Core Idea ESS3 Vocabulary

Earth and Human Activity

How do Earth's surface processes and human activities affect each other?

- Earth
- human activities
- planetary systems
- resource
- renewable or replaceable
- Natural hazards
- Population
- climate change
- biosphere
- modeling
- climate

ESS3.A: NATURAL RESOURCES

How do humans depend on Earth's resources?

- Earth's land, ocean, atmosphere, and biosphere
- resources, including air, water, soil, minerals, metals, energy, plants, and animals
- resources that are renewable over human lifetimes
- resources that are nonrenewable (mineral resources and fossil fuels)
- resources that are irreplaceable if lost (extinct species).
- Materials important to modern technological societies are not uniformly distributed across the planet (e.g., oil in the Middle East, gold in California).
- Elements
- Earth's crust
- Resource extraction
- fresh water availability
- food production via agriculture
- commerce
- geopolitical relationships
- scarcity
- value
- All forms of resource **extraction** and land use have associated economic, social, environmental, and geopolitical **costs** and **risks**, as well as **benefits**.
- scientific modeling
- long-term environmental impact

Grade Band Endpoints for ESS3.A

By the end of grade 2.

- **Living things** need **water**, **air**, and **resources** from the **land**, and they try to live in places that have the things they need.
- natural resources
- **soil** and **water** to grow **food**
- **wood** to burn to provide heat or to build shelters
- **materials** such as **iron** or **copper** extracted from Earth to make cooking pans.

By the end of grade 5.

- All materials, energy, and fuels that humans use are derived from **natural** sources, and their use affects the **environment** in multiple ways.
- Some resources are **renewable** over time, and others are not.

By the end of grade 8.

- Earth's land, ocean, atmosphere, and biosphere
- Minerals, fresh water, and biosphere **resources** are limited, and many are not **renewable** or **replaceable** over human lifetimes.
- These resources are **distributed** unevenly around the planet as a result of past geological processes (link to ESS2.B).
- Renewable energy resources, and the technologies to exploit them, are being rapidly developed.

By the end of grade 12.

- Resource availability has guided the development of human society.
- All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks, as well as benefits.
- New technologies and regulations can change the balance of these factors.

ESS3.B: NATURAL HAZARDS

How do natural hazards affect individuals and societies?

- Natural processes
    - earthquakes, tsunamis, volcanic eruptions, severe weather, floods, and coastal erosion
- Understanding these kinds of hazards helps us prepare for and respond to them.

Natural hazards and other geological events have shaped the course of human history, sometimes significantly altering the size of human populations or driving human migrations.

- natural hazard
- Loss of life and economic costs have been greatly reduced by improving construction, developing warning systems, identifying and avoiding high-risk locations, and increasing community preparedness and response capability.
- Magma
- Earthquake
- mapping of fault
- satellite monitoring of weather patterns
- forecast
- **Natural hazards** and other **geological events** have shaped the course of human history, sometimes significantly **altering** the size of human populations or driving human migrations.
- Natural hazards can be **local**, **regional**, or **global** in origin, and even local events can have distant impacts because of the interconnectedness of human societies and Earth's systems.
- Human activities can contribute to the **frequency** and **intensity** of some natural hazards (e.g., flooding, forest fires), and risks from natural hazards increase as populations—and population densities—increase in vulnerable locations.

Grade Band Endpoints for ESS3.B

By the end of grade 2.

- severe weather
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By the end of grade 5.

- hazards result from natural processes (e.g., earthquakes, tsunamis, volcanic eruptions, severe weather, floods, coastal erosion).
- natural hazards
- impacts

By the end of grade 8.

- Some **natural hazards**, such as volcanic eruptions and severe weather, are preceded by **phenomena** that allow for **reliable**
- prediction
- unpredictable
- geological forces
- forecast

By the end of grade 12.

- arable land
- These events have significantly altered the sizes of **human populations** and have driven **human migrations**.

- Natural hazards can be **local**, **regional**, or **global in origin**
- **risks** increase with populations growth.
- Human activities can contribute to the **frequency** and **intensity** of some natural hazards.

ESS3.C: HUMAN IMPACTS ON EARTH SYSTEMS

How do humans change the planet?

- chemical and geological **evidence**
- evidence
- human activities in agriculture, industry, and everyday life have had major **impacts** on the land, rivers, ocean, and air.
- Humans affect the **quality**, **availability**, and **distribution** of Earth's water through the **modification** of streams, lakes, and groundwater.
- Large areas of land, including such delicate **ecosystems** as **wetlands**, **forests**, and **grasslands**, are being **transformed** by human agriculture, mining, and the expansion of settlements and roads.
- Human activities now cause **land erosion** and **soil movement** annually that exceed all natural processes.
- Air and water **pollution** caused by human activities affect the condition of the atmosphere and of rivers and lakes, with **damaging effects** on other species and on human **health**.
- The activities of humans have significantly **altered** the **biosphere**, **changing** or destroying **natural habitats** and causing the **extinction** of many living species.
- These changes also affect the viability of **agriculture** or **fisheries** to support human populations.
- **Land use patterns** for agriculture and **ocean use patterns** for fishing are affected not only by changes in population and needs but also by changes in **climate** or local conditions (such as **desertification** due to overuse or **depletion** of fish populations by **overextraction**).
- Thus humans have become one of the most significant **agents of change** in the near-surface Earth system.
- And because all of **Earth's subsystems** are **interconnected**, changes in one system can produce **unforeseen changes** in others.
- advanced technologies
- sustainability
- ecosystems
- human population grows
- per-capita consumption of natural
- developed lifestyles
- longevity
- human impacts

- negative effects
- reversible
- responsible management
- treating sewage
- reducing the amount of materials
- use, and reusing and recycling materials
- **Regulations** regarding water and **air pollution** have greatly reduced **acid rain** and **stream pollution**, and **international treaties** on the use of certain refrigerant gases have halted the growth of the annual **ozone hole** over Antarctica.
- **Regulation of fishing** and the development of **marine preserves** can help restore and maintain **fish populations**.
- alternative energy sources
- environmental impacts
- fossil fuels
- sustainability of human societies
- biodiversity
- adverse impacts
- Scientists and engineers
- developing technologies
- ecosystem degradation.

Grade Band Endpoints for ESS3.C

By the end of grade 2.

- Things that people do to **live** comfortably can **affect** the world around them.
- But they can make **choices** that **reduce their impacts** on the land, water, air, and other living things—for example, by reducing **trash** through **reuse** and **recycling**.

Recorded history, as well as chemical and geological evidence, indicates that human activities in agriculture, industry, and everyday life have had major impacts on the land, rivers, ocean, and air.

By the end of grade 5.

- **Human activities** in agriculture, industry, and everyday life have had major **effects** on the land, vegetation, streams, ocean, air, and even outer space.
- But individuals and communities are doing things to help protect Earth's resources and environments:
    - **treating** sewage
    - **reducing** the amounts of materials they use

- **regulating** sources of pollution such as emissions from factories and power plants or the runoff from agricultural activities.

By the end of grade 8.

- Human activities have significantly **altered** the **biosphere**, sometimes damaging or destroying **natural habitats** and causing the **extinction** of many other species.
- But changes to Earth's environments can have different **impacts** (negative and positive) for different living things.
- Typically, as **human populations** and **per-capita consumption** of natural resources increase, so do the **negative impacts** on Earth unless the activities and technologies involved are engineered otherwise.

By the end of grade 12.

- The **sustainability** of human societies and the **biodiversity** that supports them requires **responsible management** of **natural resources**.
- **Scientists** and **engineers** can make major contribution
  - developing technologies that produce less pollution and waste and that preclude ecosystem degradation.
- When the source of an **environmental problem** is understood and **international agreement** can be reached, human activities can be regulated to **mitigate** global impacts (e.g., acid rain and the ozone hole near Antarctica).

ESS3.D: GLOBAL CLIMATE CHANGE

How do people model and predict the effects of human activities on Earth's climate?

- Global climate change
- Drivers
- natural phenomena
- human activities
- consequences
- Earth's surface systems, including the **biosphere**
- Humans are now so numerous and **resource dependent** that their activities affect every part of the environment, from outer space and the **stratosphere** to the deepest ocean.
- science-based predictive models
- long-term change
- plan
- Global changes
- accumulated human knowledge
- scientific research
- historical records
- weather conditions
- **phenology** or times when plants bloom, animals give birth or migrate, and lakes and rivers freeze and thaw

- And scientists can **deduce** long-past climate **conditions** from such sources as **fossils**, pollen grains found in sediments, and **isotope ratios** in samples of ancient materials.
- mathematical climate models
- simulation
- physics and chemistry of the many Earth systems and their **complex interactions** with each other.
- computational models
- existing evidence
- patterns
- forecast
- impacts of climate change are uneven and may affect some regions, species, or human populations more severely than others.
- **Climate models** are important tools for
    - **predicting**, for example, when and where new water supplies will be needed,
    - when and which **natural resources** will become **scarce**,
    - how weather **patterns** may change and with what **consequences**,
    - whether proposed technological concepts for controlling **greenhouse gases** will work, and how soon people will have to leave low-lying coastal areas if sea levels continue to rise.
    - discoveries are being made for example,
        - about how the **biosphere** is responding to the climate changes that have already occurred,
        - how the **atmosphere** is responding to changes in **anthropogenic greenhouse gas emissions**, and
        - how **greenhouse gases** move between the ocean and the atmosphere over long periods.
    - Such information, from **models** and other scientific and engineering efforts, will continue to be essential to **planning** for humanity's—and the global climate's—future.
- It is important to note that although **forecasting** the **consequences** of **environmental change** is crucial to society, it involves so many **complex phenomena** and uncertainties that **predictions**, particularly long-term predictions, always have **uncertainties**.
- These arise not only from uncertainties in the underlying **science** but also from uncertainties about **behavioral**, **economic**, and **political factors** that affect human activity and changes in activity in response to recognition of the problem.
- However, it is clear not only that human activities play a major role in climate change but also that impacts of **climate change**—for example,
    - increased frequency of severe storms due to **ocean warming**—have begun to influence human activities.
    - The prospect of future impacts of climate change due to further increases in **atmospheric carbon** is prompting consideration of how to avoid or restrict such increases.

Grade Band Endpoints for ESS3.D

By the end of grade 2.

- [Intentionally left blank.]

By the end of grade 5.

- If Earth's global **mean temperature** continues to rise, the lives of humans and other organisms will be **affected** in many different ways.

By the end of grade 8.

- Human **activities**, such as the release of **greenhouse gases** from **burning fossil fuels**, are major factors in the current rise in Earth's **mean surface temperature** (global warming).
- Reducing human vulnerability to whatever climate changes do occur depend on the understanding of **climate science**, engineering capabilities, and other kinds of knowledge, such as understanding of human behavior and on applying that knowledge wisely in decisions and activities.

By the end of grade 12.

- **Global climate models** are often used to understand the process of **climate change** because these changes are **complex** and can occur slowly over **Earth's history.**
- Though the magnitudes of humans' impacts are greater than they have ever been, so too are humans' abilities to **model**, **predict**, and **manage current** and future impacts.
- Through **computer simulations** and other studies, important discoveries are still being made about how the ocean, the **atmosphere**, and the **biosphere interact** and are modified in response to human activities, as well as to changes in human activities.
- Thus **science** and **engineering** will be essential both to understanding the possible impacts of **global climate change** and to informing decisions about how to slow its rate and consequences—for humanity as well as for the rest of the planet.