

Water on the Earth

Elaine Mao



Water makes up nearly three-quarters of the Earth's surface, but it does more than just cover our planet - it also plays a vital role in shaping it.

Consider the Grand Canyon. Measuring 277 miles long, 18 miles wide and more than 1 mile deep, it is considered one of the Seven Natural Wonders of the World and attracts more than 5 million visitors per year. This geological marvel was created by the waters of the Colorado River through the processes of weathering and erosion. Weathering is the process by which moving water breaks down soil, rock and minerals, and erosion is the process by which the flowing water transports soil and rock from one spot and deposits it elsewhere. The two processes often occur in conjunction.

Weathering and erosion are very slow processes. Geologists believe the Colorado River has been flowing through the Grand Canyon for at least 17 million years, and it has been gradually shaping the canyon this entire time. The flowing water of the river and its tributaries has carved away at the rock of the Colorado Plateau, creating the sight we are familiar with today.

Caves and caverns are another example of weathering and erosion. Limestone caves, such as the Carlsbad Caverns in New Mexico, are formed when rainwater mixes with carbon dioxide in the ground and wears away at the limestone. Sea caves, which can be found along coastlines, are formed when powerful waves crash against the shore and break away chunks of rock. Ice caves are formed when glaciers melt, and the ice melt flows across the ground as a stream.

You don't have to travel very far to see the effects of weathering and erosion for yourself, though. If you've ever been to the beach, you've already seen evidence of how powerful of a force moving water can be—and all you had to do was look down. The sand covering the beach is actually the result of rocks being broken down into tiny pieces and then washed ashore by the waves.

Although weather and erosion are responsible for creating beautiful sights such as sandy beaches and the Grand Canyon, there are many negative consequences as well. Landslides are some of the most dangerous side effects of erosion. When hillsides or mountainsides are gradually worn away, they can become unstable and break down, especially when triggered by extreme weather such as floods, heavy rain or snow. Every year, landslides cause massive amounts of property damage and casualties.

Erosion is a natural process, and it is often beneficial for the planet. However, excessive erosion can cause major problems, including desertification and the ecological collapse of entire areas. If erosion happens at a pace faster than the land can regenerate itself, this can render the land desert-like and incapable of supporting life. Believe it or not, soil is actually a valuable and nonrenewable resource, as it contains nutrients and minerals crucial for agricultural productivity. It takes thousands and thousands of years to build up enough soil in a region for the land to be productive, but erosion can wear it away much faster than that, especially at the rate it has been occurring in recent decades. Over the past 40 years, the world has lost 30 percent of its agriculturally productive land as a result of erosion.

Although erosion occurs naturally at a very slow rate, human activities have sped up the process by an estimated 10 to 40 times globally. The biggest culprit is unsustainable agricultural practices and the industrialization of agriculture. The mechanized equipment used in modern agriculture allows for deep plowing of the soil. This breaks the soil into finer particles, which is desirable for agriculture because it facilitates planting and also increases the plants' access to oxygen. However, deep plowing also increases the amount of soil that is vulnerable to being washed away by erosion. Throughout much of history, plowing had to be done manually, and it was a labor-intensive process. With the mechanization of agriculture, farmers are able to plow much deeper and more often than ever before, resulting in disastrous consequences for soil quality.

The effect of erosion on soil productivity has been felt all over the world, in Africa, Asia, Australia, New Zealand, the United States and Southern and Eastern Europe. In more affluent countries, the use of artificial fertilizer has become more prevalent as a way to offset the reduction in soil quality that occurs when the nutrient-rich layers of topsoil are washed away. However, this in turn has created a new set of problems. Over-application of fertilizer is common, and much of the excess gets washed away and transported to nearby bodies of water, where the nutrients in the fertilizer can upset the local ecosystem.

Deforestation has also played a role in the rapid increase in erosion globally. Trees and plant roots naturally bind the soil and anchor it to prevent too much from being washed away. They also provide cover and reduce the speed at which rain hits the ground, absorbing much of the impact. This allows the water to trickle to the ground and absorb slowly, rather than flow over the surface and wash away the soil. Deforestation of lands for agriculture and development has rendered large regions of the world unproductive. The effect is amplified in areas that are used for urban development, where the ground is covered with a layer of asphalt or concrete. These surfaces make it difficult for water to penetrate the ground, and increase the volume of runoff to surrounding areas. In addition, the runoff from urban areas is often polluted with fuel, oil and other chemicals.

Lastly, climate change has led to more extreme climate events, including extreme rainfall and hurricanes. Scientists predict that increased rainfall intensity and quantity will lead to greater rates of erosion. Rising sea levels have also increased the rate of coastal erosion, which has been increasingly problematic for low-lying developed areas along the coast, such as in Florida and Hawaii.

As erosion has become a bigger problem in past decades, scientists have been working to better understand the phenomenon. In 1965, American scientists came up with the Universal Soil Loss Equation, a way to estimate soil erosion by raindrop impact and surface runoff. The mathematical equation has since been applied all over the world, helping scientists predict which conservation measures will have the greatest impact on reducing soil loss.

Scientists have found that the most effective way to reduce soil loss from erosion is to increase the amount of vegetative cover (from grass, plants and trees, for example) on the ground. In recent years, there has also been a gradual shift toward more ecologically conscious agricultural practices. Societies around the world have begun to feel the devastating effects of decades of unsustainable agricultural practices and deforestation, and many have started taking preventative measures. As the consequences of modern industrial agriculture have become apparent, farmers have been encouraged to take steps to reduce erosion. It is now considered good practice to minimize plowing of the land to preserve the integrity of the soil. Crop rotation is a good alternative: planting different kinds of crops can improve soil structure and keep the soil enriched with necessary nutrients and minerals, and with better soil, frequent plowing becomes less necessary.

However, despite all measures to prevent soil loss, it's important to remember that humans will never have complete control over the processes of weathering and erosion. Water will continue to shape the world we live in, sometimes for better and sometimes for worse, and it's up to us to simply make the best of it.

Name: _____ Date: _____

1. What are the processes by which water can shape the Earth?

- A deforestation and climate change
- B weathering and erosion
- C soil productivity and fertilization
- D deep plowing and agriculture

2. What does the author list and describe in the passage?

- A the positive effects of industrialization
- B the tourism industry around the Grand Canyon
- C the history of climate change
- D the ways that moving water can shape and change the land

3. Excess erosion can be a large problem. What details from the text support this conclusion?

- A Rapid erosion can leave the land desert-like and unable to sustain life.
- B Beautiful and massive structures like the Grand Canyon are made by erosion.
- C The Universal Soil Loss Equation estimates soil erosion by raindrop impact and surface runoff.
- D Weathering and erosion turn rocks into sand.

4. How does the author present the Grand Canyon and the Carlsbad Caverns?

- A as effects of landslides
- B as geological mysteries
- C as negative effects of erosion
- D as positive effects of erosion

5. What is the main idea of this passage?

- A Erosion is a natural process, and it is often beneficial for the planet.
- B Agricultural practices and industrialization are changing to address the issues of erosion.
- C Erosion and weathering are powerful effects of water that can have harmful effects.
- D Deforestation has played a role in the rapid increase in erosion globally.

6. Read the following sentences: "In recent years, there has also been a gradual shift toward more ecologically conscious agricultural practices. Societies around the world have begun to feel the devastating effects of decades of **unsustainable** agricultural practices and deforestation, and many have started taking preventative measures."

As used in the passage, what does the word "**unsustainable**" mean?

- A dangerous to farmers
- B not able to be maintained
- C very important
- D unhealthy to animals

7. Choose the answer that best completes the sentence below.

Human activities have sped up the process of erosion by an estimated 10 to 40 times globally. _____, farmers have been encouraged to take steps to reduce erosion.

- A Before
- B Since
- C Consequently
- D Because

8. Describe how the Grand Canyon formed.

9. What are some of the main reasons for the large global increase in the rate of erosion?

10. Has the rapid rise of erosion rates been adequately recognized by farmers and scientists as a problem? Use specific evidence from the passage to support your answer.

Teacher Guide & Answers

Passage Reading Level: Lexile 1300

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8. Describe how the Grand Canyon formed.

Suggested answer: The flow of the Colorado River has been breaking down the rock of the Colorado Plateau for the last 17 million years, carving out the canyon.

9. What are some of the main reasons for the large global increase in the rate of erosion?

Suggested answer: Unsustainable agricultural practices, the industrialization of agriculture, and deforestation have all sped up the rate of erosion.

10. Has the rapid rise of erosion rates been adequately recognized by farmers and scientists as a problem? Use specific evidence from the passage to support your answer.

Suggested answer: Answers may vary and should be supported by the passage. Students could agree by citing the development of the Universal Soil Loss Equation, the discovery that increasing vegetative cover can reduce soil loss, and the fact that farmers now consider it good practice to minimize plowing. Students could disagree by emphasizing that the author identified the shift toward ecologically conscious agricultural practices as "gradual," and that societies have only "started" taking preventative measures.