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Natural disasters and environment

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Abstract
An environmental disaster or ecological disaster is defined as a catastrophic event regarding the natural environment that is due to human activity. This point distinguishes environmental disasters from other disturbances such as natural disasters and intentional acts of war such as nuclear bombings. Environmental disasters show how the impact of humans' alteration of the land has led to widespread and/or long-lasting consequences. These disasters have included deaths of wildlife, humans and plants, or severe disruption of human life or health, possibly requiring migration. People cannot find absolutely natural environments on Earth, and naturalness usually varies in a continuum, from 100% natural in one extreme to 0% natural in the other. The massive environmental changes of humanity in the Anthropocene have fundamentally effected all natural environments: including from climate change, biodiversity loss and pollution from plastic and other chemicals in the air and water. More precisely, we can consider the different aspects or components of an environment, and see that their degree of naturalness is not uniform. If, for instance, in an agricultural field, the mineralogic composition and the structure of its soil are similar to those of an undisturbed forest soil, but the structure is quite different. The natural environment or natural world encompasses all living and non-living things occurring naturally, meaning in this case not artificial. The term is most often applied to the Earth or some parts of Earth. This environment encompasses the interaction of all living species, climate, weather and natural resources that affect human survival and economic activity.

Keywords: Ecological, flood, mudslide, earthquake, avalanche, drought, disasters, anthropogenic, natural hazards, hydrological, climatological, meteorological, biological, tornadoes, hurricanes, landscape environment, natural environment, interministerial

Introduction
An environmental disaster or ecological disaster is defined as a catastrophic event regarding the natural environment that is due to human activity. This point distinguishes environmental disasters from other disturbances such as natural disasters and intentional acts of war such as nuclear bombings. Environmental disasters show how the impact of humans' alteration of the land has led to widespread and/or long-lasting consequences. These disasters have included deaths of wildlife, humans and plants, or severe disruption of human life or health, possibly requiring migration. The natural environment or natural world encompasses all living and non-living things occurring naturally, meaning in this case not artificial. The term is most often applied to the Earth or some parts of Earth. This environment encompasses the interaction of all living species, climate, weather and natural resources that affect human survival and economic activity. The concept of the *natural environment* can be distinguished as components:

- Complete ecological units that function as natural systems without massive civilized human intervention, including all vegetation, microorganisms, soil, rocks, atmosphere, and natural phenomena that occur within their boundaries and their nature.
- Universal natural resources and physical phenomena that lack clear-cut boundaries, such as air, water, and climate, as well as energy, radiation, electric charge, and magnetism, not originating from civilized human actions.

In contrast to the natural environment is the built environment. Built environments are where humans have fundamentally transformed landscapes such as urban settings and agricultural land conversion, the natural environment is greatly changed into a simplified human environment. Even acts which seem less extreme, such as building a mud hut or a photovoltaic system in the desert, the modified environment becomes an artificial one.

Though many animals build things to provide a better environment for themselves, they are not human, hence beaver dams, and the works of mound-building termites, are thought of as natural.

People cannot find *absolutely natural* environments on Earth, and naturalness usually varies in a continuum, from 100% natural in one extreme to 0% natural in the other. The massive environmental changes of humanity in the Anthropocene have fundamentally effected all natural environments: including from climate change, biodiversity loss and pollution from plastic and other chemicals in the air and water. More precisely, we can consider the different aspects or components of an environment, and see that their degree of naturalness is not uniform. If, for instance, in an agricultural field, the mineralogic composition and the structure of its soil are similar to those of an undisturbed forest soil, but the structure is quite different.

Definition

A natural disaster is characterized by the abnormal intensity of a natural agent (flood, mudslide, earthquake, avalanche, drought) when the usual measures to be taken to prevent this damage were not able to prevent their emergence or were not able to be taken. An interministerial order notices the state of natural disaster. He allows the compensation of the damage directly caused to the insured goods, set up by the 13 July 1982 law, relative to the compensation of the victims of natural disasters. A natural disaster is recorded only if it causes damage not covered by usual insurance policies.

Forest fires and damage related to wind are not the subject of natural disaster rulings because they are insurable in conformance with the basic guarantee. In that case, no order of natural disaster is taken even if goods were destroyed.

a sudden and terrible event in nature (such as a hurricane, tornado, or flood) that usually results in serious damage and many deaths The earthquake was one of the worst natural disasters of this century.

What is disaster?

Disasters are serious disruptions to the functioning of a community that exceed its capacity to cope using its own resources. Disasters can be caused by natural, man-made and technological hazards, as well as various factors that influence the exposure and vulnerability of a community.

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.

What are hazards?

Natural hazards are naturally occurring physical phenomena. They can be

- Geophysical: a hazard originating from solid earth (such as earthquakes, landslides and volcanic activity)
- Hydrological: caused by the occurrence, movement and distribution of water on earth (such as floods and avalanches)
- Climatological: relating to the climate (such as droughts and wildfires)
- Meteorological: relating to weather conditions (such as cyclones and storms)
- Biological: caused by exposure to living organisms and their toxic substances or diseases they may carry (such as disease epidemics and insect/animal plagues)

Man-made and technological hazards are events that are caused by humans and occur in or close to human settlements. They include complex emergencies, conflicts, industrial accidents, transport accidents, environmental degradation and pollution.

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 wide range 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 Disasters
Sinkholes	Limnic Eruption	Cyclonic	AIDS
Landslides	Flood	Storm	Tuberculosis
Volcanic Eruption	Tsunami	Blizzard	Hepatitis A
Earthquakes		Cold waves	Hepatitis B
Avalanche		Drought	Hepatitis C
		Hailstorms	
		Tornadoes	

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

Tornadoes

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 seek shelter. 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.

Hurricanes

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 suffering in 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 happening are 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 a variety 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 and friends on a regular basis.

Earthquake

An earthquake occurs when the Earth's plates shift, causing a violent shaking of the ground that can 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. Here are some symptoms of emotional distress caused by earthquakes:

Being easily startled, having trouble sleeping or sleeping too much, and having thoughts and memories ofthe 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

Environmental impacts of natural disasters

It is recognized that many significant nonmarket effects result from natural disasters, including environmental impacts. Though our committee had a keen interest in these topics, it became clear that these impacts—though often significant—did not fit easily with this study's main report and conclusions for the following reasons:

1. not all disasters result in significant ecosystem impacts (e.g., many earthquakes have but minor impacts on ecosystems);
2. some extreme events have positive impacts on ecosystems (e.g., floods can help rejuvenate floodplain vegetation and are important drivers of many ecological processes in floodplains); and,
3. these impacts are mainly nonmarket and are exceptionally difficult to quantify and/or monetize. Though there are emerging efforts in quantifying and monetizing ecosystem services (e.g., Costanza, 1997), they are in their infancy and are not yet widely accepted.

Nonetheless, the magnitude of the environmental impacts of many disasters compelled the committee to discuss them and we do so in this Appendix. Though no specific recommendations regarding how environmental costs should be incorporated in loss estimates we provide here, we encourage policymakers in the relevant executive branch agencies to devote more attention and perhaps research to these issues. It is important in assessing environmental impacts to distinguish between impacts of disasters on the *natural environment* from those on the human-made *landscape environment.* As mentioned, events that

societies label as natural "disasters" may also have beneficial ecological consequences. However, these benefits tend to only manifest themselves months or years after an extreme event (e.g., rejuvenation of a coniferous forest months and/or years after fires), or are often not readily apparent (e.g., recharging of groundwater stocks after a flood). These benefits to ecological systems are of course typically overshadowed by immediate, negative impacts on societies and structures; hence, the use of the term natural "disasters."

Ecosystems for resilience in the face of disasters and climate change

The increasing incidence and severity of disasters such as hurricanes, floods and landslides are leaving more people vulnerable each year, particularly the poor and marginalized.

Climate change is increasing the frequency and intensity of these climate-related hazards, leading to a higher number of deaths and injuries as well as increased property and economic losses. Human vulnerability to natural hazards is further exacerbated by ongoing environmental degradation, high population densities in exposed areas, increased frequency of extreme weather events and lacking or ineffective government policies.

Environmental degradation reduces the capacity of these ecosystems to provide important services to communities like food, firewood, medicines and protection from natural hazards. It also greatly reduces a landscape's ability to sequester carbon - a crucial element in climate change mitigation.

On the other hand, healthy ecosystems has important roles to play in reducing the risks of disasters through multiple ways. Healthy ecosystems such as wetlands, forests and coastal areas, including mangroves and sand dunes can not only reduce vulnerability to hazards by supporting livelihoods but also act as physical barriers that reduce the impact of hazard events.

The most vulnerable are often those who are most dependent on natural resources for their livelihoods. Ecosystem restoration and sustainable management of natural resources can therefore play a critical role in people's ability to prevent, cope with and recover from disasters.

Social vulnerability and environmental disaster

According to author Daniel Murphy, different groups of people are able to adapt to environmental disasters differently due to social factors such as age, race, class, gender, and nationality. Murphy argues that while developed countries with access to resources that can help mitigate environmental disasters are often the countries that contribute the most to factors that can increase the risk of said disasters, developing countries experience the impacts of environmental disasters more intensely than their wealthier counterparts. It is often the case that the populations that do not contribute to climate change are not only in geographic location that experience more environmental disasters, but also have fewer resources to mitigate the impact of the disasters. For example, when Hurricane Katrina hit Louisiana in 2005, many scientists argued that climate change had increased the severity of the hurricane. Although the majority of the U.S. emissions that can contribute to climate change come from industry and transport, the people who were hardest-hit by Katrina were not the heads of large companies within the country. Rather, the poor black communities within Louisiana were the most devastated by the hurricane, despite not contributing as heavily to factors like climate change that likely increased the severity of Hurricane Katrina.

Mitigation effort

There have been many attempts throughout recent years to mitigate the impact of environmental disasters. Environmental disaster is caused by human activity, so many believe that such disasters can be prevented or have their consequences curbed by human activity as well. Efforts to attempt mitigation are evident in cities such as Miami, Florida, in which houses along the coast are built a few feet off of the ground in order to decrease the damage caused by rising tides due to rising sea-levels. Although mitigation efforts such as those found in Miami might be effective in the short-term, many environmental groups are concerned with whether or not mitigation provides long-term solutions to the consequences of environmental disaster.

Environmental disasters

Top 10 of anthropogenic and natural environmental disasters

Anthropogenic environmental disasters

1. Bhopal: the Union Carbide gas leak
2. Chernobyl: Russian nuclear power plant explosion
3. Seveso: Italian dioxin crisis
4. The 1952 London smog disaster
5. Major oil spills of the 20th and 21st century
6. The Love Canal chemical waste dump
7. The Baia Mare cyanide spill
8. The European BSE crisis
9. Spanish waste water spill
10. The Three Mile Island near nuclear disaster

1. Bhopal: The union carbide gas leak

December 3, 1984 has become a memorable day for the city of Bhopal in Madya Pradesh County, India. Shortly after midnight, a poisonous gas cloud escaped from the Union Carbide India Limited (UCIL) pesticide factory. The cloud contained 15 metric tons of methyl isocyanate (MIC), covering an area of more than 30 square miles. The gas leak killed at least 4.000 local residents instantly and caused health problems such as oedema for at least 50.000 to perhaps 500.000 people. These health problems killed around 15.000 more victims in the years that followed. Approximately 100.000 people still suffer from chronic disease consequential to gas exposure, today. Research conducted by the BBC in 2004 pointed out that this pollution still causes people to fall ill, and ten more die every year. This event is now known as the worst industrial environmental disaster to ever have occurred.

The cause of the accident has been researched after the disaster. Apparently water ended up in MIC storage tanks, causing an exothermal reaction that released an amount of poisonous gas large enough to open the safety valves. Normally scrubbers would intercept escaping gas, but these were temporarily out of order for repair. Research showed that factory personnel neglected a number of safety procedures. There were no valves to prevent water from entering the storage tanks. The cooling installation of the

tanks and the flaring installation that might have flared the gas that was released were out of order. Safety was very low in this factory of Union Carbide, compared to its other locations. The safety procedures were neglected because of budget cuts.

Union Carbide was accused of deliberate evasion of regular safety procedures. During lawsuits where victims demanded compensation, documents were revealed which proved that Union Carbide regularly used untested technology in the Bhopal factory. When the gas leak occurred doctors were not informed of the nature of the gas. This caused the correct treatment and emergency measure to be held off.

The manager of Union Carbide, Warren Anderson, was accused of culpable homicide. However, he did not occur in court and both the Indian and American government did not take adequate measures to make sure this man was tried. This led to a series of protests organized by environmental organizations, such as Greenpeace.

Union Carbide denied responsibility for the accident on their website, stating that: "The Bhopal plant was owned and operated by Union Carbide India, Limited (UCIL), an Indian company in which Union Carbide Corporation held just over half the stock. The other stockholders included Indian financial institutions and thousands of private investors in India. The plant was designed, built, and managed by UCIL using Indian consultants and workers."

About the cause of the accident, they claimed that: "A thorough investigation was conducted by the engineering consulting firm Arthur D. Little. Its conclusion: the gas leak could only have been caused by deliberate sabotage. Someone purposely put water in the gas storage tank, causing a massive chemical reaction. Process safety systems had been put in place that would have kept the water from entering into the tank by accident."

After a long procedure in February 1989 eventually a settlement was achieved. Union Carbide promised to pay 470 million dollars compensation. Only a very small part of this compensation was paid to survivors of the environmental disaster. Union Carbide states on its website that it paid the full settlement to the Indian government within 10 days time. In 2004 the Supreme Court forced the Indian government to pay the remaining 330 million dollars compensation to the victims and their familes.

Union Carbide sold the Indian factory to a battery producer. In 2001 Dow Chemical Company took control of Union Carbide. These take-overs led to a discussion on responsibility for cleaning up the tons of poisonous waste that are still present in the environment consequential to the 1984 disaster. Environmental activists are trying to convince Dow Chemical Company to clean up this potential minefield of toxic chemicals. These could cause nervous system failure, liver and kidney disease and possibly cancer for many years to come.

Today, the location is still polluted with thousands of tons of toxic chemicals, such as hexachlorobenzene and mercury. These chemicals are stored in open barrels. Rainfall causes rinsing out of pollution to local drinking water sources. According to BBC research, some wells even contain up to 500 times the legal limit of these toxins. Local residents still suffer from a number of diseases, which appear to be very uncommon among people that do not live in the disaster area.

2. Chernobyl: Russian nuclear power plant explosion

On April 26, 1986 tests were conducted in nuclear reactor 4 of the Chernobyl nuclear power plant in Ukraine, located 80 miles from Kiev. These tests required part of the security system to be shut down. Errors in the reactor design and errors in judgment of the personnel of the power plant caused cooling water to start boiling. This caused reactor stress, resulting in energy production increases to ten times the normal level. Temperatures reached more than 2000 °C, causing fuel rod melting and further cooling water boiling.

Extreme pressures in cooling water pipes resulted in cracks, which caused steam to escape. At 1:23h in the middle of the night the escaped steam caused an explosion slamming off the roof of the building, starting a major fire and simultaneously forming an atmospheric cloud containing approximately 185 to 250 million curies of radioactive material.

Fire and explosion instantly killed 31 people. Two days after the explosion, the Swedish national radio reported that 10.000 times the normal amount of cesium-137 existed in the atmosphere, prompting Moscow to officially respond. The following day over 135.000 people were evacuated from within a 30 km radius of the accident. This area was labelled the 'special zone'. The evacuation of the special zone was permanent, as the high levels of radioactivity have been predicted to exist for several centuries.

The radioactive cloud was blown north and northwest by wind, causing the first mention of the accident to be after radioactivity measurements in Sweden. The cloud covered a large area in Europe. On May 2, the cloud even reached the Netherlands, causing fresh fruit and vegetable consumption to be prohibited.

There are many estimates concerning the number of victims that suffer from symptoms induced by radiation. Reliable data is still lacking. The World Health Organization (WHO) stated that approximately 800.000 people have worked on fire extinguishing, restoring the reactor and cleaning up pollution in the first year after the accident. These people only remained in the area for short periods of time to prevent health problems. Ukrainian government figures show that more than 8.000 Ukrainians have died as a result of exposure to radiation during the first cleanup operation. It is stated that the eventual death toll resulting from the nuclear explosion ranges from 30 to 300.000 and many unofficial sources put the toll over 400.000.

The people that have lived in the Chernobyl area during the accident suffer from various health problems. Immediately following the accident, hundreds of people were diagnosed with radiation sickness. Particularly in Belarus, there has been a dramatic increase in the number of thyroid cancers (2.400%) and leukaemia (100%).Children of Chernobyl victims suffer from birth defects (250% increase), causing cancer and heart diseases. Approximately 64% of all Ukrainian children under 15 suffering from cancer lived in the most contaminated areas. Genetic defects often result in mutations causing missing limbs (see picture).

The extraordinary increase in the number of these illnesses can be associated with the exposure of the population to the aggressive radioactive particles released by the Chernobyl explosion. Four dangerous substances were released, which are not identified as such by our bodies.

- Plutonium is recognized as iron by the body and distributed by the blood system. It causes cancers and blood disorders. It has a half-life of 24.400 years and will be present in a 30 km radius around the Chernobyl site for many centuries to come
- Cesium 137 is mistaken for potassium and in absorbed by the muscles

- Iodine 131 is not recognized as a radioactive substance and is therefore absorbed by the thyroid gland. It causes thyroid cancer, particularly in children between 0 and 18 years old. An operation can save the children, but a scar known as the 'Belarussian Necklace' marks them as Chernobyl victims forever
- Strontium 90 is recognized by the body as calcium and causes leukaemia upon distribution throughout the bone structure

Governments in the region estimate that up to seven million people were affected by the accident. Four years after the accident, 627.000 Soviets were already under permanent observation for symptoms and effects of radiation poisoning. The number of individuals that will ultimately be affected by the Chernobyl disaster has been estimated as high as 11 times that of the cancer deaths expected from the combined 1945 bombings of Hiroshima and Nagasaki. Today it is believed that over 4 million people in the Ukraine, Belarus and western Russia still live on contaminated ground.

All Chernobyl-related health effects and the fear of death from radiation have resulted in mental defects in many children. Suicide rates have increased 1.000% in the area.

After the explosion reactor 4 was wrapped in a concrete sarcophagus (see picture) in November 1986 to protect the area. After some time the other three reactors where running again. In 1989 the construction of a 5th and 6th reactor was abandoned. There was some discussion going on about the safety of the sarcophagus of reactor 4. On the long run this would not be a very solid construction and according to many it must be replaced. We now know that this replacement must be carried out soon, because the reactor has begun to leak radiation. Holes and fissures in the structure now cover 1.000 square metres. These cracks and holes are futher exacerbated by the intense heat inside the reactor, which is still over 200 degrees Celsius.

The replacement of the sarcophagus is a very costly operation and is therefore still under discussion. It is also very uncertain if there is even a construction method that would guarantee permanent protection from the large bulk of radiation still present in the remains of reactor 4.

After the Chernobyl disaster international organizations pressured the Ukrainian government to close the remaining reactors. This was disadvantageous for the country, because it derived 5% of its power supply from the power plant. Eventually, it was decided that the power plant would be closed in winter of the year 2000. The Ukrainian government tried to obtain a postponement, but the reactor was nevertheless closed in December 2000.

Dangerous chemicals emitted by the nuclear power plant after the explosion continue to spread by bush fires and weather conditions, re-contaminating soil, air and water. New radiation hot spots are still being discovered today in Belarus and Ukraine and evacuations will need to continue well into the 21st century. Plans have now been made to build a 20.000 ton steel shell to replace the failed sarcophagus around reactor 4. If construction is successful, this will be ready by 2007.

3. Seveso: Italian dioxin crisis

On midday of July 10, 1976 an explosion occurred in a TCP (2,4,5-trichlorophenol) reactor in the ICMESA chemical company in Meda, Italy. A toxic cloud escaped into the atmosphere containing high concentrations of TCDD, a highly toxic form of dioxin. Downwind from the factory the dioxin cloud polluted a densely populated area of six kilometres long and one kilometre wide, immediately killing many animals. A neighbouring municipality that was highly affected is called Seveso. The accident was named after this village. The dioxin cloud affected a total of 11 communities.

The media now mentions Seveso in line with major disasters such as Bhopal and Chernobyl, which have both become international symbols of industrially related disease. However, the Seveso story is remarkably different when it comes to handling the pollution and the victims because earlier accidents had shown dioxin to be an extremely dangerous substance. Polluted areas were researched and the most severely polluted soils were excavated and treated elsewhere. Health effects were immediately recognized as a consequence of the disaster and victims were compensated. A long-term plan of health monitoring has been put into operation. Seveso victims suffered from a directly visible symptom known as chloracne (see picture), but also from genetic impairments.

The Seveso accident and the immediate reaction of authorities led to the introduction of European regulation for the prevention and control of heavy accidents involving toxic substances. This regulation is now known as the Seveso Directive. This Directive was a central guideline for European countries for managing industrial safety.

The most remarkable feature of the Seveso accident was that local and regional authorities had no idea the plant was a source of risk. The factory existed for more than 30 years and the public had no idea of the possibility of an accident as it occurred in 1976. The European Directive was created to prevent such ignorance in the future and to enhance industrial safety. The Council of Ministers of The European Committee adopted the Directive in 1982. It obligates appropriate safety measures, and also public information on major industrial hazards, which is now known as the ‘need to know’ principle.

4. The 1952 London smog disaster

December 1952 brought an episode of heavy smog to London, which lasted until March 1953. Light winds and a high moisture content created ideal conditions for smog formation. The unusual cold in London in the winter of 1952-1953 caused additional coal combustion and many people travelled only by car, which caused the occurrence of a combination of black soot, sticky particles of tar and gaseous sulphur dioxide. This resulted in the heaviest winter smog episode known to men.

Measurements suggested that the concentration of particulate matter in the air had reached 56 times its normal level. Sulphur dioxide concentrations increased to seven times its peak level. The smoke particles trapped in the fog gave it a yellow-black colour. Sulphur dioxide reacted with substances in foggy droplets to form sulphuric acid, adding an intense form of acid rain to the process.

By night of December 5 the smog was so dense that visibility dropped to only a few meters. Smog easily entered buildings, causing cinemas, theatres and stores to be closed. Transport became largely impossible. Motor vehicles were abandoned, trains were disrupted and airports were also closed.

The smog episode killed approximately 12.000 people, mainly children, elderly people and people suffering from

chronic respiratory or cardiac disease. The number of deaths during the smog disaster was three or four times that on a normal day. They could be attributed to lung disease, tuberculosis and heart failure. Mortality from bronchitis and pneumonia increased more than sevenfold.

Peaks of smoke and sulphur dioxide were in line with peaks in deaths. However, most deaths occurred because of breathing in acid aerosols, which irritates or inflames the bronchial tubes. Acidity was not measured, but estimates show that the pH probably fell to 2 during the peaks in the smog episode.

The highest death rate during the smog episode occurred on December 8 and December 9, at 900 deaths per day. In some parts of the city death rates even increase to nine times the normal number. Until spring the death rate remained high at almost a thousand more deaths per week than expected in a normal winter.

This heavy pollution and its resulting death toll made people aware of the seriousness of air pollution. The London smog disaster resulted in the introduction of the first Clean Air Acts in 1956.

5. Major oil spills of the 20th and 21st century

At the end of the 20th century and the beginning of the 21st century there have been oil spills all over the world, caused either by naval accidents or during major wars. It is impossible to determine which of these oil spills had the most severe consequences for its environment. Consequently, we will sum up a number of oil spills in this environmental disaster top 10. First, we will describe some events that obtained a lot of media attention.

Amoco Cadiz

In 1978 on March 16 the Liberian super tanker Amoco Cadiz stranded on Portsall Rocks off the coast of Brittany, France because of failure of the steering mechanism at 9:15. Although Captain Pasquale Bandari hoisted the international signal for "Not under Command" almost immediately, he did not request assistance until 11:20, when his engineer determined that the damage was irreparable. The Amoco Cadiz started drifting to shore where touching the bottom ripped open the hull and storage tanks.

The crew of the tanker was rescued by helicopter, but the ship broke in two releasing 230.000 tons of crude oil, which spread through the English Channel. The oil spill polluted approximately 300 kilometres of coastline, destroying fisheries, oysters and seaweed beds. Beaches of 76 Breton communities were polluted by oil.

Cleanup efforts were restricted for two weeks following the accident, as a result of the isolated location of the grounding and rough seas. Severe weather eventually caused the complete break-up of the ship before any additional oil could be removed from the wreck.

This was one of the largest environmental disasters known to men in the 1970's. It would be another ten years before the resulting lawsuits were wound up. In 1988 a US federal judge ordered Amoco Oil Corporation to pay 85,2 million dollars in fines, consisting of 45 million dollars for the costs of the spill and an additional 39 million dollars of interest.

Piper Alpha

On July 6, 1988 an explosion occurred on the oil and gas production platform Piper Alpha of Occidental Petroleum Ltd. and Texaco in the North Sea. Piper Alpha was located on the Piper Oilfield, about 190 kilometres from Aberdeen in 144 metres of water. There were about 240 people working on the platform. The explosion and resulting fire killed 167 of them. It is now said that evacuation plans were inadequate and therefore failed preventing any of the deaths. By the time rescue helicopters arrived, flames over 100 metres in height prevented safe approach. Only 62 workers were pulled from the sea alive.

A nearby platform called Tartan continued to pump gas into the upstream pipelines of Piper Alpha after the explosion because they did not have the authority to shut down production, even when the Piper Alpha caught fire. The released gas caused a second explosion and the fire increased, covering the entire platform. The personnel that had the authority to order evacuation of Piper Alpha had been killed during the first explosion, which destroyed the control room. It led to people still trying to get of the platform hours after the fire had started.

The Cullen Enquiry was set up in November 1988 to establish the cause of the disaster. It was pointed out that the initial explosion was caused by a leakage of natural gas condensate building up beneath the platform, because of maintenance work on a pump and a related safety valve. It resulted in the ignition of secondary oil fires and the melting of upstream gas pipelines. Piper Alpha's operator, Occidental, was found guilty of having inadequate maintenance procedures.

Exxon Valdez

In 1989 the American oil tanker Exxon Valdez clashed with the Bligh Reef, causing a major oil leakage. The tanker had left the Valdez terminal in Alaska, navigating through Prince William Sound. Captain Joseph Hazelwood informed the coast guard they would change course to avoid collision with some small icebergs present in the region. The coast guard instructed the captain to sail north.

After Busby Island the tanker was supposed to turn back south, but it did not turn rapidly enough, causing the collision with the reef at 0:04 hours. This caused an oil spill of between 41.000 and 132.000 square meters, polluting 1900 km of coastline. The oil spill killed approximately 250.000 sea birds, 2.800 sea otters, 250 bald eagles and possibly 22 killer whales.

Exxon Mobil, the owner of the Exxon Valdez, has paid approximately 3,5 billion dollars in connection with the accident, of which 2,1 billion was meant for the cleanup operation. Both Exxon and the government have ordered investigations of the disaster, because of the large sums of money involved.

Ironically, official NOAA (National Oceanic and Atmospheric Administration) investigations have shown that most of the damage from the oil spill was caused by the cleaning operation following the disaster. It is clamed that pressure-washing was responsible for killing most of the marine life. On stretches of beach that were uncleaned life seemed to recover after 18 months, whereas on the cleaned parts of the beach it did not recover for the next 3 to 4 years. Oil spill clean up is still performed because in the public's opinion this is still the way to save most animals.

The Exxon Valdez oil spill had, and still has, a large deal of media attention. Many people still remember the spill today. However, Exxon Valdez did not cause the largest oil spill in human history. According to Bjorn Lomborg, it is not even in the top 10. A much larger disaster was caused for example during the Gulf War in 1991.

The gulf war

In August 1990 Iraqi forces invaded Kuwait, starting the Gulf War in which an allegiance of 34 nations worldwide was involved. In January 1991 of the Gulf War, Iraqi forces committed two environmental disasters. The first was a major oil spill 16 kilometres off the shore of Kuwait by dumping oil from several tankers and opening the valves of an offshore terminal. The second was the setting fire to 650 oil wells in Kuwait.

The apparent strategic goal of the action was to prevent a potential landing by US Marines. American air strikes on January 26 destroyed pipelines to prevent further spillage into the Gulf. This however seemed to make little difference. Approximately one million tons of crude oil was already lost to the environment, making this the largest oil spill of human history. In the spring of 1991, as many as 500 oil wells were still burning and the last oil well was not extinguished until a few months later, in November.

The oil spills did considerable damage to life in the Persian Gulf (see picture). Several months after the spill, the poisoned waters killed 20.000 seabirds and had caused severe damage to local marine flora and fauna. The fires in the oil wells caused immense amounts of soot and toxic fumes to enter the atmosphere. This had great effects on the health of the local population and biota for several years. The pollution also had a possible impact on local weather patterns.

Tricolor

Of cars wreckages that were once transported by the Tricolor. The freight value was approximately 49 million euros. The ship has an additional value of 40 million euros.In the early hours of December 14, 2002 the Norwegian ship Tricolor collided with the Bahama container ship Kariba in the French Channel. The accident was caused by fog and human errors. The Kariba was heavily damaged, but managed to reach the Antwerp harbour. The crew of Tricolor was rescued by emergency teams, which experienced low visibility that made the rescue operation very hard. Fortunately, nobody was hurt.

Despite warning signals on the location of the Tricolor the Nicola collided with the wreck on December 16. The Nicola could be safely removed from the scene but the Tricolor was now much more severely damaged. The ship was declared total loss and Berger Smit started to pump 2.200 tons of oil from the wreck.

In January 2003 the oil tanker Vicky collided with the Tricolor, causing some oil from the Vicky to flow into sea and reach French and Belgium shores. Fortunately damages were limited and the Tricolor did not leak any oil.

By the end of January even more extreme weather caused Berger Smit to collide with the Tricolor wreck, which started leaking oil. It became apparent that at least 1.000 tons of oil had leaked away into the Channel. The oil reached France and Belgium, causing thousands of dead seabirds to wash ashore.

After this third collision a confederation was ordered by the French government to remove the wreck to prevent further environmental damage. Eventually, the ship was broken into nine small pieces, heaved from the water and carried away.

At this moment the sea soil still contains hundreds

Other

There have been many other accidents involving oil spills throughout the years. Many received not nearly as much media attention as the ones mentioned above. Some more examples of oil spills:

- 1967 Liberian tanker Torrey Canyon spills 120.000 ton oil near Cornwall
- 1968 Witwater tanker spills 14.000 barrels of oil near Panama coast
- 1969 tanker Hamilton trader spills 4.000 barrels of oil in Liverpool Bay, England
- 1970 tanker Arrow spills 77.000 barrels of oil near Nova Scotia, Canada
- 1971 tanker Wafra spills 20.000 barrels of oil near Cape Agulhas, Africa
- 1972 tanker Sea Star catches fire after collision in Gulf of Mexico
- 1974 Dutch tanker Metulla spills 53.000 ton crude oil near South-Chilli
- 1976 Liberian tanker Argo Merchant spilled 29.000 square meters of oil near the Massachusetts coast
- 1976 Spanish tanker Urquillo spills more than 100.000 ton oil near Spain
- 1977 tanker Al Rawdatain spills 7.350 barrels of oil near Genoa, Italy
- 1977 tanker Borug spills 213.692 barrels of oil near the coast of Taiwan
- 1978 Brazilian Marina spills 73.600 barrels of oil near Sao Sebastiao, Brazil
- 1979 Betegeuse spills 14.720 barrels of oil near Bantry Bay, Ireland
- 1979 Ixtoc I exploratory well in Mexico blows out and spills 600.000 tons of oil
- 1984 Alvenus tanker grounds southeast of Cameron, Louisiana and spills 65.000 barrels of oil
- 1985 ARCO Anchorage spills 5.690 barrels of oil near the coast of Washington
- 1986 unknown oil spill reaches the coast of Georgia and is later appointed to the Amazon Vulture tanker
- 1989 Aragon tanker spills 175.000 barrels of oil near Madeira, Portugal
- 1990 tanker American Trader grounds near Huntington Beach, California and spills 9458 barrels of oil
- 1990 Cibro Savannah tanker catches fire and spills 481 square meters of oil
- 1990 Jupiter tanker catches fire in Bay City, Mexico and causes oil spill
- 1990 Mega Borg tanker catches fire and spills 19.000 square meters of oil near Galveston, Texas
- 1991 tanker Bahia Paraiso spills 3.774 barrels of oil near Palmer Station, Antarctica
- 1992 Greek tanker Aegean Sea spills 70.000 ton oil near Galicia
- 1993 Bouchard B155 tanker spills 1.270 square meters of fuel oil after collision with 2 ships
- 1996 Liberian tanker Sea Empress spills 147.000 ton oil near Wales
- 1999 Maltese tanker Erika spills 30.000 ton oil near Brittany
- 2001 tanker Jessica spills 900 ton oil near the Galapagos Isles
- 2002 Bahamese Prestige spills oil near Galicia

6. The love canal chemical waste dump

In 1920 Hooker Chemical had turned an area in Niagara Falls into a municipal and chemical disposal site. In 1953 the site was filled and relatively modern methods were

applied to cover it. A thick layer of impermeable red clay sealed the dump, preventing chemicals from leaking out of the landfill.

A city near the dumpsite wanted to buy it for urban expansion. Despite the warnings of Hooker the city eventually bought the site for the meagre amount of 1 dollar. Hooker could not sell for more, because they did not want to earn money off a project so clearly unwise. The city began to dig to develop a sewer, damaging the red clay cap that covered the dumpsite below. Blocks of homes and a school were built and the neighbourhood was named Love Canal.

Love Canal seemed like a regular neighbourhood. The only thing that distinguished this neighbourhood from other was the strange odours that often hung in the air and an unusual seepage noticed by inhabitants in their basements and yards. Children in the neighbourhood often fell ill. Love Canal families regularly experienced miscarriages and birth defects.

Lois Gibbs, an activist, noticed the high occurrence of illness and birth defects in the area and started documenting it. In 1978 newspapers revealed the existence of the chemical waste dump in the Love Canal area and Lois Gibbs started petitioning for closing the school. In August 1978, the claim succeeded and the NYS Health Department ordered closing of the school when a child suffered from chemical poisoning.

When Love Canal was researched over 130 pounds of the highly toxic carcinogenic TCDD, a form of dioxin, was discovered. The total of 20.000 tons of waste present in the landfill appeared to contain more than 248 different species of chemicals. The waste mainly consisted of pesticide residues and chemical weapons research refuse.

The chemicals had entered homes, sewers, yards and creeks and Gibbs decided it was time for the more than 900 families to be moved away from the location. Eventually President Carter provided funds to move all the families to a safer area. Hooker's parent company was sued and settled for 20 million dollars.

Despite protests by Gibbs's organization some of the houses in Love Canal went up for sale some 20 years later. The majority of the houses are on the market now and the neighbourhood may become inhabited again after 20 years of abandonment. The houses in Love Canal are hard to sell, despite a renaming of the neighbourhood. It suffered such a bad reputation after the incident that banks refused mortgages on the houses.

None of the chemicals have been removed from the dumpsite. It has been resealed and the surrounding area was cleaned and declared safe. Hooker's mother company paid an additional 230 million dollars to finance this cleanup. They are now responsible for the management of the dumpsite. Today, the Love Canal dumpsite is known as one of the major environmental disasters of the century.

7. The baia mare cyanide spill

Workers in gold mines use cyanide (CN) to purify gold from rocks. This is applied for example in Rumania. At 22:00 hours on January 30, 2000 cyanide (fig. 2) used in a gold mine in Baia Mare overflowed into the major river the Somes and subsequently into the river Tisza. The cause of the spill was a break in the dam that surrounded a settling basin. This resulted in the release of at least 100.000 cubic meters of water with very high cyanide concentrations. The waste water did not only contain cyanide, but also heavy metals such as copper, zinc and lead. Copper concentrations exceeded the heavily polluted threshold 40-160 times, the zinc concentration was twice above this standard and the lead concentration 5-9 times greater.

Cyanide is a very aggressive toxin that can kill people. Consequently, when Rumanian authorities were notified of the spill they immediately raised the alarm. This rapid response prevented any human victims. However, the spill did kill all aquatic plant and animal life for dozens of miles downstream. On February 12 it even impacted the major European river Danube, which receives water from the Tisza. This caused the impact to be noticeable in Hungary and Serbia, as well. Inhabitants of Belgrado witnessed Danube water full of dead fish flowing by. Up to 100 people, most of them children, have been treated in hospital after eating contaminated fish. The Rumanian media entitled this environmental disaster 'the largest since Chernobyl'.

Environmental organizations claim that large companies take advantage of the flexible environmental regulation in poorer countries such as Rumania. It is stated this results in the occurrence of environmental disasters such as that in Baia Mare. The major owner of the Baia Mare gold mine is an Australian called Brett. He commented the media coverage of the Baia Mare disaster, saying reports were utterly exaggerated. He denies the high rate of fish mortality in the area had anything to do with the gold mine.

In Serbia the minister of environment has announced he will sue the ones responsible for the spill. He demands an international trial. Fishery has been banned from the Tisza and the population was recommended not to use the water. This has caused many local residents to suffer from drinking water shortages and has caused some losses in the fishing industry.

8. The european bse crisis

Bovine Spongiform Encephalopathy (BSE), is a fatal cow disease. The disease is sometimes called '*mad cow disease*' because it causes cows to act strangely and collapse on the spot (see picture). It is concentrated mainly in the cow's brain, spinal cord and certain organs such as the spleen.

BSE was caused by feeding cows with meat and bone meal, a high-protein substance obtained from butchered sheep and cows. This was applied in Europe because soybeans, the main ingredient of regular cow feed, was hard to obtain.

The accumulation of prions (proteinaceous infectious particles) over many generations caused animals to fall ill, increasing the infectious tissue concentration in newly produced meat. In Europe it was first discovered in British cattle in 1986. Contrarily to other European countries, in Britain it was not required for the animal feed to undergo a steam boiling process for sterilization. This gave the infectious agents a chance to spread. In 1996 the British mistake came to light and European countries banned the import of British cow meat, causing the British meat industry to suffer major losses.

The ban of British meat export appeared to have been implemented too late and consequently BSE started spreading throughout Europe (table 1). Many countries started to test its animals. When BSE was suspected on a farm transporting of animals and meat was banned. The animals were killed and their carcases burned. This may have caused air pollution, because cow incineration was carried out in open air without proper filtering on many occasions.

Table 1: Year of discovery of first bse cases by country

Country	Year
Ireland	1989
Portugal	1990
Switzerland	1990
Belgium	1993
Netherlands	1997
Denmark	2000
France	2000
Spain	2000
Italy	2001
Germany	2003

Many countries banned the use of meat and bone meal after the outbreak of BSE in Europe. However, in Germany meat and bone meal was still permitted in cow feed until 2000. This caused an aftermath of the epidemic in 2003.

BSE was not only harmful to cows; in 1996 it was discovered that a human equivalent of the fatal brain disease existed. The infection is known as Creutsfeldt Jacobs Disease (vCJD). Once infectious prions are activated, the disease runs its course within 12 to 18 months and ultimately results in death. Symptoms include depression, coordination problems, memory loss and mood swings, pain in the limbs, bad headaches, cold extremities, pain in the feet, rashes and short-term memory loss.

It is assumed that humans are affected with the BSE-related disease by consuming the organs and tissues from cattle in which the BSE-causing agents are present. Infection can only occur when consumption cows with BSE are 30 months old or older. Estimates state that 400.000 cattle infected with BSE entered the human food chain in the 1980s. The age of these cows prior to slaughter is unknown.

vCJD killed nearly 90 people in the UK by 2003. Deaths from the disease were also reported in France and Italy. In 2004 a total of 158 Europeans acquired or died from vCJD, most of which were Britains (148). It is now suspected that slaughtering practises and horticultural fertilization practices may also cause the human variant of BSE, but this is still researched.

Table 2: Reported BSE cases in Europe by country

Country	Number of BSE cases (cows)
Austria*	2
Belgium	125
Chez Republic*	9
Denmark	13
Finland*	1
France	891
Germany	312
Greece*	1
Ireland	1353
Italy	117
Lichtenstein*	2
Luxembourg	2
Netherlands	75
Poland*	14
Portugal	875
Spain	412
Switzerland*	453
UK	183.803

Note that the BSE epidemic of 1990-2001 was mainly concentrated in the western European Union countries.

The incidences of BSE are relatively small in number, but the discovery of the disease had a dramatic effect on European beef consumption, which fell to 27%. In 2001 the European BSE epidemic ceased, having only an aftermath in Germany in 2003 (see above). Even after bringing the BSE epidemic under control people are still being diagnosed with its human variant each year, because of its long incubation period. The full extent of the outbreak may still be unknown.

9. Spanish waste water spill

On April 25, 1998 the dam of the mining residual tank of a pyrite mine in Aznalcollar, Spain suffered a rupture, releasing sludge and contaminated wastewater. The wastewater entered the Guadiamar River, polluting the river with heavy metals such as cadmium, lead, zinc and copper. It affected an area of 4.634 hectares, contaminating 2.703 hectares with sludge and 1.931 with acidic water.

The river pollution caused cultivation lands and forests to be affected. Harvests were no longer fit for consumption, causing financial problems for farmers in the area. Major fish mortality occurred and birds died as a result of consumption of polluted fish. It took one whole month for the river water to recover to its original state.

After the wastewater flow had entered the river a major cleanup operation started, including the installation of walls to prevent further spreading of contaminants and the removal of contaminated sludge. The pH values of the soil were restored by liming and arsenic was removed by adding iron oxyhydroxides, causing a precipitation reaction.

Company technicians stated that the rupture of the residual tank was caused by a deep landslide, which provoked the movement of a certain section of the wall. Authorities also researched the cause of the disaster. Apparently the dam was a weak construction and warnings of possible breakthrough were neglected. The Canadian/ Swedish corporation Boliden was held responsible for the wastewater spill. The company was sentenced to financing the cleanup operation and paying compensation to victims.

10. The three mile island near nuclear disaster

At approximately 4:00 a.m. on March 28, 1979 the main feed water pumps in the non-nuclear cooling system of reactor 2 of the Three Mile Island nuclear power plant near Harrisburg, Pennsylvania failed. This caused cooling water to drain away from the reactor resulting in partial melting of the reactor core. Operator errors, a stuck valve, faulty sensors and design errors together resulted in a release of approximately one thousandth as much radiation as during the Chernobyl explosion.

Fortunately about 18 billion curies of radiation that could have been released were held by the containment structure around the reactor. This caused some advocates to think that serious nuclear accidents will not occur in the United States. However, many experts have claimed that only luck kept the accident from being worse. The reactor core, according to them, was only just short of becoming hot enough to totally melt down. Complete melt-down was only prevented by immediate implementation of safety measures.

It is very uncertain how much radiation was exactly released at the nuclear accident. It is estimated that this was about 2,5 million curies. A few days after the accident had occurred all children and pregnant women were evacuated from an 8 km radius of Three Mile Island as a safety precaution.

Radiation from the Three Mile Island reactor has contributed to the premature deaths of some elderly people

that lived in the region. Dairy farmers reported that many animals have died consequential to the accident and local residents have developed cancers. Some studies suggested that premature deaths and birth defects also resulted from the nuclear melt-down.
The reactor cleanup started in August 1979 and officially ended in December 1993 at a cost of around 975 million dollars. From 1985 to 1990 almost 100 tonnes of radioactive fuel were removed from the site. Reactor 2 had been online only three months, but now had a ruined reactor vessel and was unsafe to walk in, therefore it has been permanently closed. Reactor 1 was restarted in 1985, but many plans for building new reactors of the same type were dismissed later.

Natural environmental disasters

1. Global epidemics (the Plague, Spanish Flu and AIDS)
2. The Bangladesh arsenic crisis
3. The 2004 Asian earthquake and tsunami
4. Hurricane Mitch
5. Izmit: the 1999 Turkish earthquakes
6. The 1953 Dutch flood disaster
7. Brazil: the 1998 Roraima wildfires
8. Phillipines: the Mount Pinatubo volcanic eruption
9. The 1925 Ellington, Missouri tornado
10. The Beijing and Queensland dust storms

1. Global epidemics

Throughout the centuries, epidemics have led to disaster. Outbreaks such as the Spanish Flu and the plague are included in history books for their memorable death toll. In an ecological sense, these outbreaks can be viewed as a natural mechanism to limit the human population. Epidemics may be the most effective natural mechanism to kill many people at the same time.

The plague

In the fourteenth century Europe, Asia and Africa were hit with a serious outbreak of the plague, now commonly known as The Black Death. The disease is caused by the bacterium Pasteurellapestis or Yersinia pestis, which is transmitted from rodents to humans by a flea. Symptoms of the disease include fever, delirium, pneumonia and enlarged, pus-filled lymph nodes. These nodes would open to the skin and drain spontaneously.
The epidemic started in Asia. It is suspected that it spread to humans from Asian rodents. In the mid-fourteenth century the Port of Caffa in the Black Sea was attacked by Tartans from the sea. These Tartans fell ill with the plague and decided to retreat. But before they did so the dead bodies of their comrades were catapulted into Caffa. Italians that were present there retreated to Italy, causing this first historical event of biological warfare to spread the plague to Europe.
The European population back than counted approximately 100 million people. Between 1347 and 1351, at least 25 and possibly 75 million people died of the plague, destroying the European social structure. Death tolls caused the disappearance of law enforcement, religious ceremonies and medical practise in the areas where the plague was worst.
After many people were killed plague epidemics suddenly ceased. Today we still do not fully understand the reason for this sudden epidemical retreat. Possibly, only resistant humans lasted in the end. Perhaps reservoirs of the plague are still in waiting, ready to spread when conditions are right. Fortunately hygiene and medication have been able to prevent a new plague epidemic from occurring so far.

Spanish flu

Symptoms of the Spanish Flu included a blue tint to the face and coughing up blood caused by severe obstruction of the lungs. People tried to stop the epidemic by isolating those that had symptoms, but it did little good.
The Spanish Flu vanished within eighteen months, and the actual cause was not determined at the time. It appears to have been an H1 virus type. At the time people thought the flu was the result of a bacterial infection, and many years were spent looking for a vaccine in vain.
It has been suggested that rapid movement of soldiers and weakened immune systems as a consequence of chemical warfare contributed to the spread of the Spanish Flu during World War I. The epidemic eventually killed at least as many people as the war itself.

HIV/AIDS

It is suggested that the AIDS crisis today is an epidemic that could take similar forms as the fourteenth century plague. AIDS (Acquired Immunodeficiency Syndrome) is caused by the Human Immunodeficiency Virus (HIV). HIV is a retrovirus that infects cells of the human immune system, causing people to become much more susceptive to disease. People infected with AIDS die for example of pneumonia.
HIV is transmitted through penetrative (anal or vaginal) and oral sex, blood transfusion, the sharing of contaminated needles in hospitals and during drug injection, and between mother and infant during pregnancy, childbirth and breastfeeding. When someone is HIV positive, treatment is required. HIV cannot be cured, but transmission to AIDS can be postponed by medication.
From 1980 to 2001 an estimated 62 million people were infected with the HIV virus globally, which is roughly 0,5% of the world population. Not every infected person obtains the disease. Eventually, 22 million people succumbed and died of the disease. It is estimated that about 94% of the infections occur in developing countries. Two-thirds of all HIV-infected people live in sub-Saharan Africa. In total 8,4% of all adult sub-Saharan Africans were infected with AIDS in 2001. Botswana is the most devastated country, with 1 in 3 adults infected with AIDS. Life expectancy of Botswanians has been dropping and the annual population growth rate in the country has declined.
AIDS disrupts local economies and social structures. More and more people are sick and dependent and the number of healthy workers decreases. Many children are left without parents at a very young age or are born HIV-infected. This causes many children to stay at home from school, resulting in a further effect on economy.
The World Health Organization estimated in 2000 that 25% of the units of blood transfused in Africa were not tested for HIV and that 5- 10% of cases of HIV infection in Africa were transmitted through blood.
Other countries that were hard hit with AIDS are in Asia and South America. In Asia, the nations of Cambodia, India, Myanmar and Thailand have suffered major loses as a result of the AIDS epidemic. In Latin America and the Caribbean area Brazil and Haiti also have major segments of their populations that are infected. As in Botswana, the disease decreases life expectancies and causes population declines
After a person is HIV-infected it takes several week to several months before the disease is identified in blood tests. It may take longer, sometimes even 10 years, before symptoms occur (see figure). In the mean time people can still infect others.

Despite the many efforts of developed countries, such as the Live 8 concerts for AIDS in Africa in 2005, the epidemic lingers on. Its full effect may not be visible for another generation or more.

2. The Bangladesh arsenic crisis

Arsenic is a poisonous metalloid that can be found in three forms; yellow, grey and black arsenic. Arsenic compounds are used as pesticides and in various alloys. It is not only toxic to insects and some plants, but also to humans. Its toxicity stems from the similarity of the chemical structure to phosphorus, causing it to partly substitute phosphorus in chemical reactions.

Bangladesh, Asia (see picture) has had major drinking water problems for many decades. Most people used to drink surface water, which led to the spread of pathogens such as cholera and dysentery. International organizations started promoting groundwater welling for drinking water production. It was however not known that groundwater in Bangladesh contained significant amounts of arsenic. The arsenic present in the groundwater is of natural origin, being released from subsurface sediment layers under anoxic conditions. Many other Asian countries, such as Vietnam, Cambodia and Tibet are thought to have similar geological environments as Bangladesh. These countries may also have high-arsenic groundwater.

When drinking water wells were installed in Bangladesh, approximately 57 million Bangladeshi people started drinking groundwater with arsenic concentrations far above the legal limit of 0,05 mg/L. After several years of applying groundwater as drinking water over a quarter of the Bangladeshi population exhibited symptoms of arsenic poisoning (arsenicosis).

Arsenic poisoning kills people by disrupting the digestive system. Symptoms include changes in skin colour, formation of skin patches (see picture), stomach pains, vomiting, delirium and gangrene. Chronic low level arsenic poisoning in Bangladesh also results in cancers, such as lung cancer, skin cancer, kidney cancer and bladder cancer.

The arsenic problem was first discovered in the early 1980s, but public awareness of the arsenic crisis did not emerge until the mid-1990s. The World Health Organisation has described the naturally occurring arsenic as the largest mass poisoning of a population in history. Today, more than 85 million Bangladeshi people are drinking the arsenic-rich groundwater. It is very probable at least 80 million people now suffer from arsenic poisoning. The exact number is uncertain because it may sometimes take up to 10 years before arsenic poisoning can be diagnosed.

Legal proceedings began in London in 2003 to determine whether the British Geological Survey was negligent in failing to detect arsenic in Bangladeshi water supplies. The organization conducted research on behalf of the Bangladesh government in 1992, but did not test the groundwater for arsenic. The organization pleas 'not guilty' and argues that at the time of its report little was known about the geological origins of arsenic poisoning.

3. The 2004 Asian earthquake and tsunami

We have very recently experienced a natural environmental disaster that made worldwide news. In December 2004 an oceanic earthquake of 9-9,3 on a Richter scale caused devastation in Asian countries. The earthquake was among the 10 deadliest in history. Scientists reported that it had lasted nearly ten minutes when most major earthquakes last no more than a few seconds. Since 1900 the only earthquakes recorded with a greater magnitude were the 1960 Great Chilean Earthquake (9,5), the 1964 earthquake in Prince William Sound (9,2), and the 1957 earthquake near the Andreanof Islands (9,1). But all these areas were less densely populated than the Asian earthquake area in 2004 and therefore had a much smaller death toll.

The earthquake centred in the Indian Ocean off the coast of northern Sumatra, Indonesia. It caused the entire planet to vibrate at least a few centimetres. It also triggered earthquakes in entirely different regions, such as Alaska.

The earthquake resulted in a tsunami (see picture); a series of harbour waves of more than 30 meters high, which washed ashore. It caused in serious damage and killed people in Sri Lanka, South India, Thailand, Indonesia, Somalia, Myanmar, Malaysia, the Maldives and other countries. It took officials months to establish an eventual death toll, which is now estimated at between 230.000 and 310.000 people. Tens of thousands of people are still missing. The death toll of the Asian earthquake is surpassed only by an earthquake in China in 1557, which killed over 830.000 people.

In February 2005, every day 500 bodies were found. These were collected and identified, a process that lasted a very long time and caused a terrible stench in the afflicted regions. Bodies were buried as soon as possible for fear of disease. Among the dead were at least 9.000 foreign tourist that stayed in the region. Sweden was the hardest hit European country with 500 people dead or missing.

The true total death toll is not known as many bodies were swept out to sea. Additional deaths may be caused by epidemics and starvation. Millions of people have lost their houses and are packed together in refugee camps on very small space.

The Tsunami not only impacted humans, but also the environment. Severe damage was inflicted on ecosystems such as coral reefs, sand dunes and rock formations, animal and plant biodiversity and groundwater. In addition, the spread of solid and liquid waste and industrial chemicals polluted the water. The destruction of sewage collectors and treatment plants still form a serious threat to the environment. The United Nations Environment Program (UNEP) works with local governments to determine ecological damage and appropriate policy measures.

The Tsunami caused by the earthquake in the Asian region was the worst in human history. The United Nations declared that the relief operation would be the costliest ever. A worldwide collection for tsunami funds resulted in an unbelievable amount of money for emergency aid and restoration of the area. It is estimated this will take between 5 and 10 years.

This year (2006) a report was released by the Tsunami Evaluation Coalition (TEC) on the efficiency of international aid after the earthquake and tsunami in Asia. TEC is a cooperation between UN-organisations such as Unicef and WHO, consultancies, donors and organisations for humanitarian aid such as Oxfam Novib.

The main positive conclusions were

- High efficiency of the first aid
- Rapid reconstruction of schools and health centres
- Rapid restoring of the fishery sector

The main areas of improvement were

- The quality of international aid, and support of large international organisations for small local organisations
- A general lack of cooperation between organisations because of large funding
- Unequal distribution of funding; first aid was more adequately funded, whereas more money was required for restoration
- International organisations focus too much on promoting their own name, causing information transfer to be inefficient
- Costs for housing and personnel were far too high
- Disaster response quality should be improved, and this was not attended to so far

The Richter scale

The Richter scale was developed by Charles Richter in 1935. It is a measure to indicate the intensity of an earthquake. Each number on the scale is a measure of the amount of energy released. This is based on the amplitude of seismic waves measured at seismographic sites, corrected for distance to the earthquake site.

The Richter scale is a logarithmic scale, meaning an increase of 1 unit magnitude in reality is an increase of 10 times in amplitude. This does not represent the energy released. For example the energy of a magnitude 6 earthquake is 31 times greater than that of a magnitude 5 earthquake.

Table 3: Categories of the richter scale

<3,5	Generally not felt, but recorded
3,5-5,5	Felt, but rarely causing any damage
<6,0	Slight damage to well-constructed buildings, heavy damage to poorly constructed buildings
6,1-6,9	May damage inhabited areas up to 100 km wide
7,0-7,9	Major earthquake that may cause serious damage in a very wide area (see 3)
>8,0	Serious earthquake that causes damage hundreds of kilometres away from the epicentre
>9,0	Rare great earthquake, major damage in a large region of over 1000 km (see 1)

4. Hurricane Mitch

Tropical cyclones are a type of low pressure system which generally forms in the tropics. They are an important part of the atmospheric circulation system, which moves heat from the equatorial region toward higher latitudes. Tropical cyclones can be either tropical storms, typhoons or hurricanes, depending on the winds speed.

Hurricanes are tropical cyclones that develop an area of calm in the centre of the circulation. Surrounding this area is an area of 16-80 km wide where strong thunderstorms and winds circulate around the centre. The circulation route depends on the hemisphere. In the Southern Hemisphere it is clockwise, whereas in the Northern Hemisphere it is counter-clockwise. Hurricanes can achieve wind speeds of up to 305 km/h.

In 1998 the category 5 Hurricane Mitch caused devastation in Central America, gaining wind speeds of 290 km/h and killing more than 18.000 people. Most deaths were caused by floods resulting from heavy rains (90 cm) associated with the hurricane.

Mitch formed in the Atlantic near Africa and travelled north along the coasts of Nicaragua and Honduras. It headed west for some time before approaching the coast again and heading into central Honduras. Mitch weakened and entered Guatemala as a mere tropical depression, but it soon started to reorganize. It again became a hurricane when it reached Yucatan and Florida later and it was even tracked north of Great Britain. Most damage was done in Honduras and Nicaragua, but El Salvador and Guatemala also received significant damage. Total damage estimates are up to 5 billion US dollars.

Hurricane Mitch was the second destructive hurricane to hit Honduras after Fifi in 1974, which killed an estimated 8.000 people. Mitch was the deadliest hurricane in more than 200 years, and the second deadliest ever. The Great Hurricane of 1780 remains the deadliest to this day. The name Mitch was disregarded in 1999 and was replaced by Matthew in 2004.

The saffir-simpson hurricane scale

Hurricanes are ranked according to the Saffir-Simpson hurricane scale, according to wind speeds. The scale was developed in 1969 by civil engineer Herbert Saffir and National Hurricane Center director Bob Simpson. In terms of effects, the rankings are not absolute because any type of hurricane can inflict terrible damage, even when wind speeds are not very high relatively. If hurricanes with low wind speeds result in floods and landslides damages are still considerable.

Table 4: Categories of the saffir-simpson hurricane scale

Category	Wind speed (km/h)	Effects
1	119-153	No real damage to buildings. Some coastal flooding.
2	154-177	Some roofing, door and window damage. Considerable damage to vegetation.
3	178-209	Destruction of mobile homes. More inland flooding damage.
4	210-249	Erosion and flooding of inland areas. Roofs are torn off.
5	>250	Complete roof failures and some complete building failures. Flooding and landslides. Usually mass evacuation is implemented.

Other hurricanes

There have been hurricanes all over the tropics for many centuries.

Examples of some other hurricanes

Atlantic	Canada	United States
1893 Sea Islands hurricane	1869 Saxby Gale	1919 Florida Keys Hurricane
1934 Yucatan Hurricane	1934 Great August Gale	1949 Palm Beach Hurricane
1974 Hurricane Fifi	1954 Hurricane Hazel	1960 Hurricane Donna
1994 Hurricane Gordon	1991 The Perfect Storm	1992 Hurricane Andrew
2004 Hurricane Jeanne	2003 Hurricane Juan	2004 Hurricane Charley

5. Izmit: in 1999 Turkish earthquakes

On August 17, 1999 a heavy earthquake of 7,5 on a Richter scale (see 1) hit Izmit, a city in Turkey. It occurred on one of the world's longest and best-studied horizontal motion faults, called the east-west trending North Anatolian fault. This fault causes earthquakes at less than 20 km depth, causing people at the surface to be close to where the energy is released.

The earthquake killed some 17.000 people and left thousands more without a home. On November 12 another tremor of 7,2 on a Richter scale hit the location, killing 450 more and leaving 3000 people injured.

Survivors of the earthquake were put together in temporary camps. Water transports were set up to prevent more people dying of dehydration. Fear of epidemics in these camps was very high.

Eyewitnesses compared the results of the earthquake to wartime in Sarajevo. Many buildings in Turkey collapsed during the earthquake. It was said later that structural failure was partly to blame. Power lines were down, roads and rail links smashed and water supplies and telephone lines interrupted. It took a considerable amount of time to repair damages in areas where this was still presumed possible.

The earthquake caused considerable environmental damage because it set fire to a refinery storing 700.000 tons of oil. By the time the fire burned out air, land and water were polluted. According to Greenpeace the earthquake caused cracks in the Petkim waste dump, exposing chemical waste that was dumped there for years. A PVC factory, waste treatment plant and incinerator were also damaged. Fortunately, despite all these events of pollution damages to the environment were limited by the cleanup operation.

Turkey has had a long history of earthquakes. In 1939 and 1967 earthquakes had already occurred on the North Anatolian fault, but these were not as strong as the first 1999 earthquake. The earthquake was the strongest the world had experienced for more than a decade, particularly because of the high death toll. The 2004 Asian earthquake now surpasses this.

6. The 1953 dutch flood disaster

On Saturday, January 31 of 1953 the Dutch weather service gave out a warning of an approaching northwester storm on the North Sea. In the night of January 31 – February 1 the storm reached the Netherlands and started increasing. The storm than included heavy winds of 150 km/h.

After the flood of 1916 strong dikes were built that gave people a false sense of safety. Additionally communication was limited, causing storm warnings to pass over many people. Most people did not have television, there were no nocturnal radio broadcasts and most people did not own telephones, causing many to be unaware of the danger ahead.

The storms caused a change in the water level. The expected ebb tide stayed out and spring tide was reached somewhere in the middle of the night. At 2:00 the Netherlands started flooding, causing dikes to break through at more than 60 locations in three provinces. The southern islands were almost completely flooded, causing thousands of houses and farms to be ruined or dragged into sea. People were fleeing to higher places, such as dikes and attics and were trapped there. On Sunday afternoon the flood increased and water levels were even higher than the previous night.

The floods caused a total of 1835 deaths. In some villages up to 10% of the population was killed. More than 47.000 cows and pigs and more than 140.000 pieces of poultry drowned during the flood. A total of more than 200.000 hectares was flooded and 72.000 people were evacuated from their homes. The 1953 flood became the largest natural disaster since the 1570 flood.

Directly after the disaster measures were taken to rebuild the dikes. On February 18, 1953 the Delta Committee was established and in 1955 the Delta law was presented. Starting in 1958, the Delta works were finished in 1986 with the grand opening of the Oosterschelde flood barrier. The Netherlands now has strong dikes and dams that tie together the islands. The flood warning system is improved and the country gained a reputation for its high level of flood protection.

Despite the high level of protection floods still occur in the Netherlands. In 1993, 1995 and 1998 flooding of the rivers Rhine and Muse caused considerable damage. In 1995 up to 250.000 people were evacuated from their homes. Additionally, global warming may cause sea level rise, resulting in more flooding of the country in the future particularly because the height of the western part of the country is slowly decreasing. This means that continual strict water management is required.

7. Brazil: the 1998 roraima wildfires

In 1998 raging wildfires brought on by unimaginable droughts were sweeping the northern Brazilian state Roraima. The fires took place on its savannahs, grassland and deciduous forests. Hundreds of people were killed in the fires and one of the planets most primitive peoples, the Yanomami Indians, were threatened.

It is thought that the first fires started because of forest clearing for agricultural land. Farmers in Brazil often burned parts of forest to gain fertile farmland. Droughts caused fires to linger, rather than burn out.

Burning fronts were as wide as 5,6 kilometres. News reports and local residents described flames and smoke reaching as high as 30 m into the air. The smoke blocked the sun and blackened the sky. The fires were completely out of control and spread rapidly as a result of persistent winds, eventually destroying more than 34.000 km^2 of forest.

The rapidly spreading fires ruined most of the province's agricultural land and killed livestock and wild animals in very large numbers. Incalculable damage was done to the environment. According to some environmental institutes it would take more than 100 years for the forests to recover. Estimates stated that 12-16% of the vegetation in the

province was destroyed.
One of the most prominent consequences of the wildfires is atmospheric pollution. In 1998 this caused many people to experience respiratory disease and other symptoms. It is estimated that the number of people hospitalized with breathing problems increased up to 3,2 percent during the burning period in Brazil when compared to other years. This severely increased the expenditure in the health sector.

Other effects of Brazilian wildfires on society were

- Disruption of air and ground transportation services by smoke
- otential contributions to global climate change by greenhouse gas production
- Water quality reduction
- Interruptions in the electrical energy supply
- Deaths and property loss
- Biodiversity loss
- Problems for commercial plantations

Many problems raised during the Roraima wildfires. Outside sources were not mobilized quickly enough to stop the fires from spreading. There was no external communication between fire fighting organizations. There was a severe lack of adequate fire fighting equipment and of air support. The fire fighters were often not adequately trained to work in the circumstances regarding the Brazilian wildfires. Farmers kept on clearing forest by combustion even after warnings not to do so by the government. Brazilian law now prohibits burning during the dry season.
We are not likely to forget the 1998 Brazilian wildfires. According to researchers, these fires were the worst in the history of the Amazon region.

Other known wildfires

Wildfires have occurred all over the world, particularly in forest regions.

Examples of other known wildfires

- 1871 forest fires in Wisconsin and Michigan: destroyed 1,7 million hectares and killed 2.200 people
- 1915 Great Siberian fire: destroyed 1 million km^2 of land. Huge amounts of smoke blocked incoming solar radiation, decreasing global temperatures
- 1980 Canada forest fires: destroyed 4,8 million hectares
- 1983 Ash Wednesday fires in South Australia and Victoria: destroyed over 0,5 million hectares, including 24 towns, forest and pasture. The fires killed 76 people and injured another 3.500
- 1988 Yellowstone National Park fires, US: destroyed 650.000 hectares and cost 120 million dollars
- 1991 forest fires in Oakland and Berkley, California: killed 25 people, injured 150, destroyed 2.886 homes, and caused some 1,5 billion dollars in damage
- 1998 Indonesia fires: smoke travelled for thousands of miles, affecting millions of people
- 2000 Cerro Grande fires in New Mexico: destroyed at least 235 homes and burned some 20.230 hectares

8. Philippines: the Mount Pinatubo volcanic eruption

Mount Pinatubo is an active volcano situated on the isle of Luzon in the Philippines, on the borders of the Pampagna, Balaan and Zambales provinces.
After more than 500 years of dormancy, the volcano erupted in 1991, producing the largest and most violent eruption of the 20th century. Volcanic activity in the Pinatubo was triggered by a series of earthquakes in the area. It caused a 7 km high atmospheric ash column containing 5 billion cubic metres of ash. Ashes reached heights of up to 30 km at the peak of the eruption.
Volcanic deposits, ashes and mudflows destroyed much of the area surrounding the volcano. Thousands of houses were demolished in the eruption. The ash cloud from the volcano covered an area of some 125.000 km^2, bringing total darkness to much of central Luzon.
The Philippine Institute of Volcanology and Seismology led by Raymundo Punongbayan issued a warning indicating the possibility of a major eruption within two weeks. As a result of the institute's predictions of the volcanic eruption and the incorporated warning, approximately 200.000 people could be evacuated on time. If these predictions had not been made, the volcanic eruption would have led to tens of thousands of deaths. Now, thankfully, the number of deaths was limited to 847. Another 173 people were injured and 23 went missing. Roofs collapsing under the weight of accumulated wet ash killed most people. Starvation was also a noted cause of death, particularly because arable land was covered in ash and there was no harvest. Livestock was killed massively during the eruptions. Damage to health facilities in the area caused people to die from disease because of overdue hospitalization.
The eruption emitted thousands of tonnes of aerosols into the atmosphere, causing the impact to be noticeable all over the world. Some 15 million tons of sulphur dioxides were emitted, resulting in acid rain from sulphuric acid formation and in cooling of the earth's temperature by 1 ^oC. It also increased ozone layer destruction.
The eruption of Mount Pinatubo severely hampered the economic development of the surrounding areas. It cost billions of dollars to repair the damage to surrounding cities. Education and working facilities were disrupted.
In all, the eruption ejected about ten cubic kilometres (2.5 $mile^3$) of material, making it the largest eruption since that of Novarupta in 1912 and some ten times larger than the 1980 eruption of Mount St. Helens.

Other volcanic eruptions

Mount Pinatubo is not the only volcano that erupted in the 20^{th} century. Volcanic eruptions have been recorded long before the 20th century, for example Vesuvius in Italy in 79 AD. This eruption ruined the cities Pompeii and Herculaneum and killed 15.000 people. Even now, volcanic eruptions still occur.

Examples of recorded eruptions in the past centuries

- 1586 Kelut, Indonesia – caused 10.000 deaths
- 1631 Vesuvius, Italy – caused 3.500 deaths
- 1772 Papandayan, Indonesia – caused 3.000 deaths
- 1783 Asama, Japan – caused 1.377 deaths
- 1783 Laki, Iceland – 9.350 deaths, most due to starvation
- 1792 Mount Unzen, Japan – caused tsunami and 14.300 deaths
- 1815 Tambora, Indonesia – 92.000 deaths, caused by starvation and disease
- 1882 Galunggung, Indonesia – caused 4.000 deaths

- 1883 Krakatau, Indonesia – caused tsunami and 36.417 deaths
- 1902 Mount Pelée, West Indies – devastation of St. Pierre and 40.000 deaths
- 1919 Kelut, Indonesia – caused 5.110 deaths
- 1951 Lamington, Papua New Guinea – caused 3.000 deaths
- 1963 Aguna, Indonesia – caused 1.184 deaths
- 1982 El Chichon, Mexico – caused 2.000 deaths
- 1985 Nevado del Ruiz, Columbia – deadly mudflow, 25.000 deaths
- 1991 Mount Unzen, Japan
- 1994 Rabaul, Papua New Guinea
- 1997 Soufrière Hills, Montserrat, West-Indies
- 2004 Manam, Indonesia – 10.000 people evacuated, most still living in temporary camps

9. The 1925 Ellington, Missouri tornado

The United States have a history of tornadoes, destroying homes and land and killing people on their way. About 80% of all tornadoes occur in the US, mostly on the Great Plains. A tornado consists of a rapidly rotating vortex of air that forms a funnel (see picture). Tornadoes become harmful when the funnel touches earth. Winds of 250-300 km/h cause tornadoes to lift objects weighing hundreds of tons and may even drain entire lakes. Tornadoes typically cause destruction in areas of 1 km wide and 10-20 km long.

In 1925 a particularly violent F5 scale (see below) tornado hit Ellington, Missouri in the United States and blew over a number of towns in Missouri, Illinois and even Indiana. This tornado had the highest death rate and the highest number of destroyed buildings of all tornadoes in the US history. The tornado blew through a ridge where a series of mining towns were situated. These towns became the main targets of the devastating winds associated with the tornado (table 5).

The tornado was not very visible consequential to the large amount of dust present in the area. Low visibility and the great forwards speed of the tornado caused many people to be surprised by its occurrence. This caused a high death toll in many different cities.

When the tornado hit West Frankfort most men were working in the mine. About 800 miners had to await a power-failure before they could reach their homes. The 127 deaths and 450 injuries caused by the tornado were mostly among their women and children.

Table 5: Death tolls of the Missouri tornado in various states/ towns

State	Town	Death toll
Missouri	Ellington	1
	Annapolis	2, 75 injured
	Perry County	1
	Bollinger County	32
	Other	13
Illinois	Gorham	34, town was destroyed
	Desoto	69
	Murphysboro	234
	Parrish	22
	West Frankfort	127, 450 injured
	Hamilton/ White County	65
Indiana	Princeton	71

The Missouri tornado is currently the number 1 United States tornado with the highest death toll and the most violent winds. In total it killed 671 people and injured another 2.027. Tornadoes still occur and when Americans are surprised by tornadoes in the future, these may cause even more destruction than the Missouri tornado of 1925.

The fujita scale

Like earthquake, the strength of a tornado is measured according to a scale, the so-called Fujita scale. The scale was introduced in 1971 by Theodore Fujita of the University of Chicago and Allan Pearson, head of the Forecast Center in Kansas City, Missouri. It is based on the intensity by the damage it inflicts on human-built structures. The actual F scale of a tornado is determined after it has hit, according to satellite images, eye-witness accounts and visible damage. There are a total of six separate categories.

Table 6: Categories of the fujita tornado scale

Scale number	Wind speed (km/h)	Damage
F1	73-115	Light - broken tree branches and some damage to chimneys
F2	116-180	Considerable - roofs flown of houses and cars lifted slightly
F3	181-250	Severe - walls damaged, cars fully lifted and most trees uprooted
F4	251-330	Devastating - cars and badly constructed houses thrown around
F5: Twister	331-415	Incredible - strong frame houses levelled off foundations and swept away, automobile-sized missiles fly away in excess of 100 meters
F6: Super twister	416-510	Inconceivable - top end of F5 category

Other tornadoes

Tornadoes have occurred all over the United States for many centuries.

Examples of other past tornadoes

- 1840 Natchez: 317 dead, 109 injured
- 1869 St. Louis: 255 dead, 1000 injured
- 1884 Great Southern Tornadoes (60): 170 dead
- 1890 Louisville: 125 dead
- 1899 New Richmond: 117 dead, 200 injured
- 1908 Texas/ Georgia: 320 dead, 770 injured
- 1913 Omaha, Nebraska: 94 dead, 350 injured
- 1920 Mississippi/Alabama: 224 dead
- 1927 Missouri/Arkansas/Texas: 217 dead
- 1932 Alabama/ Georgia/Tennessee: 330 dead
- 1936 Tupelo, Mississippi: 216 dead, 700 injured
- 1936 Gainesville, Georgia: 203 dead, 1.600 injured
- 1944 West Virginia: 144 dead
- 1945 Oklahoma: 102 dead
- 1947 Texas/Oklahoma/Kansas: 181 dead, 970 injured
- 1952 Arkansas: 208 dead
- 1953 Waco: 114 dead, 597 injured
- 1953 Flint: 115 dead, 844 injured
- 1955 Udall, Kansas: 115 dead (1/2 of population)

- 1965 Palm Sunday Outbreak: 271 dead
- 1966 Mississippi/Alabama: 61 dead
- 1971 Mississippi Delta Outbreak: 119 dead, 1000 injured
- 1974 Xenia, Ohio: 350 dead
- 1979 Wichita Falls: 60 dead, 1.740 injured
- 1984 Carolina: 67 dead, 1.248 injured
- 1994 Georgia/ South Carolina: 42 dead, 320 injured
- 1999 Texas/ Oklahoma/ Kansas: 45 dead, 775 injured

There are many more tornadoes that caused death and destruction in various regions of the United States. The ones mention above are but examples of the damage a tornado can do.

10. The Beijing and Queensland dust storms

Estimates have shown that dust storms blow about 11,8 millions metric tons of desert sand from Africa to the Northeast Amazon Basin in Brazil annually. Dust storms occur everywhere around the world. Their natural function is replacement of soils and carrying nutrients from one part of the globe to another. Iron and other nutrients are blown out to sea where they maintain marine ecosystems. Central and South American rain forests also receive vital nutrients from Saharan dust storms.

Causes of dust storms include droughts and poor farming and grazing practises. Oxford University geography professor Andrew Goudie stated in 2001 that cars driving the Sahara are another possible cause of dust storm formation.

Dust storms have increased as a result of extensive deforestation and desertification in many regions. This has caused some countries to start forestation projects.

Sensitive or allergic people suffer from dust storms, because these carry not only nutrients but also microbes and pollens. For most people however, dust storms are mainly a nuisance because visibility is decreased and all their possessions are covered in a thick layer of dust.

China

In 1998 a violent dust storm hit Beijing, China, darkening the skies. This was the worst dust storm in over a decade. Dust was blown from the Gobi Desert near Mongolia into the city. At least 12 people went missing during the storm and power and water supplies were cut. Three Beijing construction workers were killed when strong winds blew iron wire and asphalt off the top of a 2-story building.

Residents ran for cover in the streets, using towels to cover their faces, and the city's busy traffic ground to a halt in most areas. On the most busy roads in town visibility had decreased to only 500 meters.

Schools were closed in China, North Korea and even Russia after the dust storm started. In the capital of South Korea, Seoul, children and elderly people were advised to stay indoors to prevent breathing problems. About 35 domestic flights in Seoul were cancelled and 70 were called off before take-off.

In total, more than 100 million people were affected by the 2000 dust storm. It is said that the storm was caused by arid weather and prevailing winds, and by pasture ploughing. The government wants to try to prevent future dust storms from hitting Beijing by planting a green belt of trees around the capital.

Australia

In 2002 Queensland, Australia was hit by a violent desert storm, which shut down regional airports and urged residents to stay indoors. Visibility fell as low as 50 meters in regions with reduced vegetation cover. The dust storm was at least 6 km high at Chaleville, South Queensland and blew more than a million tonnes of dust into the region. Some claimed this was the worst dust storm witnessed in 20 years.

It was said the cause of the dust storm was a gusty southerly wind change moving over Queensland. Like in Beijing, people with asthma, children and elderly people were advised to stay inside to prevent breathing problems. Cars were obligated to drive with dipped headlights on. Aviation forecasters stated that many airports were closed.

Conclusion

A natural disaster is a major adverse event resulting from natural processes of the Earth; examples include firestorms, duststorms, floods, hurricanes, tornadoes , volcanic eruptions, earthquakes, tsunamis, storms, and other geologic processes. A natural disaster can cause loss of life or damage property, and typically leaves some economic damage in its wake, the severity of which depends on the affected population's resilience and on the infrastructure available [2].

In modern times, the divide between natural, man-made and man-accelerated is quite difficult to draw with human choices like architecture, fire, resource managementor even climate changepotentially playing a role. 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 impact 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.

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