evidence of the need to deploy a warning system and an emergency response plan to cope with such events (Grynszpan, 2003), as well as specifically addressing social factors, such as the living conditions of the elderly and the numbers of elderly, mentally ill, and other vulnerable people (WHO, 2003).

Contrasting with previous Australia case, France's economic strength did not mean it had a capacity to face and react to an extreme hazard. Lack of disaster preparedness (including an early warning system) andcentralized coordination were key to the high impacts verified.

Global Risk Analysis

Relevant data for risk analysis and mitigation exists at many levels; however, the data is often in disparate repositories at differing levels ofaccuracy, thus difficult to use in hazard analysis. Tapscott and Williamsnoted that “[U.S.] Government agencies are one of the largest sources of public data, and yet most of it goes completely unutilized, when it could provide a platform for countless new public services” (2007, p. 200). Upson (2007) noted that “a truism holds that you spend 80 percent of the time hunting down usable data” to support analysis and modelling efforts.

Up-to-date population data would be particularly valuable in hazard analysis and risk mitigation. The U.S. National Academies recently published a valuable report, Tools and Methods for Estimating Populations at Risk from Natural Disasters and Complex Humanitarian Crises (The National Academies, 2007), which noted that every country should be encouraged and supported in their efforts to maintain nationalcensus data and that “[t]he work of national statistical offices, which collect and analyse population data, should also be better integrated with relief organizations who are using the data ‘on the ground.’ ”

Efforts are underway to create a comprehensive set of spatial data: theGlobal Earth Observation System of Systems (GEOSS). This effort, initiated by IEEE, is intended to support modelling with “relevant sources of Earth-based information…logically connected and recordedin well-documented formats” (Upson, 2007).

Conclusions

Project managers are ideally suited to conduct analysis of natural hazards in their own project planning and to support efforts to expandrisk analysis and mitigation at the national and international levels.

This effort would fall into the category of “environmental stewardship,” called for out by Jeffrey Sachs in his classic volume, The End of Poverty. Sachs noted that “even though the local effects of global climate change are extremely hard to forecast, we can be sure that many of the world's poorest places are at risk of being overwhelmed by . A key intervention recommended by Sachs is “climate forecasting and adjustment: improved measurement of seasonal, interannual, and long-term climate changes, with a view toward prediction as well as adjustment to climate changes” (Sachs, 2005, p. 283). The adjustment to climate change can be done through risk mitigation at the start of future projects.

Given the future increasing impacts of climate change on vulnerable populations worldwide, it is imperative that project managers do their best individually and collectively to make a difference. By promoting riskanalysis and improved communications in particular, the project management community can play a key role in helping to anticipate andmitigate future problems. One existing forum is PMI's International Development Specific Interest Group (IDSIG). Another is the PMI Education Foundation, which seeks to share project management best practices worldwide.