# Fairfield Public Schools
# Science Curriculum

## The Dangerous Planet:
## Natural Disasters and Catastrophes

# The Dangerous Planet: Description

The Earth is a dynamic planet! Hurricanes, earthquakes, floods, tsunamis …What causes these natural disasters? Are they getting worse? In this course you will discover Earth's raw power and its ability to create and destroy. From there we will investigate engineering solutions and the resilience of humankind.

**Standards for this course are taken from the *Next Generation Science Standards* and are of three types:**

**Disciplinary Core Ideas (DCIs)**: Shown as content objectives, these standards define what students should know about the most essential ideas in the major science disciplines. The focus is on a limited number of core ideas in science and engineering both within and across the disciplines to avoid the shallow coverage of a large number of topics and to allow more time for teachers and students to explore each idea in greater depth. Reduction of the sheer sum of details to be mastered is intended to give time for students to engage in scientific investigations and argumentation and to achieve depth of understanding of the core ideas presented.

**Science and Engineering Practices (SEP)**: These standards enable students to apply the content in the DCI's and the skills of practicing scientists and engineers to explain phenomena and solve real world problems. Engaging in the practices of science helps students understand how scientific knowledge develops; such direct involvement gives them an appreciation of the wide range of approaches that are used to investigate, model, and explain the world. Engaging in the practices of engineering likewise helps students understand the work of engineers, as well as the links between engineering and science.

**Crosscutting Concepts:** These standards provide students with connections and intellectual tools that are related across the differing areas of disciplinary content and can enrich their application of practices and their understanding of core ideas. These broad concepts tie together the influence of engineering, technology, and science on society and the natural world.

http://www.nextgenscience.org/next-generation-science-standards

# The Dangerous Planet: Natural Disasters and Catastrophes

## Enduring Understandings

The geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation and human activities.
Motions of the mantle and the plates occur primarily through thermal convection, which involves the cycling of matter due to the outward flow of energy from Earth's interior and inward movement of denser materials. These processes lead to earthquakes and volcanoes.
The many dynamic feedbacks between the biosphere, geosphere and hydrosphere cause a continual co-evolution of Earth's surface and the life that exists on it.

## Course Essential Questions

- How is the earth structured, and what implications does that have for life on the surface?
- How does the hydrosphere interact with the geosphere?
- What are the interactions between weather, climate and humans?

# The Dangerous Planet: Semester-at-a-Glance

| Unit | Title | Unit Essential Questions |
|---|---|---|
| 1 | Earthquakes and Volcanoes | • Why does the ground shake?<br>• Why are tsunami waves so devastating?<br>• Why are there no volcanoes in CT? Where did the igneous rock come from? |
| 2 | Floods | • Why do certain areas flood?<br>• How can we design against flooding?<br>• How do humans cause flooding? |
| 3 | Hurricanes and Tsunamis | • Are hurricanes getting stronger?<br>• Why are tsunami waves so devastating?<br>• How can we protect ourselves from hurricanes? |

# Unit 1: Earthquakes and Volcanoes

## Overview

Radioactive decay in the core provides the energy that powers movement within the earth, causing many natural disasters. Movement of the plates results in earthquakes (and secondarily tsunamis) and volcanoes.

## Performance Expectations

**At the conclusion of this unit, students will be able to:**

**HS-ESS1-5.** Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.

**HS-ESS2-1.**Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.

**HS-ESS2-3.** Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection.

**HS-ESS2-5.** Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.

## Unit Essential Question

- Why does the ground shake?
- Why are there no volcanoes in CT? Where did the igneous rock come from?

## Crosscutting Concepts

**Patterns**

Empirical evidence is needed to identify patterns. (HS-ESS1-5)

**Stability and Change**

Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. (HS-ESS2-1)

**Energy and Matter**

Energy drives the cycling of matter within and between systems. (HS-ESS2-3)

**Structure and Function**

The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials. (HS-ESS2-5)

## NGSS Unit Standards

**DISCIPLINARY CORE IDEAS (DCI):**

**ESS1.C: The History of Planet Earth**

- Continental rocks, which can be older than 4 billion years, are generally much older than the rocks of the ocean floor, which are less than 200 million years old. (HS-ESS1-5)

**ESS2.B: Plate Tectonics and Large-Scale System Interactions**

- The radioactive decay of unstable isotopes continually generates new energy within Earth's crust and mantle, providing the primary source of the heat that drives mantle convection. Plate tectonics can be viewed as the surface expression of mantle convection. (HS-ESS2-3)
- Plate tectonics is the unifying theory that explains the past and current movements of the rocks at Earth's surface and provides a framework for understanding its geologic history. (HS-ESS2-1)
- Plate movements are responsible for most continental and ocean floor features and for the distribution of most rocks and minerals within Earth's crust (HS-ESS2-1)

**PS4.A Wave properties**

- Geologists use seismic waves and their reflection at interfaces between layers to probe structures deep in the planet. (secondary to HS-ESS2-3)

**ESS2.A - Earth materials and systems**

- Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. (HS-ESS2-1), (HS-ESS2-2)
- Evidence from deep probes and seismic waves, reconstructions of historical changes in Earth's surface and its magnetic field, and an understanding of physical and chemical processes lead to a model of Earth with a hot but solid inner core, a liquid outer core, and a solid mantle and crust. Motions of the mantle and its plates occur primarily through thermal convection, which involves the cycling of matter due to the outward flow of energy from Earth's interior and gravitational movement of denser materials toward the interior. (HS-ESS2-3)

**ESS2.C: The Roles of Water in Earth's Surface Processes**

- The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower the viscosities and melting points of rocks. (HS-ESS2-5)

**SCIENCE AND ENGINEERING PRACTICES (SEP):**

**Engaging in Argument from Evidence**

- Evaluate evidence behind currently accepted explanations or solutions to determine the merits of arguments. (HS-ESS1-5)

**Developing and Using Models**

- Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-ESS2-1), (HS-ESS2-3)

**Planning and Carrying Out Investigations**

- Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-ESS2-5)

**Corresponding CT Core Standards:**

**ELA/Literacy –** WHST.9-12.2, RST.11-12.8, RST.11-12.1, RST.11-12.2, WHST.9-12.7, SL11-12.5

**Mathematics –** MP.2, MP.4, HSN-Q.A.1, HSN-Q.A.2, HSN-Q.A.3

# Unit 2: Floods

## Overview

Floods drastically alter the earth and can take place in a matter of minutes. It's up to us to adapt to and interact with the environment in a safe and meaningful way.

## Performance Expectations

**At the conclusion of this unit, students will be able to:**

**HS-ESS2-5.** Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.

**HS-ESS3-1**. Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.

**HS-ESS3-3.** Create a computational simulation to illustrate the relationships among the management of natural resources, the sustainability of human populations, and biodiversity.

**HS-ESS3-4**. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

## Unit Essential Questions

- Why do certain areas flood?
- How can we design against flooding?
- How do humans cause flooding?

## Crosscutting Concepts

**Structure and Function**

- The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials. (HS-ESS2-5)

**Cause and Effect**

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-ESS3-1)

**Stability and Change**

- Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. (HSESS3-3),(HS-ESS3-5)
- Feedback (negative or positive) can stabilize or destabilize a system. (HSESS3-4)

## NGSS Unit Standards

**DISCIPLINARY CORE IDEAS (DCI):**

**ESS2.C: The Roles of Water in Earth's Surface Processes**

- The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower the viscosities and melting points of rocks. (HS-ESS2-5)

**ESS3.A: Natural Resources**

- Resource availability has guided the development of human society. (HS-ESS3-1)

**ESS3.B: Natural Hazards**

- Natural hazards and other geologic events have shaped the course of human history; they have significantly altered the sizes of human populations and have driven human migrations. (HS-ESS3-1)

**ESS3.C: Human Impacts on Earth Systems**

- The sustainability of human societies and the biodiversity that supports them require responsible management of natural resources. (HS-ESS3-3)
- Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation. (HS-ESS3-4)

**SCIENCE AND ENGINEERING PRACTICES (SEP):**

**Planning and Carrying out Investigations**

- Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-ESS2-5)

**Using Mathematics and Computational Thinking**

- Create a computational model or simulation of a phenomenon, designed device, process, or system. (HS-ESS3-3)

**Constructing Explanations and Designing Solutions**

- Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS-ESS3-1)
- Design or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ESS3-4)

**Corresponding CT Core Standards:**

**ELA/Literacy –** WHST.9-12.7, RST.11-12.1, RST.11-12.8, WHST.9-12.2

**Mathematics –** MP.2, MP.4, HSN-Q.A.1, HSN-Q.A.2, HSN-Q.A.3

# Unit 3: Hurricanes and Tsunamis

## Overview

Water's ability to absorb solar energy contributes to the formation of hurricanes (typhoons) and tsunamis. Engineers can design buildings to withstand the impact of high impact winds and flooding. We can also engineer natural solutions to increase an area's natural ability to absorb an impact.

## Performance Expectations

**At the conclusion of this unit, students will be able to:**

**HS-ESS2-4.** Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.

**HS-ESS3-4**. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

## Unit Essential Questions

- Are hurricanes getting stronger?
- Why are tsunami waves so devastating?
- How can we protect ourselves from hurricanes?

## Crosscutting Concepts

**Cause and Effect**

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-ESS2-4)

**Stability and Change**

- Feedback (negative or positive) can stabilize or destabilize a system. (HSESS3-4)

## NGSS Unit Standards

**DISCIPLINARY CORE IDEAS (DCI):**

**ESS1.B: Earth and the Solar System**

- Cyclical changes in the shape of Earth's orbit around the sun, together with changes in the tilt of the planet's axis of rotation, both occurring over hundreds of thousands of years, have altered the intensity and distribution of sunlight falling on the earth. These phenomena cause a cycle of ice ages and other gradual climate changes. (secondary to HS-ESS2-4)

**ESS2.A: Earth Materials and Systems**

- The geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles. (HS-ESS2-4)

**ESS2.D: Weather and Climate**

- The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems and this energy's re-radiation into space. (HSESS2-2) (HS-ESS2-4)
- Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. (HS-ESS2-6), (HS-ESS2-4)

**ESS3.C: Human Impacts on Earth Systems**

- Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation. (HS-ESS3-4)

**SCIENCE AND ENGINEERING PRACTICES (SEP):**

**Developing and Using Models**

- Use a model to provide mechanistic accounts of phenomena. (HS-ESS2-4)

**Connections to Nature of Science**

- Science arguments are strengthened by multiple lines of evidence supporting a single explanation. (HS-ESS2-4)

**Constructing Explanations and Designing Solutions**

- Design or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ESS3-4)

**Corresponding CT Core Standards:**

**ELA/Literacy –** RST.11-12.1, WHST.9-12.1, WHST.9-12.7, SL11-12.5, RST.11-12.8

**Mathematics –** MP.2, MP.4, HSN-Q.A.1, HSN-Q.A.2, HSN-Q.A.3