Publisher's Note

Some books about disasters focus on the science, using events as examples but without providing detailed narrative descriptions of what happened. Disaster chronologies, on the other hand, describe events in varying degrees of detail, but generally do not offer a look at the underlying scientific principles and other general concerns. This book was conceived to address both aspects in an accessible manner that is scholarly rather than sensationalized. The three-volume set combines clearly explained scientific concepts with gripping narrative details about 163 significant disastrous events from history. *Notable Natural Disasters,* 2nd edition, is illustrated with ample photographs, maps, tables and diagrams to aid the reader.

Previously published in Salem Press's *Magill's Choice* series (2007), this edition is updated and expanded. It includes such recent events as the earthquake in Nepal in 2015; the 2011 Fukushima earthquake, tsunami, and nuclear disaster in Japan; and the Zika epidemic, which was recognized an official public health emergency of international concern by the World Health Organization (WHO) from February to November, 2016.

Overviews

Volume 1 includes 23 overviews of significant natural events that are frequently involved in disasters:

Avalanches
Blizzards, Freezes, Ice Storms, and Hail
Droughts
Dust Storms and Sandstorms
Earthquakes
El Niño
Epidemics
Explosions
Famines
Fires
Floods
Fog
Heat Waves
Hurricanes, Typhoons, and Cyclones
Icebergs and Glaciers
Landslides, Mudslides, and Rockslides
Lightning Strikes
Meteorites and Comets
Smog
Tornadoes
Tsunamis
Volcanic Eruptions
Wind Gusts

Each overview focuses on scientific explanation, opening with a few sentences that define the natural phenomena and its importance. This is followed by the factors involved (animals, chemical reactions, geography, geological forces, gravitational forces, human activity, ice, microorganisms, plants, rain, snow, temperature, weather conditions, wind) and the regions affected (cities, coasts, deserts, forests, islands, lakes, mountains, oceans, plains, rivers, towns, valleys).

Several sections follow, including:

- **Science:** explains the science behind the phenomenon in general terms understandable to the layperson;
- **Geography:** gives the names and descriptions of the continents, countries, regions, or types of locations where the phenomena occur;
- **Prevention and Preparations:** describes measures that can be taken to prevent or predict disasters to avoid or minimize the loss of life and property, including drills, warning systems, and evacuation orders;
- **Rescue and Relief Efforts:** explains what is done in the aftermath of disasters to find and treat casualties, including typical wounds received and any special challenges faced by rescue workers. This section also includes efforts of relief organizations and programs;
- **Impact:** describes the typical short-term and long-term effects on humans, animals, property, and the environment of these phenomena;
- **Historical Overview:** gives a broad sense of the disaster type beginning with the first recorded occurrences and offering highlights of notable events up to the present day;
- **Milestones:** a table of major events, such as significant disasters, relevant scientific discoveries, and establishment dates for programs, organizations, and classification systems.

All overviews end with a Bibliography.

■ The Disasters

Volumes 2 and 3 include 163 entries on earth's notable disasters. The narrative-style essays offer facts, figures, and interesting stories. Events were chosen based on loss of life, widespread destruction, and interesting circumstances. They range in time from 65,000,000 B.C.E. to 2016 and cover five continents.

Each entry begins with a summary of basic information, including the year and a general description of location or the popular designation for the disaster. The most accurate date and place for the event are identified. Magnitude on the Richter

scale, either official or estimated, is given for earthquakes. The best speed estimate is listed for hurricanes, if available. For tornadoes, the most reliable F-rating is offered. Measure on the Volcanic Explosivity Index is provided for some eruptions. Estimated temperature in Fahrenheit or Celsius is listed for heat waves. This facts and figures section ends with Results – the most accurate figures possible for total numbers of dead or injured, people left homeless, damage, structures or acres burned, and so forth.

Each entry then provides readers with an account of the disaster that includes broad scientific and historical facts and narrative details. The entries end with a list of books, chapters, magazines, or newspapers that readers can seek out for further information on that particular event.

■ Special Features

Helpful back matter has been provided in two locations. At the back of Volume 1:

- A Glossary defines essential scientific terms, especially meteorological and geological terms;
- The Time Line records major disasters and related milestones;
- A Bibliography offers sources for more material about disasters.

At the back of volume 3:

- A List of Organizations and Agencies provides information about significant warning and relief efforts;
- The Category List breaks the events into types;
- The Geographical List organizes the events by region, country, or state;
- The Subject Index.

The articles were written by experts in the fields covered. Every essay is signed, and the contributors' names and affiliations are listed in the front matter that follows this Publisher's Note. Editor Robert Carmichael, Professor Emeritus of geology and geophysics at the University of Iowa, has also taught at Meiji University (Japan) and Tokyo Institute of Technology. He has been a research geophysicist for Shell Oil and a principal investigator for NASA on a project to analyze the earth's crust. He has edited *Physical Properties of Rocks and Minerals* (CRC Press, 1989) and authored a section on rocks and minerals in the *Encyclopaedia Britannica* (Macropaedia). We are grateful for his knowledge and enthusiasm.

Editor's Introduction

Disasters can be defined as *calamitous events which cause great harm or damage*. Disasters can become important elements in historical memory for individuals and societies around the world, just as they can provoke concern about the unpredictability of the future. Some disasters are natural, meaning they are caused by uncontrollable forces of nature. Earthquakes, tsunami waves, volcanic eruptions, tornadoes and hurricanes, blizzards, many wildfires, and most landslides and floods can be considered natural events without complication. But others are a combination of spontaneous natural occurrences and elements of human activity like carelessness, failure of design or technology, inadequate planning, or lack of response. The human element can cause or make worse the consequences of an event; here we include some epidemics, droughts, explosion, floods, fires, environmental pollution such as oil or chemical spills, nuclear accidents, maritime and flight disasters.

Some disasters are rapid, dramatic, and unexpected, while others are slow to become evident. Some are local events like landslides, wildfires, or tornadoes. Others have a regional effect and consequence, such as earthquakes, volcanoes, major flooding, hurricanes, or environmental accidents and pollution. Others still are large-scale and even global in character, such as might be the case for a large catastrophic meteorite impact or global climate change.

Disasters, regarding both the welfare of people and the safety and stability of the built environment, provide a challenge to the order that we might want for our lives and communities. What is evident, however, based on our own experience and the historical record, is that *there is nothing permanent in the world except change*. Originally the words of Greek philosopher Heraclitus (c. 540-475 B.C.E.), they may have referred to social or political matters, but his words also apply to changes in the physical and natural environment. This was certainly true of his own locale, the eastern Mediterranean (including Greece, Egypt, and the Mid-East), with its long record of earthquakes and other calamitous events.

A disaster can have far-reaching and long-lasting consequences for humankind and for human culture, understood as the artifacts and forms of life of a civilization. Consider, for example, the tremendous volcanic eruption, about 1470 B.C.E. on the island of Thera (Thira), part of the Santorini cluster of islands south of Greece. The widespread and thick ash-fall, a destructive tsunami sea-wave, and further debris eruptions resulted in great coastal devastation including ruined agriculture, livestock, and fishing activity. The affected area included the larger island, Crete, to the south of Thera, where the advanced culture of the Minoan civilization was centered.

After their environment was rendered almost uninhabitable, the population gradually dispersed to parts of the adjacent mainland, including Greece, where city-states such as Mycenae began to flourish. It is not too much of a stretch to surmise that this great natural disaster caused the protracted collapse and dispersal of a civilization that re-rooted itself in Greece and eventually migrated westward into Europe.

The cataclysmic eruption on Thera may also have inspired an enduring mythological story. Orally transmitted tales could have been the basis for the legendary "lost continent of Atlantis" that appears in the writings of Plato (427-347 B.C.E.) and others—in which an island home of a rich and advanced civilization was catastrophically destroyed by earthquake and flood.

Notable Natural Disasters presents both the underlying principles and science behind disasters, and a description of the greatest or most memorable of such events. The significance of an event is related to the momentous nature of the occurrence, its effect and consequences. These can include the number of people killed or injured, harm to the health of humans and other life, environmental degradation, and human activity disrupted. In addition to immediate tragedy and turmoil, there can be local or widespread economic effects related to the ruin of infrastructure, the relocation of populations, and the impairment of public services or industrial and commercial activity.

This work is intended to be informational and educational, with interesting narrative details that contribute both a technical and a human dimension. By considering the causes, geographic frequency, and the likelihood of disasters, we will better understand their origins and also appreciate the need for anticipating many events of a geological, meteorological, technological, or environmental nature. With the benefit of hindsight and by studying the historical record, communities can attempt to design structures and modify lifestyles so that they are better equipped to withstand the consequences of hazards.

Robert S. Carmichael

Dust Storms and Sandstorms

Factors involved: Geological forces, human activity, plants, rain, weather conditions, wind
Regions affected: Deserts, plains, valleys

Definition

Dust storms and sandstorms are composed of airborne and windblown clouds of soil particles, mineral flakes, and vegetative residue that impact climate, air temperature, air quality, rainfall, desertification, agricultural productivity, human health, and human habitation of the land.

Science

Dust storms result from wind erosion, desertification, and physical deterioration of the soil caused by persistent or temporary lack of rainfall and wind gusts. Dust storms develop when wind velocity at 1 foot above soil level increases beyond 13 miles per hour, causing saltation and surface creep. In saltation, small particles are lifted off the surface, travel 10 to 15 times the height to which they are lifted, then spin downward with sufficient force to dislodge other soil particles and break down earth clods. In surface creep, larger particles creep along the surface in a rolling motion. The larger the affected area, the greater the cumulative effect of saltation and surface creep, leading to an avalanche of soil particles across the land, even during moderate wind gusts. The resulting soil displacement erodes the structure and texture of the remaining soils, reduces the moisture content of the soil, exposes bedrock, and limits the type of vegetation sustainable on the remaining soil.

Dust storms remove smaller and lighter soil particles, leaving behind the larger and denser particles and granular minerals associated with deserts, and erode rock surfaces, creating dust and granular particles. As soils become drier and more dense, and as ground cover is reduced, the number and intensity of subsequent dust storms increases. Arid or semiarid soil eventually becomes desert. Atmospheric dust increases soil and air temperature by trapping heat in the lower atmosphere. Dust may also reduce soil and air temperature by reflecting the sun's heating radiation back into space. Changes in air temperature, coupled with dust in the atmosphere and drier land surfaces, reduce local rainfall, encouraging desertification.

A dust storm approaches a Kansas town in 1935. (National Oceanic and Atmospheric Administration)

Dust storms result from the dislodging of small, light soil particles, mineral flecks, and decomposing vegetation matter. Dust storms rise miles into the atmosphere and have both local and global impacts. Sandstorms result from dislodging larger, heavier particles of soil and rock. They tend to occur in conjunction with desert cyclones. Sandstorms remain close to ground level and have primarily local impacts. Dust and sandstorms may occur simultaneously.

There are many types of dust storms. Haze reduces visibility to three-fourths of a mile or less and results from persistent wind gusts across arid soils or across temporarily dry or disturbed semi-arid soils. Dust devils lift silt and clay particles several hundred yards into the air. Tornadoes generate local vortices that lift silt, clay, mineral flecks, and vegetation residue more than a mile high and transport it hundreds of square miles. Cyclones form at the leading edge of thunderstorm cells, extending across a front of several hundred miles, generating winds up to 150 miles per hour, and lifting particles and debris several miles into the upper atmosphere and jet stream for distribution around the globe.

Geography

Dust storms and sandstorms of global significance originate in the arid deserts and semiarid lands covering 36 percent of the earth's land surface. Major deserts are

located in northern Africa, northeast Sudan, southwest Africa, the Arabian Peninsula, southwest Asia, the Middle East, northern and western China, central Australia, southwest North America, parts of southern and western South America, the Caucasus of Russia, central Spain, and the southern coast of the Mediterranean Sea. In addition, dust storms arise when normally semiarid lands periodically become arid, undergo abnormally strong windy periods, or have their vegetation removed by humans or nature. These areas include sub-Saharan Africa, the U.S. Midwest, the northern coast of the Mediterranean, the steppe of central Asia, and all lands immediately adjacent to deserts.

Globally significant storms cover areas of several hundred to several thousand square miles and transport dust from one continent to another. Locally significant dust storms originate in overly cultivated agricultural fields, residential or commercial developments denuded of ground cover, major road construction sites, and any lands experiencing a temporary drought. Local storms are often confined to only a few square miles in area.

Locales with the highest frequency of dust storms are Mexico City and Kazakhstan in central Asia, with about 60 storms per year; western and northern China, with 30 storms each year; West Africa, with 20 storms; and Egypt, with 10 storms. Storms of the longest known duration occurred in the southwestern United States, with a storm of twenty-eight days in Amarillo, Texas, in April, 1935, and a storm of twenty-two days in the Texas Panhandle in March of 1936.

Prevention and Preparations

The number and intensity of dust storms and sandstorms are reduced through soil conservation practices, such as covering the soil with vegetation, reducing soil exposure on tilled land, creating wind barriers, installing buffer strips around exposed soils, and limiting the number and intensity of soil disturbing activities on vulnerable arid and semiarid soils. Vegetative cover slows the wind at ground level, protects soil particles from detachment, and traps blowing or floating soil particles, chemicals, and nutrients. Because the greatest wind erosion damage often occurs during seasons when no crops are growing or when natural vegetation is dormant, dead residues and standing stubble of the previous crop often remain in place until the next planting season. Planting grass or legume cover crops until the next planting season, or as part of a crop rotation cycle or no-till planting system, also reduces dust.

No-till and mulch-till planting systems reduce soil exposure to wind erosion. No-till systems leave the soil cover undisturbed before inserting crop seeds into the ground through a narrow slot in the soil. Mulch-till planting keeps a high percentage of the dead residues of previous crops on the surface when the new crop is planted. Row

crops are planted at right angles to the prevailing winds to absorb wind energy and trap moving soil particles. Crops are planted in small fields to prevent avalanching caused by an increase in the amount of soil in particles transported by wind as the distance across bare soil increases.

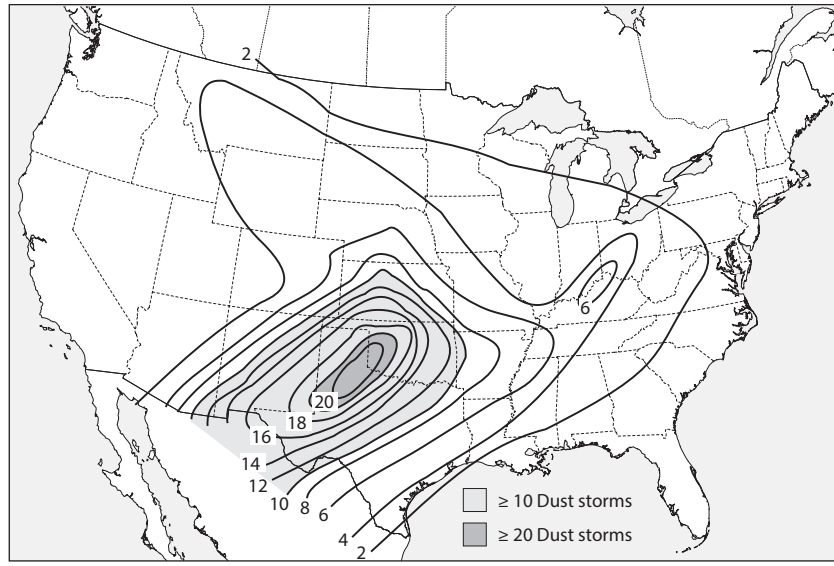
Because wind breaks slow wind speeds at the surface of the soil, good wind barriers include tree plantings, cross-wind strips of perennial shrubs, and high grasses. The protected area is ten times the height of the barrier. Alley cropping is used in areas of sustained high wind; crops are planted between rows of larger, mature trees.

Strip farming reduces field width, thereby reducing wind erosion. Large fields are subdivided into narrow cultivated strips. Planting crops along the contour lines around hills is called contour strip cropping. Planting crops in strips across the top of predominant slopes is called field stripping. Crops are arranged so that a strip of hay or sod, such as grass, clover, alfalfa, or a close-growing small grain, such as wheat or oats, is alternated with a strip of cultivated row crop, such as tobacco, cotton, or corn. In areas of high wind, the greater the average wind velocity, the narrower the strips. Blown dust from the row-crop strip is trapped as it passes through the subsequent strip of hay or grain, thereby reducing dust. Contour strip cropping or field stripping can reduce soil erosion by 65 to 75 percent.

Limiting land-disturbing activities by humans on highly vulnerable arid and semiarid soils reduces the number and intensity of both dust storms and sandstorms. Deserts are especially vulnerable to impacts of animal herds and motor-vehicle traffic. Many fragile desert plants, shrubs, and trees are easily destroyed by animal or human activity, especially foraging and vehicle traffic. The surface of the desert consists of a thin layer of small and microscopic plants, microorganisms, and insects, whose combined activities produce a thin crust that limits the impact of wind on the surface of the desert. When this crust is broken by surface traffic, the underlying sands and minerals are vulnerable to wind erosion. Natural repair to the broken crust and natural revegetation processes may take decades or centuries.

Rescue and Relief Efforts

Little can be done to protect humans, buildings, or crops from the impact of dry wind tornadoes or cyclones producing major dust storms or sandstorms, but soil conservation measures reduce the number and intensity of these storms. The effects of these storms on humans is partly ameliorated by remaining indoors, by wearing heavy clothing or remaining inside vehicles when outdoors, and by covering the nose and mouth to prevent the ingestion of dust, spores, and pollens.



The number of dust storms occurring in March, 1936, during the Dust Bowl years.

Impact

Sandstorms and dust storms have moved sufficient soil particles over the centuries to reshape continents; alter the distribution of plant and animal life; alternately heat and cool the earth; and silt rivers, lakes, and oceans. The volume of annual wind-blown dust is approximately equal to the volume of soil transported each year through water erosion. Approximately half a billion tons of dust is borne aloft each year, with more than half that dust deposited in the world's oceans.

The desertification processes associated with sandstorms and dust storms impacted the historic rise and fall of many civilizations, including the early Pueblo Indians of the American Southwest, the Harappan civilization of southwest Asia, the city-states of Arabia, and the caravan empires of sub-Saharan Africa. Dust storms on agricultural lands cause soil nutrient loss, reduce the moisture-retaining capacity of the soil, and concentrate salts and fertilizer acids in the soil, thereby reducing agricultural production. Efforts to replace lost topsoil with fertilizers have proven futile. Crop yields are reduced by up to 80 percent.

Sandstorms kill people and animals and damage, destroy, or bury roads, buildings, machinery, and agricultural fields. Many people and animals are killed each year by the force of the storms or by ingestion of wind-borne particles. In 1895, more than 20 percent of the cattle in eastern Colorado died of suffocation in a particularly intense dust storm.

Dust storms are a major source of air pollution and a major distribution vehicle for mold spores, pollens, and other harmful airborne particles. One pathogen causing "valley fever" or "desert rheumatism" kills approximately 120 people each year in the United States alone. Sandstorms and intense dust storms contribute to traffic accidents and disrupt mass-transportation systems. In many southwestern American states, dust storms are responsible for up to 20 percent of all traffic accident fatalities.

Gordon Neal Diem

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