# *Natural Disasters 11th edition Abbott Solutions Manual*

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# Instructor's Manual to Accompany Abbott/Natural Disasters, 11/e

## Chapter 1. Natural Disasters and the Human Population

Overview

Natural disasters occur worldwide, causing tens, even hundreds, of thousands of deaths, and tens of billions of dollars of damage per year. Such events include earthquakes, volcanic eruptions, tsunami, floods, landslides, wildfires, hurricanes, and tornadoes. While fatalities tend to be greatest in densely populated areas, financial and insurance losses from natural disasters are greatest in wealthy countries with more infrastructure to be damaged and where insurance coverage is greater. Knowledge of the size and frequency (or the inverse, return period) of past events helps in assessing the likelihood of future disasters and is essential in the development of mitigation strategies to minimize death and damage. Another part of the puzzle is accurate analysis of both benefits and costs of possible mitigation strategies.

The number of human beings on Earth has increased astronomically over time. The growth can be described as exponential growth, wherein the rate of population increase at any time depends on the population at that time. This produces ever more rapidly increasing numbers of people. A rule of thumb is that the time to double the population is roughly 70/growth rate (percent/year). Since the present-day growth rate is about 1.2%/year, this rule predicts that Earth's population should double in 58 years. The consequences of population increase include famine and increases in crime, pollution, disease, and overcrowding. Examples from history, such as the events on Easter Island, tell us that we have already reached the carrying capacity in some smaller regions and lead us to consider what the carrying capacity of the Earth is, in total, for humans.

Moreover, the growth rate itself has increased, from perhaps 0.0015%/year 10,000 years ago to its present rate of 1.2%/year. This is most likely due to increases in technology and public health that have allowed people over the centuries to progressively improve their housing, improve food and water supplies, fight disease, and survive childbirth. An increasing growth rate produces super-exponential population growth (population increases even faster than exponentially).

Today, the growth rate has decreased or is remaining constant in most developed countries, but it continues to rise in underdeveloped regions. This contrast might lead to optimism that underdeveloped countries, if we can increase their standard of living, might be able to reduce their population growth rates and achieve a stable population by reducing birth rates along with death rates. However, one must also consider the demographics. If a greater part of the population is young (of child-bearing age or younger), it is probable that population will increase rapidly even if birth rates are low.

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Learning Objectives

1. Identify the common types of natural disasters.

2. Understand the concepts of magnitude, frequency, and return period.

3. Understand the concepts of exponential growth and carrying capacity.

4. Be able to explain the factors that have led to increased growth rates over the millennia since human beings first evolved.

Changes to the 11th Edition

1. Natural disasters data all updated
2. World population updated to mid-2017
3. Several figures, tables and photos modified.
4. Text updates in several topics

Critical Thinking Questions

1. What natural disasters could strike your hometown? Research and discuss your town's history of disasters over the last 100 years.

2. Discuss why there have been rapid and very large increases in economic and insurance losses from natural disasters over the last 50 years.

3. There is an old story about a man who did a favor for a king, thereby saving the kingdom and preserving the king's reign. When the king asked what the man wanted for a reward, the man replied that he would like as many gold pieces as could cover a chess board, in the following scheme: one piece of gold would be placed on the first square, and for each successive square the gold pieces should be doubled: two on the second square, four on the third, etc. The king laughed loud and long at this response, thinking that he was paying off his debt to the man very cheaply. After all, how many gold pieces could it possibly take to cover a chessboard with its 64 squares?

    a) Answer the king's question: how many gold pieces would he need to pay? Did he get off cheaply?
    b) What is the doubling "interval" (expressed in chessboard squares) of the gold? Discuss how this story relates to the concept of exponential growth discussed in Chapter 1.

4. Consider population distribution, i.e., the relative numbers of people of different ages in a population. For a population of a given size, what distribution would produce the lowest growth rate? What distribution would produce the highest growth rate? Is there a distribution that could maintain a stable population? Discuss.

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## Chapter 2. Internal Energy and Plate Tectonics

Overview

The early history of the Solar System and Earth are introduced and the sources of Earth's internal energy are discussed. The most basic divisions of the Earth are crust, mantle, and core. The core is the innermost and densest region, composed mainly of iron with a solid inner part and a liquid outer part. Circulation in the outer core creates the Earth's magnetic field. The rocky mantle, extending from close to the Earth's surface to roughly half the Earth's radius, is the second densest region. The shallowest and least dense part of the solid Earth is the rocky crust.

With the exception of the uppermost part, the mantle is hot enough that it flows in a ductile manner even though it is mostly solid. A ductile region near Earth's surface is called the asthenosphere. The lithosphere floats buoyantly on top of the asthenosphere like icebergs float in seawater. Loads, such as those due to ice sheets or mountain belts, change the pressure in the underlying asthenosphere and cause it to flow; the crust is thus made to move up or down. This process of buoyancy-driven vertical motion of the surface of the Earth is known as isostasy. The concept of isostasy is introduced explaining how the lithosphere compensates for varying density and topography in an Earth that can flow and adjust to lateral variations.

The outermost region of the Earth (crust plus uppermost mantle) is cold and strong, and is organized into a number of thin but very wide lithospheric plates. According to the theory of plate tectonics, the relative motions of these plates are responsible for most earthquakes, volcanic eruptions, and mountain-building on Earth. A new plate is formed by up-welling and solidification of magma at divergent plate boundaries, and old plates are recycled into the mantle at subduction zones, one type of convergent plate boundary. Evidence for plate tectonics includes the shape of continental outlines, fossil correlations, sea-floor magnetization, earthquake locations, locations of mid-ocean ridges and trenches, deep earthquakes defining subduction zones, the distribution of sea-floor of different age, hot-spot tracks, thickness of marine sediments, and the distribution of ocean water depth.

The concept of Uniformitarianism, first discussed by James Hutton, suggests that the gradual processes we observe today, operating over immense time spans, are responsible for the major changes and events we see in the geological record. Thus the present is the key to the past.

Natural disasters necessarily involve the concentration and release of energy. Sources of energy include impacts of extraterrestrial objects, gravity, the Earth's internal heat generated from radioactive decay, and the external energy supplied by the Sun.

Energy and mass are transferred from place to place within the Earth, oceans, and atmosphere, driving the rock and hydrologic cycles and changing the surface of the Earth. In the rock cycle, rocks are eroded to sediments, perhaps buried and cemented to form

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sedimentary rocks or heated and deformed to make metamorphic rocks, or melted to magma, which later crystallizes as igneous rock. Any of these might subsequently be exposed anew at the Earth's surface to be eroded. In the hydrologic cycle, water evaporates, falls back to the Earth as rain or snow, flows over land or underground to rivers, lakes, and oceans, where it may be evaporated again and undergo another round. The release of energy from the Earth's interior drives the construction of topography. Competing with this is the destruction of topography caused by the motion of water and pull of gravity across the Earth's surface.

## Learning Objectives

1. Identify the basic divisions of the Earth (crust, mantle, core; lithosphere, asthenosphere).

2. Be able to explain the difference between brittle, ductile, and elastic deformation. Suggest places in the Earth (e.g., surface, at depth) where each style of deformation is likely to be dominant.

3. Understand isostasy and how mountain ranges are supported.

4. Understand how the principle of Uniformitarianism provides a means for understanding the geological past through observing present-day processes.

5. Understand energy concepts: where does the energy for natural disasters come from?

6. Understand how water and rock move through the hydrologic and rock cycles, respectively.

## Changes to the 11th Edition

1. New maps of global earthquake epicenters and ocean-floor ages
2. Expanded coverage of plumes versus hot spots
3. Text and figure captions clarified in several places.
4. Five years after Japan 2011 radioactivity disasters

## Critical Thinking Questions

1. The lithospheric plates move around the surface of the Earth, but the surface area of the Earth has not changed over geological time. If a new spreading center (divergent plate boundary) were to develop, what other plate changes might also occur at the same time?

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2. Figure 2.25 shows the evolution of the continents with time. Using these to extrapolate, what do you think the continental configuration will look like 50 million years in the future?

3. Ancient mythological and religious tales often ascribe catastrophic events to the anger of God or the gods. Do you think any of these catastrophes might actually be natural events? Which ones?

4. The structure of the whole Earth can be thought of as an onion. Why does it take on this form? What role does density play in the organization of the structure of the whole Earth? Does the density of the inner layers increase uniformly throughout the Earth? What are the implications of this?

5. There are three different styles of rock deformation: brittle, ductile, and elastic. Can you identify various common objects (e.g., foods) that show these styles of deformation?

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