HS-ESS3 Earth and Human Activity

Students who demonstrate understanding can:

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. [Clarification Statement: Examples of key natural resources include access to fresh water (such as rivers, lakes, and groundwater), regions of fertile soils such as river deltas, and high concentrations of minerals and fossil fuels. Examples of natural hazards can be from interior processes such as volcanic eruptions and earthquakes, surface processes (such as tsunamis, mass wasting, and soil erosion), and severe weather (such as hurricanes, floods, and droughts). Examples of the results of changes in climate that can affect populations or drive mass migrations include changes to sea level, regional patterns of temperature and precipitation, and the types of crops and livestock that can be raised.]

HS-ESS3-2. Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.* [Clarification Statement: Emphasis is on the conservation, recycling, and reuse of resources (such as minerals and metals) where possible, and on minimizing impacts where it is not. Examples include developing best practices for agricultural soil use, mining (for coal, tar sands, and oil shales), and pumping (for petroleum and natural gas). Science knowledge indicates what can happen in natural systems—not what should happen.]

HS-ESS3-3. Create a computational simulation to illustrate the relationships among the management of natural resources, sustainability of human populations, and biodiversity. [Clarification Statement: Examples of factors that affect the management of natural resources include costs of resource extraction and waste management, per-capita consumption, and the development of new technologies. Examples of factors that affect human sustainability include agricultural efficiency, levels of conservation, and urban planning.] [Assessment Boundary: Assessment for computational simulations is limited to using provided multi-parameter programs or constructing simplified spreadsheet calculations.]

HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.* [Clarification Statement: Examples of data on the impacts of human activities could include the quantities and types of pollutants released, changes to biomass and species diversity, or areal changes in land surface use (such as for urban development, agriculture and livestock, or surface mining). Examples for limiting future impacts and costs could range from local efforts (such as reducing, reusing, and recycling resources) to large-scale geoenvironmental design solutions (such as altering global temperatures by making large changes to the atmosphere or ocean.)]

HS-ESS3-5. Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems. [Clarification Statement: Examples of evidence, for both data and climate model outputs, are for climate changes (such as precipitation and temperature) and their associated impacts (such as on sea level, glacial ice volumes, or atmosphere and ocean composition).] [Assessment Boundary: Assessment is limited to one example of a climate change and its associated impacts.]

HS-ESS3-6. Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity. [Clarification Statement: Examples of Earth systems to be considered are the hydrosphere, atmosphere, cryosphere, geosphere, and biosphere. An example of the far-reaching impacts from a human activity is how an increase in atmospheric carbon dioxide results in an increase in photosynthetic biomass on land and an increase in ocean acidification, with resulting impacts on sea organisms and marine populations.] [Assessment Boundary: Assessment does not include running computational representations but is limited to using the published results of scientific computational models.]

Science and Engineering Practices

Analyzing and Interpreting Data
Analyzing data in 9–12 builds on K–8 experiences and progresses to more sophisticated analyses of data. Students make conclusions and predictions by observing patterns and trends in data and by testing explanations against new evidence. Students develop more sophisticated questions and hypothesize about causes. Students engage in the full cycle of investigations—planning and carrying out investigations, analyzing and interpreting data, and revising explanations or models based on data analysis.

Students who demonstrate understanding can:

HS-ESS3-3. Use a computational representation of phenomena or design solutions to describe and support claims and evidence based on scientific knowledge, principles, and theories.

Constructing Explanations and Designing Solutions
Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to more sophisticated explanations and designs that are supported by multiple and independent student-generated source of evidence consistent with scientific knowledge, principles, and theories. Students engage in argument from evidence in 9–12 builds on K–8 experiences and progresses to more sophisticated evaluations of evidence. Students develop more sophisticated questions and hypothesize about causes. Students engage in the full cycle of investigations—planning and carrying out investigations, analyzing and interpreting data, and revising explanations or models based on data analysis.

Students who demonstrate understanding can:

HS-ESS3-4. Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to more sophisticated evaluations of evidence. Students develop more sophisticated questions and hypothesize about causes. Students engage in the full cycle of investigations—planning and carrying out investigations, analyzing and interpreting data, and revising explanations or models based on data analysis.
Scientific Investigations Use a Variety of Methods
- Science investigations use diverse methods and do not always use the same set of procedures to obtain data. (HS-ESS3-5)
- New technologies advance scientific knowledge. (HS-ESS3-5)

Scientific Knowledge is Based on Empirical Evidence
- Scientific knowledge is based on empirical evidence. (HS-ESS3-5)
- Arguments are strengthened by multiple lines of evidence supporting a single explanation. (HS-ESS3-5)

Connections to Nature of Science

Science Arguments are Strengthened by Multiple Lines of Evidence
- Arguments may also come from current scientific or historical evidence and scientific reasoning to defend and critique claims and explanations about natural and designed world(s). Arguments may also come from current scientific or historical evidence and logical arguments regarding relevant factors (e.g., economic, societal, environmental, ethical considerations). (HS-ESS3-2)

Connections to other DCIs in this grade-band: **HS-P.S.1.B** (HS-ESS3-3); **HS-P.S.3.B** (HS-ESS3-2),(HS-ESS3-5); **HS-P.S.3.D** (HS-ESS3-2),(HS-ESS3-5); **HS.L.S.1.C** (HS-ESS3-5); **HS.L.S.2.A** (HS-ESS3-2),(HS-ESS3-3); **HS.L.S.2.B** (HS-ESS3-2),(HS-ESS3-3),(HS-ESS3-6); **HS.L.S.2.C** (HS-ESS3-3),(HS-ESS3-4),(HS-ESS3-6); **HS.L.S.4.D** (HS-ESS3-2),(HS-ESS3-3),(HS-ESS3-4),(HS-ESS3-5); **HS.E.S.S.2.D** (HS-ESS3-5); **HS.E.S.S.2.E** (HS-ESS3-3)

Articulation of DCIs across grade-bands: **HS-P.S.1.B** (HS-ESS3-3); **HS-P.S.3.B** (HS-ESS3-5); **HS-P.S.3.D** (HS-ESS3-2),(HS-ESS3-5); **HS.L.S.1.C** (HS-ESS3-5); **HS.L.S.2.A** (HS-ESS3-1),(HS-ESS3-2),(HS-ESS3-3); **HS.L.S.2.B** (HS-ESS3-2),(HS-ESS3-3),(HS-ESS3-4),(HS-ESS3-6); **HS.L.S.2.C** (HS-ESS3-3),(HS-ESS3-4),(HS-ESS3-5); **HS.L.S.4.D** (HS-ESS3-1),(HS-ESS3-2),(HS-ESS3-3); **HS.E.S.S.2.A** (HS-ESS3-1),(HS-ESS3-2),(HS-ESS3-3); **HS.E.S.S.2.B** (HS-ESS3-1),(HS-ESS3-2),(HS-ESS3-3),(HS-ESS3-4),(HS-ESS3-5); **HS.E.S.S.3.C** (HS-ESS3-2),(HS-ESS3-3),(HS-ESS3-4),(HS-ESS3-5),(HS-ESS3-6); **HS.E.S.S.3.D** (HS-ESS3-4),(HS-ESS3-5),(HS-ESS3-6)

Common Core State Standards Connections:

**ELA/Literacy –**

**RST.11-12.1** Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-ESS3-1),(HS-ESS3-2),(HS-ESS3-4),(HS-ESS3-5)

**RST.11-12.2** Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in a simpler but still accurate terms. (HS-ESS3-5)

**RST.11-12.7** Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-ESS3-5)

**RST.11-12.8** Evaluate the hypotheses, data, analytic, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-ESS3-2),(HS-ESS3-4)

**WHST.9-12.2** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-ESS3-1)

**Mathematics –**

**MP.2** Reason abstractly and quantitatively. (HS-ESS3-1),(HS-ESS3-2),(HS-ESS3-3),(HS-ESS3-4),(HS-ESS3-5),(HS-ESS3-6)

**MP.4** Model with mathematics. (HS-ESS3-3),(HS-ESS3-6)

**HSN-Q.A.1** Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data display s. (HS-ESS3-1),(HS-ESS3-4),(HS-ESS3-5),(HS-ESS3-6)

**HSN-Q.A.2** Define appropriate quantities for the purpose of descriptive modeling. (HS-ESS3-1),(HS-ESS3-4),(HS-ESS3-5),(HS-ESS3-6)

**HSN-Q.A.3** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-ESS3-1),(HS-ESS3-4),(HS-ESS3-5),(HS-ESS3-6)

*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea. The section entitled "Disciplinary Core Ideas" is reproduced verbatim from A Framework for K-12 Science Education: Practices, Cross-Cutting Concepts, and Core Ideas. Integrated and reprinted with permission from the National Academy of Sciences.*

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