Stanford NGSS Integrated Curriculum

An Exploration of a Multidimensional World

UNIT 4

SCALE
Stanford Center for Assessment, Learning & Equity

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Stanford NGSS Integrated Curriculum: An Exploration of a Multidimensional World
Unit 4: Save the Andes!

Essential Question: How can we sustain biodiversity in a modern, changing world?

Total Number of Instructional Days: 26.5 – 27.5

Lift-Off Task: Humans and the Environment	**Task 1:** Sculpting Landscapes	**Task 2:** Disrupting Earth's Natural Systems	**Task 3:** Living in Harmony – Weighing the Consequences

Connect to the Culminating Project using the Project Organizer

Group Culminating Project:
Scientific Poster Presentation of a Proposal to Save the Andes

Individual Culminating Project
Journal Article That Details a Proposal to Save the Andes

Unit 4 Pop-Out
Who is At-Risk in Natural Hazards?
(*Implement after Task 1*)

7th Grade Science Unit 4: Save the Andes!

Unit Overview

Storyline for Unit 4

As human beings, we depend completely on the natural resources from ecosystems. Each of these ecosystems has a natural system of cycles and interactions that keeps it stable and functioning in just the right way. In this unit, students will learn that when we start to interfere with this natural stability for our own benefits, huge problems occur that can be very difficult to repair. For their culminating project, students consider these issues within the context of the Andes Mountains and try to find solutions to address them.

In the Lift-Off Task, students watch a video that caricaturizes the ways in which humans interact with their environment in order to help students make an emotional connection to the themes of this unit. Based on what they see, students generate questions about the phenomenon of human interactions with the environment. As students investigate these questions throughout the rest of the unit, they will begin to see their own impact on global and local biodiversity, which will inform their plan to preserve the biodiversity of the Andes region.

In Task 1, students connect the general phenomenon introduced in the Lift-Off Task to the context of the project—how humans threaten the current biodiversity in the Andes Mountains. However, before students can think about how humans negatively impact the Andes, they must first consider how the Andes ecosystem functions naturally. In this task, students explore evidence of geoscience processes to help them understand which processes formed the Andes Mountains, across varying time and spatial, or geologic scales.

In Task 2, students discover that humans' reliance on the Earth for services is causing major disruptions of the natural processes they explored in Task 1. This leads to physical and biological changes that are affecting natural populations and much more. By the end of this task, students will be better equipped to examine their own role in the disruption of natural processes in places like the Andes Mountains, and to determine how seemingly small changes can lead to larger changes in the Andes ecosystem.

Task 3 requires students to move beyond their emotional reaction to the problems in Task 2, and instead asks that students consider why saving the Andes region makes logical sense. In this task, students learn why preserving biodiversity is essential to maintaining ecosystems as a whole, creating an imperative to design solutions to maintain it. Here, students have an opportunity to practice Internet research as they search for environmental solutions already in place around the world. In the end, students will weigh the advantages and disadvantages of any conservation plan in order to determine whether it will gain enough public support to become a reality.

Once students are complete with all learning tasks, they are ready to complete their culminating project. The students' task is to create a proposal to save the Andes! They will start by understanding what a stable Andes ecosystem should look like and identify the ways that humans have changed the Andes. After an evaluation of multiple solutions that people are already trying, each group makes a plan to save the Andes from one specific human activity. As a group, they will create a scientific poster to present at an Environmental Science Conference, keeping in mind that any proposal will require the help of people all over the world to change their way of life…it is their job to find a reasonable solution to convince their audience. Individually, they will write and submit an article for publication in the associated Environmental Science Journal.

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Unit Overview

Three-Dimensional Breakdown of the Performance Expectations

This unit was developed to align with, teach, and assess students' understanding and skills related to these Performance Expectations. Below, we have mapped out the disciplinary core ideas, crosscutting concepts, and science and engineering practices addressed in this unit. Aspects of the dimensions that are not explicitly addressed in this unit are crossed out.

Performance Expectations	Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
MS-ESS2-2. Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales. [Clarification Statement: Emphasis is on how processes change Earth's surface at time and spatial scales that can be large (such as slow plate motions or the uplift of large mountain ranges) or small (such as rapid landslides or microscopic geochemical reactions), and how many geoscience processes (such as earthquakes, volcanoes, and meteor impacts) usually behave gradually but are punctuated by catastrophic events. Examples of geoscience processes include surface weathering and deposition by the movements of water, ice, and wind. Emphasis is on geoscience processes that shape local geographic features, where appropriate.]	**Constructing Explanations** ● Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) 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.	**ESS2.A: Earth's Materials and Systems** ● The planet's systems interact over scales that range from microscopic to global in size, and they operate over fractions of a second to billions of years. These interaction ns have shaped Earth's history and will determine its future. **ESS2.C: The Roles of Water in Earth's Surface Processes** ● Water's movements—both on the land and underground—cause weathering and erosion, which change the land's surface features and create, underground formations.	**Scale, Proportion, and Quantity** ● Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small.
MS-ESS3-2. Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects. [Clarification Statement: Emphasis is on how some natural hazards, such as volcanic eruptions and severe weather, are preceded by phenomena that allow for reliable predictions, but others, such as earthquakes, occur	**Analyzing and Interpreting Data** ● Analyze and interpret data to determine similarities and differences in findings.	**ESS3.B: Natural Hazards** ● Mapping the history of natural hazards in a region, combined with an understanding of related geologic forces can help forecast the locations and likelihoods of future events.	**Patterns** ● Graphs, charts, and images can be used to identify patterns in data.

suddenly and with no notice, and thus are not yet predictable. Examples of natural hazards can be taken from interior processes (such as earthquakes and volcanic eruptions), surface processes (such as mass wasting and tsunamis), or severe weather events (such as hurricanes, tornadoes, and floods). Examples of data can include the locations, magnitudes, and frequencies of the natural hazards. Examples of technologies can be global (such as satellite systems to monitor hurricanes or forest fires) or local (such as building basements in tornado-prone regions or reservoirs to mitigate droughts).]			
MS-LS2-4. Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. [Clarification Statement: Emphasis is on recognizing patterns in data and making warranted inferences about changes in populations, and on evaluating empirical evidence supporting arguments about changes to ecosystems.]	**Engaging in Argument From Evidence** ● Construct an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem.	**LS2.C: Ecosystem Dynamics, Functioning, and Resilience** • Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations.	**Stability and Change** ● Small changes in one part of a system might cause large changes in another part.
MS-PS1-3. Gather and make sense of information to describe that synthetic materials come from natural resources and impact society. [Clarification Statement: Emphasis is on natural resources that undergo a chemical process to form the synthetic material. Examples of new materials could include new medicine, foods, and alternative fuels.] [Assessment Boundary: Assessment is limited to qualitative information.]	**Obtaining, Evaluating, and Communicating Information** ● Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods used, and describe how they are supported or not supported by evidence.	**PS1.A: Structure and Properties of Matter** ● Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. **PS1.B: Chemical Reactions** ● Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are	**Structure and Function** ● Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used.

		regrouped into different molecules and these new substances have different properties from those of the reactants.	
MS-LS2-5. Evaluate competing design solutions for maintaining biodiversity and ecosystem services.* [Clarification Statement: Examples of ecosystem services could include water purification, nutrient recycling, and prevention of soil erosion. Examples of design solution constraints could include scientific, economic, and social considerations.]	**Engaging in Argument from Evidence** ● Evaluate competing design solutions based on jointly developed and agreed-upon design criteria.	**LS2.C: Ecosystem Dynamics, Functioning, and Resilience** ● Biodiversity describes the variety of species found in Earth's terrestrial and oceanic ecosystems. The completeness or integrity of an ecosystem's biodiversity is often used as a measure of its health. **LS4.D: Biodiversity and Humans** ● Changes in biodiversity can influence humans' resources, such as food, energy, and medicines, as well as ecosystem services that humans rely on—for example, water purification and recycling (*secondary*).	**Stability and Change** ● Small changes in one part of a system might cause large changes in another part.
MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.	**Asking Questions and Defining Problems** ● Define a design problem that can be solved through the development of an object, tool, process or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions.	**ETS1.A: Defining and Delimiting Engineering Problems** ● The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that are likely to limit possible solutions.	**N/A**
MS-ETS1-2. Evaluate competing design solutions using a systematic process to	**Engaging in Argument from Evidence** ● Evaluate competing	**ETS1.B: Developing Possible Solutions** ● There are systematic	**N/A**

determine how well they meet the criteria and constraints of the problem.	design solutions based on jointly developed and agreed-upon design criteria.	processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem.	

Connections to Common Core Math and ELA Standards:

Over the course of this unit, students will gain knowledge and skills in science, as well as in math and English-language arts. Below we list the Common Core ELA and Math standards for middle school and 7th grade that are relevant to the curriculum tasks in this unit. Within the curriculum, there are opportunities to incorporate components of the following ELA and Math Standards:

Middle School Common Core ELA Standards		Unit Task
Key Ideas and Details	CCSS.ELA-Literacy.RST.6-8.1: Cite specific textual evidence to support analysis of science and technical texts.	Task 1 Task 2 Task 3 Project
Integration of Knowledge and Ideas	CCSS.ELA-Literacy.RST.6-8.7: Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).	Task 1 Task 2 Task 3 Project
	CCSS.ELA-Literacy.RST.6-8.9: Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.	Task 1 Task 3 Project
Text Types and Purposes	CCSS.ELA-Literacy.WHST.6-8.1: Write arguments focused on discipline-specific content.	Task 2 Task 3 Project
Research to Build and Present Knowledge	CCSS.ELA-Literacy.WHST.6-8.7: Conduct short research projects to answer a question (including a self-generated question) drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.	Task 2 Task 3 Project
	CCSS.ELA-Literacy.WHST.6-8.8: Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.	Task 2 Task 3 Project
	CCSS.ELA-Literacy.WHST.6-8.9: Draw evidence from informational texts to support analysis, reflection, and research.	Task 1 Task 2 Task 3 Project
Presentation of Knowledge and Ideas	CCSS.ELA-Literacy.SL.8.5: Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest.	Task 3 Project

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Reading: Informational Text	CCSS.ELA-Literacy.RI.8.8: Delineate and evaluate the argument and specific claims in a text, assessing whether the reasoning is sound and the evidence is relevant and sufficient; recognize when irrelevant evidence is introduced.	Task 2 Task 3 Project

Middle School and 7th Grade Common Core Math Standards		**Unit Task**
Mathematical Practice	CCSS.MATH.MP.2: Reason abstractly and quantitatively.	Task 1

Connections to English Language Development (ELD) Standards:

We acknowledge that language development is a key component of disciplinary understanding and helps to support more rigorous and equitable outcomes for diverse students. This curriculum thus takes into account both the receptive and productive language demands of the culminating projects and strives to increase accessibility by including scaffolds for language development and pedagogical strategies throughout learning tasks. We aim to support language acquisition through the development of concept maps; utilizing sentence frames; implementing the Critique, Correct, and Clarify technique; employing the Stronger Clearer strategy; and fostering large and small group discussions.

The California ELD Standards are comprised of two sections: the standards and a rubric. Outlined below are the standards from Section One that are met within this curriculum. For additional information, please refer to: https://www.pausd.org/sites/default/files/pdf-faqs/attachments/SS_ELD_7.pdf.

Eighth Grade ELD Standards		
Part I: Interacting in Meaningful Ways	A: Collaborative	1.Exchanging information and ideas with others through oral collaborative discussions on a range of social and academic topics
		2. Interacting with others in written English in various communicative forms (print, communicative technology, and multimedia)
		3. Offering and justifying options, negotiating with and persuading others in communicative exchanges
		4. Adapting language choices to various contexts (based on task, purpose, audience, and text type)
	B: Interpretive	5. Listening actively to spoken English in a range of social and academic contexts
		6. Reading closely literary and informational texts and viewing multimedia to determine how meaning is conveyed explicitly and implicitly through language
		7. Evaluating how well writers and speakers use language to support ideas and arguments with details or evidence depending on modality, text type, purpose, audience, topic, and content area
		8. Analyzing how writers and speakers use vocabulary and other language resources for specific purposes (to explain, persuade, entertain, etc.) depending on modality, text type, purpose, audience, topic, and content area
	C: Productive	9. Expressing information and ideas in formal oral presentations on academic topics

		10. Writing literary and informational texts to present, describe, and explain ideas and information, using appropriate technology
		11. Justifying own arguments and evaluating others' arguments in writing
		12. Selecting and applying varied and precise vocabulary and other language resources to effectively convey ideas
Part II: Learning About How English Works	A: Structuring Cohesive Texts	1. Understanding text structure
		2. Understanding cohesion
	B: Expanding and Enriching Ideas	3. Using verbs and verb phrases
		4. Using nouns and noun phrases
		5. Modifying to add details
	C: Connecting and Condensing Ideas	6. Connecting ideas
		7. Condensing ideas

Connections to Environmental Awareness:

Over the course of this curriculum, students will explore content related to various environmental principles and concepts that examine the interactions and interdependence of human societies and natural systems. In accordance with the *Education and the Environment Initiative (EEI),* tasks throughout this curriculum explore many of *California's Approved Environmental Principles and Concepts.* The principles relevant to this unit are outlined in the chart below:

Unit Task	EEI Principle	EEI Concept
Lift-Off Task Task 2 Task 3 Project	Principle I: The continuation and health of individual human lives and of human communities and societies depend on the health of the natural systems that provide essential goods and ecosystem services.	Concept A: The goods produced by natural systems are essential to human life and to the functioning of our economies and cultures.
		Concept B: The ecosystem services provided by natural systems are essential to human life and to the functioning of our economies and cultures.
		Concept C: The quality, quantity, and reliability of the goods and ecosystem services provided by natural systems are directly affected by the health of those systems.
Lift-Off Task Task 2 Task 3 Project	Principle II: The long-term functioning and health of terrestrial, freshwater, coastal and marine ecosystems are influenced by their relationships with human societies.	Concept A: Direct and indirect changes to natural systems due to the growth of human populations and their consumption rates influence the geographic extent, composition, biological diversity, and viability of natural systems.
		Concept B: Methods used to extract, harvest, transport and consume natural resources influence the geographic extent,

		composition, biological diversity, and viability of natural systems.
		Concept C: The expansion and operation of human communities influences the geographic extent, composition, biological diversity, and viability of natural systems.
Lift-Off Task Task 2 Task 3 Project	Principle III: Natural systems change in ways that people benefit from and can influence.	Concept A: Natural systems proceed through cycles and processes that are required for their functioning.
		Concept B: Human practices depend upon and benefit from the cycles and processes that operate within natural systems.
		Concept C: Human practices can alter the cycles and processes that operate within natural systems.
Lift-Off Task Task 2 Task 3 Project	Principle IV: The exchange of matter between natural systems and human societies affects the long-term functioning of both.	Concept A: The effects of human activities on natural systems are directly related to the quantities of resources consumed and to the quantity and characteristics of the resulting byproducts.
		Concept B: The byproducts of human activity are not readily prevented from entering natural systems and may be beneficial, neutral, or detrimental in their effect.
		Concept C: The capacity of natural systems to adjust to human-caused alterations depends on the nature of the system as well as the scope, scale, and duration of the activity and the nature of its byproducts.
Task 2 Task 3 Project	Principle V: Decisions affecting resources and natural systems are complex and involve many factors.	Concept A: There is a spectrum of what is considered in making decisions about resources and natural systems and how those factors influence decisions.

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Teacher Materials List

Unit Essential Question: *How can we sustain biodiversity in a modern, changing world?*

Overall Unit – All Tasks

- Unit 4, Task Cards Student Version, Lift-Off and Tasks 1 through 3
- Culminating Project Student Task Card
- Project Organizer
- Projector with Audio (for video or images, whenever needed)

Lift-Off Task (2 days)

Per Student

- Task Card Student Version: Lift-Off
- Post-Its (Optional)
- Task Card Student Version: Culminating Project
- Project Organizer

Per Group

- Poster paper and markers

Whole Class

- Projector and Speaker (for video)
- Poster paper and markers
- *See Instructions in Lift-Off for other optional materials to use for the class concept map

Task 1 (4 Days)

Per Student

- Task Card Student Version: Task 1
- Project Organizer

Per Group

- 1-2 Computers with Internet Access

Whole Class

- Resource Cards: laminate or put in sheet protectors (Recommended: put multiple copies of each resource card at the station OR create multiple of the same station so that there is more participation).

Task 2 (5 Days)

Per Student

- Task Card Student Version: Task 2
- Project Organizer

Per Group

- Computers with Internet Access

Whole Class

- Station Cards in sheet protectors for each station (1 per pair)

Task 3 (5-6 Days)

Per Student

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Teacher Materials List

- Task Card Student Version: Task 3
- Project Organizer

Per Group

- 1-2 computers with Internet Access
- Internet Research Resource Card
- Poster Paper or Digital Presentation Software
- Markers, Crayons, or Colored Pencils

Whole Class

- Projector and Speakers for Video

Culminating Project (7 days)

Per Group: Scientific Poster of Proposal to Save The Andes

- Poster Paper
- Color pencils/pens or printed computer graphics
- Computers with Internet Access

Per Student: Article of Proposal to Save the Andes

- Lined paper or computer with word processing software

Unit 4 Pop-Out (3.5 days)

Per Student

- Student Version: Unit 4 Pop-Out
- Unit 4, Pop-Out Situation – Hurricane Katrina

Whole Class

- NPR Article linked in Teacher Version
- Projector and Speakers

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Building on Prior Knowledge

Unit 4 takes all of students' knowledge about how ecosystems work and asks them to continue their inquiry of how humans affect natural systems. In this unit, students learn more about the processes that have shaped Earth, the ecosystem services Earth provides to humans, and the effects human use of these services has on the environment. By examining the example of the Andes Mountains, a region known for its biodiversity, students will be able to identify problems and evaluate solutions to maintain biodiversity in regions around the world.

The integrated model requires students to access and use a wide range of ideas from prior grades. This content knowledge spans nine different Disciplinary Core Ideas: ESS2.A. Earth's Materials and Systems; ESS2.C. The Roles of Water in Earth's Surface Processes; ESS3.B. Natural Hazards; LS2.C. Ecosystem Dynamics, Functioning, and Resilience; PS1.A. Structure and Properties of Matter; PS1.B. Chemical Reactions; LS4.D: Biodiversity and Humans, ETS1.A. Defining and Delimiting Engineering Problems; and ETS1.B. Developing Possible Solutions.

As students explore these core ideas, they build on their skills in the following science and engineering practices: Asking Questions and Defining Problems; Analyzing and Interpreting Data; Constructing Explanations; Engaging in Argument From Evidence; and Obtaining, Evaluating, and Communicating Information. In addition to science and engineering practices, students also continue to build on their knowledge of the following crosscutting concepts: Patterns; Scale, Proportion, and Quantity; Structure and Function; and Stability and Change.

*This summary is based on information found in the NGSS Framework.

K-8 Progression of Disciplinary Core Ideas, Science and Engineering Practices, and Crosscutting Concepts for Unit 4

Disciplinary Core Ideas	K-2	3-5	6-8
ESS2.A Earth's Materials and Systems	Wind and water change the shape of the land.	Four major Earth systems interact. Rainfall helps to shape the land and affects the types of living things found in a region. Water, ice, wind, organisms, and gravity break rocks, soils, and sediments into smaller pieces and move them around.	Energy flows and matter cycles within and among Earth's systems, including the sun and Earth's interior as primary energy sources. Plate tectonics is one result of these processes.
ESS2.C The Roles of Water in Earth's Surface Processes	Water is found in many types of places and in different forms on Earth.	Most of Earth's water is in the ocean and much of the Earth's freshwater is in glaciers or underground.	Water movement causes weathering and erosion, changing landscape features.
ESS3.B Natural Hazards	In a region, some kinds of severe weather are more likely than others. Forecasts allow communities to prepare for severe weather.	A variety of hazards result from natural processes; humans cannot eliminate hazards but can reduce their impacts.	Mapping the history of natural hazards in a region and understanding related geologic forces can help forecast the locations and likelihoods of future events.

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LS2.C Ecosystem Dynamics, Functioning, and Resilience	N/A	When the environment changes, some organisms survive and reproduce, some move to new locations, some move into the transformed environment, and some die.	Ecosystem characteristics vary over time. Disruptions to any part of an ecosystem can lead to shifts in all of its populations. The completeness or integrity of an ecosystem's biodiversity is often used as a measure of its health.
PS1.A Structure and Properties of Matter	Matter exists as different substances that have observable different properties. Different properties are suited to different purposes. Objects can be built up from smaller parts.	Because matter exists as particles that are too small to see, matter is always conserved even if it seems to disappear. Measurements of a variety of observable properties can be used to identify particular materials.	The fact that matter is composed of atoms and molecules can be used to explain the properties of substances, diversity of materials, states of matter, phase changes, and conservation of matter.
PS1.B Chemical Reactions	Heating and cooling substances causes changes that are sometimes reversible and sometimes not.	Chemical reactions that occur when substances are mixed can be identified by the emergence of substances with different properties; the total mass remains the same.	Reacting substances rearrange to form different molecules, but the number of atoms is conserved. Some reactions release energy and others absorb energy.
LS4.D Biodiversity and Humans	A range of different organisms lives in different places.	Populations of organisms live in a variety of habitats. Change in those habitats affects the organisms living there.	Changes in biodiversity can influence humans' resources and ecosystem services they rely on.
ETS1.A Defining and Delimiting Engineering Problems	A situation that people want to change or create can be approached as a problem to be solved through engineering. Such problems may have many acceptable solutions. Asking questions, making observations, and gathering information are helpful in thinking about problems. Before beginning to design a solution, it is important to clearly understand the problem.	Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account.	The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that are likely to limit possible solutions.
ETS1.B Developing Possible Solutions	Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people.	Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions. At whatever stage, communicating with peers about	A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. Sometimes parts of different

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		proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved.	solutions can be combined to create a solution that is better than any of its predecessors. Models of all kinds are important for testing solutions.

Science and Engineering Practices	K-2	3-5	6-8
Asking Questions and Defining Problems*	Asking questions and defining problems in K-2 builds on prior experiences and progresses to simple descriptive questions that can be tested. • Define a simple problem that can be solved through or development of a new or improved object or tool.	Asking questions and defining problems in 3-5 builds on prior experiences and progresses to specifying qualitative relationships. • Use prior knowledge to describe problems that can be solved. • Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost.	Asking questions and defining problems in 6-8 builds on prior experiences and progresses to specifying relationships between variables, and clarifying arguments and models. • Define a design problem that can be solved through the development of an object, tool, process, or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions.
Analyzing and Interpreting Data*	Analyzing data in K-2 builds on prior experiences and progresses to collecting, recording, and sharing observations. • Compare predictions (based on prior experiences) to what occurred (observable events).	Analyzing data in 3-5 builds on prior experiences and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations. When possible and feasible, digital tools should be used. • Compare and contrast data collected by different groups in order to discuss similarities and differences in their findings. • Represent data in tables and/or various graphical displays (bar graphs, pictographs, and/or pie charts) to reveal patterns	Analyzing data in 6-8 builds on prior experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. • Analyze and interpret data to determine similarities and differences in findings.

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		that indicate relationships.	
Constructing Explanations*	Constructing Explanations in K-2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena. • Use information from observations (firsthand and from media) to construct an evidence-based account for natural phenomena.	Constructing Explanations in 3-5 builds on prior experiences and progresses to the use of evidence and ideas in constructing explanations that specify variables that describe and predict phenomena. • Use evidence (e.g., measurements, observations, patterns) to construct or support an explanation or design a solution to a problem.	Constructing Explanations in 6-8 builds on prior experiences and progresses to include constructing explanations supported by multiple sources of evidence consistent with scientific ideas, principles, and theories. • Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) 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.
Engaging in Argument from Evidence*	Engaging in argument from evidence in K-2 builds on prior experiences and progresses to comparing ideas and representations about the natural and designed world(s). • Make a claim about the effectiveness of an object, tool, or solution that is supported by relevant evidence. • Construct an argument with evidence to support a claim.	Engaging in argument from evidence in 3-5 builds on prior experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s). • Make a claim about the merit of a solution to a problem by citing relevant evidence about how it meets the criteria and constraints of the problem. • Construct and/or support an argument with evidence, data, and/or a model. • Use data to evaluate claims about cause and effect.	Engaging in argument from evidence in 6-8 builds on prior experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s). • Evaluate competing design solutions based on jointly developed and agreed-upon criteria. • Construct an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem.
Obtaining, Evaluating, and Communicating Information*	Obtaining, evaluating, and communicating Information in K-2 builds on prior experiences and uses observations and texts to communicate new information. • Obtain information using various texts, text	Obtaining, evaluating, and communicating Information in 3-5 builds on prior experiences and progresses to evaluating the merit and accuracy of ideas and methods. • Obtain and combine information from books and/or other reliable	Obtaining, evaluating, and communicating Information in 6-8 builds on prior experiences and progresses to evaluating the merit and validity of ideas and methods. • Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and

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	features (e.g., headings, tables of contents, glossaries, electronic menus, icons), and other media that will be useful in answering a scientific question and/or supporting a scientific claim.	media to explain phenomena or solutions to a design problem.	possible bias of each publication and methods used, and describe how they are supported or not supported by evidence.

*These SEPs are summatively assessed using the Culminating Project or a Task prompt.

Crosscutting Concepts	K-2	3-5	6-8
Patterns*	Students recognize that patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence. • Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence.	Students identify similarities and differences in order to sort and classify natural objects and designed products. They identify patterns related to time, including simple rates of change and cycles, and to use these patterns to make predictions. • Patterns can be used as evidence to support an explanation.	Students recognize that macroscopic patterns are related to the nature of microscopic and atomic-level structure. They identify patterns in rates of change and other numerical relationships that provide information about natural and human designed systems. They use patterns to identify cause and effect relationships, and use graphs and charts to identify patterns in data. • Graphs, charts, and images can be used to identify patterns in data.
Scale, Proportion, and Quantity*	Students use relative scales (e.g., bigger and smaller; hotter and colder; faster and slower) to describe objects. They use standard units to measure length. Relative scales allow objects and events to be compared and described (e.g., bigger and smaller; hotter and colder; faster and slower).	Students recognize natural objects and observable phenomena exist from the very small to the immensely large. They use standard units to measure and describe physical quantities such as weight, time, temperature, and volume. • Natural objects and/or observable phenomena exist from the very small to the immensely large or from very short to very long time periods.	Students observe time, space, and energy phenomena at various scales using models to study systems that are too large or too small. They understand phenomena observed at one scale may not be observable at another scale, and the function of natural and designed systems may change with scale. They use proportional relationships (e.g., speed as the ratio of distance traveled to time taken) to gather information about the magnitude of properties and processes. They represent scientific relationships through the use of algebraic expressions and equations. • Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small.

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Structure and Function*	Students observe the shape and stability of structures of natural and designed objects are related to their function(s). • The shape and stability of structures of natural and designed objects are related to their function(s).	Students learn different materials have different substructures, which can sometimes be observed; and substructures have shapes and parts that serve functions. • Substructures have shapes and parts that serve functions.	Students model complex and microscopic structures and systems and visualize how their function depends on the shapes, composition, and relationships among its parts. They analyze many complex natural and designed structures and systems to determine how they function. They design structures to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used. • Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used.
Stability and Change*	Students observe some things stay the same while other things change, and things may change slowly or rapidly. • Some things stay the same while other things change.	Students measure change in terms of differences over time, and observe that change may occur at different rates. Students learn some systems appear stable, but over long periods of time they will eventually change. • Change is measured in terms of differences over time and may occur at different rates. • Some systems appear stable, but over long periods of time will eventually change.	Students explain stability and change in natural or designed systems by examining changes over time, and considering forces at different scales, including the atomic scale. Students learn changes in one part of a system might cause large changes in another part, systems in dynamic equilibrium are stable due to a balance of feedback mechanisms, and stability might be disturbed by either sudden events or gradual changes that accumulate over time. • Small changes in one part of a system might cause large changes in another part.

*These CCCs are summatively assessed using the Culminating Project or a Task prompt.

Progression of Knowledge from Kindergarten – 8th grade

ESS2.A. Earth's Materials and Systems: In Kindergarten – second grade, students begin with the basic idea that wind and water can change the shape of the land and use this knowledge to compare solutions that might prevent this from happening. In fourth grade, students build on this knowledge to investigate other factors, such as water, ice, wind, living organisms, and gravity that might also cause weathering and erosion. At both of these grade levels, students have been implicitly engaging with the idea that different earth systems interact in these particular ways. In fifth grade, students explore this idea at a broad level, developing a model that shows an example of the geosphere, biosphere, hydrosphere, and/or atmosphere interacting. This set the stage for Unit 3, in which students learned that all Earth processes are the result of energy flowing and matter cycling within and among the Earth systems that they modeled in fifth grade. In this

unit, students focus on these interactions between Earth systems at different scales to think about how they have shaped Earth's history and will determine its future.

The following is the progression of the Performance Expectations for this DCI:

2-ESS2-1 Compare multiple solutions designed to slow or prevent wind or water from changing the shape of the land.

4-ESS2-1 Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation.

5-ESS2-1 Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.

MS-ESS2-1 Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.

MS-ESS2-2 Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.

ESS2.C. The Role of Water in Earth's Surface Processes: In Kindergarten – second grade, students begin to gather information about where water can be found on Earth, whether it be in solid or liquid form. In fifth grade, students analyze more specific data about these reservoirs that they identified in K-2 and make the distinction between freshwater and saltwater. By graphing the amount of water in oceans, lakes, rivers, glaciers, groundwater, and polar ice caps, they are able to realize that nearly all of Earth's water is in the ocean and most freshwater is in glaciers or underground, not rivers and lakes. While these Performance Expectations lay the foundation by showing students where water is located on Earth, the middle school Performance Expectations take a great leap in this DCI. At the middle school level, students move towards examining how water cycles amongst Earth systems, what causes water to cycle, and how the movement of water results in weather patterns, ocean currents, and weathering and erosion that change land's features. In this unit, students focus on the latter concept—that the movement of water can change Earth's features through weathering and erosion. Because of the vast number of Performance Expectations, students engage in a wide variety of Science and Engineering Practices and Crosscutting Concepts.

The following is the progression of the Performance Expectations for this DCI:

2-ESS2-3 Obtain information to identify where water is found on Earth and that it can be solid or liquid.

5-ESS2-2 Describe and graph the amounts and percentages of water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth.

MS-ESS2-2 Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.

MS-ESS2-4 Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.

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MS-ESS2-5 Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.

MS-ESS2-6 Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates.

ESS3.B. Natural Hazards: In Kindergarten – second grade, students begin their exploration of this DCI by examining severe weather that is characteristic of a certain region. At this level, they are asking questions to determine that the purpose of forecasting severe weather is so that communities can better prepare for and respond to these events. This provides them with the justification to engage with the forecasting of other natural hazards in later grade bands. In third grade, students continue to work with weather-related hazards, but now begin to think about the actual steps humans can take to reduce the impacts of these hazards. Students continue thinking about solutions in fourth grade, but move towards other kinds of natural hazards, such as volcanic eruptions or earthquakes. This prepares students for this seventh grade unit, in which they analyze actual data to help forecast the likelihood of a future event, which will in turn mitigate effects. Up until middle school, students used the crosscutting concept of Cause and Effect as a lens to consider the relationship between natural hazards and their impacts on humans. They also engaged in Science and Engineering Practices that specifically relate to developing or evaluating solutions to mitigate effects of natural hazards, such as Engaging in Argument From Evidence and Designing Solutions. In this unit, students move away from a focus on mitigating solutions and instead practice Analyzing and Interpreting Data to identify Patterns that will help actually forecast the natural hazards.

The following is the progression of the Performance Expectations for this DCI:

K-ESS3-2 Ask questions to obtain information about the purpose of weather forecasting to prepare for, and respond to, severe weather.

3-ESS3-1 Make a claim about the merit of a design solution that reduces the impacts of a weather-related hazard.

4-ESS3-2 Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.

MS-ESS3-2 Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.

LS2.C. Ecosystem Dynamics, Functioning, and Resilience: This DCI is not introduced at the Kindergarten – second grade level. It is first introduced in third grade, but only as a secondary DCI to LS4.D. Biodiversity and Humans. In this grade band, students explore the problem that when the environment changes, there are different effects on organisms in the area. For example, some may survive and reproduce, others may move to new locations, new organisms may move in, and some may die out entirely. At this point, students are engaging with this DCI through the lens of Systems and System Models by analyzing interactions between environment and organisms. In this seventh grade unit, students build on this understanding to look more specifically at empirical evidence showing that disrupting an ecosystem can lead to shifts in all its populations. Here, students are shifting to the crosscutting concept of Stability and Change by considering how small changes in one part of the system might cause large changes in another part. Students are then ready to think broadly about how humans are affecting biodiversity and evaluate solutions to maintain the health of ecosystems as

much as possible. At all grade bands, students are engaging in the Science and Engineering Practice of Engaging in Argument From Evidence.

The following is the progression of the Performance Expectations for this DCI:

3-LS4-4 Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.

MS-LS2-4 Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

MS-LS2-5 Evaluate competing design solutions for maintaining biodiversity and ecosystem services.

PS1.A. Structure and Properties of Matter: In Kindergarten - second grade, students begin their initial exploration of matter by beginning to observe and analyze tangible materials and their properties. They also explore how an object made of small pieces can be disassembled and made into a new object, a concept that will be crucial as they begin to think about atoms, molecules, chemical reactions, and conservation of matter in later grade bands. In third-fifth grade, they build on explorations from second grade to identify specific materials based on their properties. They also use experiments to gather evidence of the law of conservation of matter, a schema they started to develop in second grade. At this point, students are moving past observations of matter they can see and towards developing an understanding that matter is made of particles too small to be seen. Thus, by Unit 2 of this seventh grade curriculum, they were able to develop models of unseen particles, such as the atomic composition of various molecules and the movement of particles in different states of matter. In Unit 3, students delved deeper into chemical reactions, learning how to determine when a chemical reaction has occurred. In this unit, students will apply this knowledge to the processes that transform natural resources to synthetic materials. Because of the vast number of Performance Expectations related to this DCI, students engage with a large range of science and engineering practices and crosscutting concepts.

The following is the progression of the Performance Expectations for this DCI:

2-PS1-1 Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.

2-PS1-2 Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.

2-PS1-3 Make observations to construct an evidence-based account of how an object made of a small set of pieces can be disassembled and made into a new object.

5-PS1-1 Develop a model to describe that matter is made of particles too small to be seen.

5-PS1-2 Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances, the total weight of matter is conserved.

5-PS1-3 Make observations and measurements to identify materials based on their properties.

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MS-PS1-1 Develop models to describe the atomic composition of simple molecules and extended structures.

MS-PS1-2 Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.

MS-PS1-3 Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.

MS-PS1-4 Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.

PS1.B. Chemical Reactions: In Kindergarten - second grade, students gather evidence to argue that some changes caused by heating or cooling can be reversed and some cannot. In doing so, they begin to experience chemical reactions without knowing that is what they are observing. In fifth grade, students take this a bit further by investigating that when substances are mixed, a new substance with different properties may be formed. At this grade level, students are also beginning to engage with the idea of conservation of matter by gathering evidence that total weight of matter is conserved in any type of change. All of this evidence prepares students for the middle school level in which they are finally asked to explicitly engage with the definition of a chemical reaction. In Units 2 and 3, students learned that in chemical reactions, the atoms that make up the original substances are regrouped into different molecules and these new substances have different properties. They modeled the law of conservation of matter at the atomic level, building on the evidence they gathered of this phenomenon in fifth grade. In Unit 3, students were also able to use their investigation skills from 5th grade to again analyze properties of substances, but this time to determine whether a chemical reaction has occurred. In addition, students learned that some chemical reactions release energy and others store energy and they used this knowledge to design a thermal-absorbing or thermal-releasing device. In this unit, students apply their knowledge of chemical reactions to a particular example: how natural resources can undergo a chemical process to form a synthetic material. Again, because of the vast number of Performance Expectations related to this DCI, students engage with a large range of science and engineering practices and crosscutting concepts. You will also notice that this DCI has many parallels to the DCI above—PS1.A. Structure and Properties of Matter—as they are often both identified within a PE.

The following is the progression of the Performance Expectations for this DCI:

2-PS1-4 Construct an argument with evidence that some changes caused by heating or cooling can be reversed and some cannot.

5-PS1-2 Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances, the total weight of matter is conserved.

5-PS1-4 Conduct an investigation to determine whether the mixing of two or more substances results in new substances.

MS-PS1-2 Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.

MS-PS1-3 Gather and make sense of information to describe that synthetic materials come from natural

resources and impact society.

MS-PS1-5 Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved.

MS-PS1-6 Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.

LS4.D. Biodiversity and Humans: Students first engage with this DCI by beginning to explore the idea of biodiversity—that there are many different kinds of living things in an area. In third grade, students use this understanding of biodiversity to think about what happens to the plants and animals that live in an area when their habitat changes. This lays the foundation for this middle school unit as students take this concept a step further and think about how these changes to biodiversity can, in turn, affect humans—for example, their food, energy sources, medicines, or any ecosystem services. While in kindergarten students are simply Planning and Carrying Out Investigations to help them conceptualize biodiversity, the focus quickly turns to thinking about solutions to maintain biodiversity in later grades. Thus, in the 3-5 and middle school grade bands, students are Engaging in Arguments to evaluate solutions. From 3-5 to middle school, students also shift from a Systems and System Models lens to considering biodiversity within the context of Stability and Change.

The following is the progression of the Performance Expectations for this DCI:

2-LS4-1 Make observations of plants and animals to compare the diversity of life in different habitats.

3-LS4-4 Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.

MS-LS2-5 Evaluate competing design solutions for maintaining biodiversity and ecosystem services.

ETS1.A. Defining and Delimiting Engineering Problems: From Kindergarten to second grade, students first begin to approach situations as problems to be solved through engineering. They learn to ask questions and gather information to clearly understand a problem. In third through fifth grade, students build on understanding the problem to also identifying criteria and constraints surrounding the problem. In this seventh grade unit, students take this process a step further by defining criteria and constraints more precisely, including consideration of scientific principles and other relevant knowledge. In Kindergarten to second grade, students focus on the science and engineering practice of Asking Questions in order to help them with the practice of Defining Problems, which continues to be the main focus in subsequent grades.

The following is the progression of the Performance Expectations for this DCI:

K-2-ETS1-1 Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.

3-5-ETS1-1 Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

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MS-ETS1-1 Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

ETS1.B. Developing Possible Solutions: During Kindergarten through second grade, students begin communicating multiple designs in the form of diagrams and sketches. By third to fifth grade, students move from mere drawings to actually testing out their designs to see how they perform under different conditions. Students then use this data to make improvements. Throughout all grade bands, students emphasize that communication of designs with peers is an essential part of the design process. In this seventh grade unit, students move towards more systematic processes to evaluate solutions for how well they meet criteria and constraints. There is also a much greater emphasis on using the data to inform improvements, focusing on the idea that parts of different solutions can be used to make an even better solution. At the different grade levels, students engage in a variety of different science and engineering practices: Developing Models in K-2, Designing Solutions (specifically comparing solutions) in 3-5, and Engaging in Argument From Evidence in 6-8. This is representative of the different practices students are engaging with, described above.

The following is the progression of the Performance Expectations for this DCI:

K-2-ETS1-2 Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.

3-5-ETS1-2 Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

MS-ETS1-2 Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

7th Grade Science Unit 4: Save the Andes!
Culminating Project

Unit Essential Question: *How can we sustain biodiversity in a modern, changing world?*

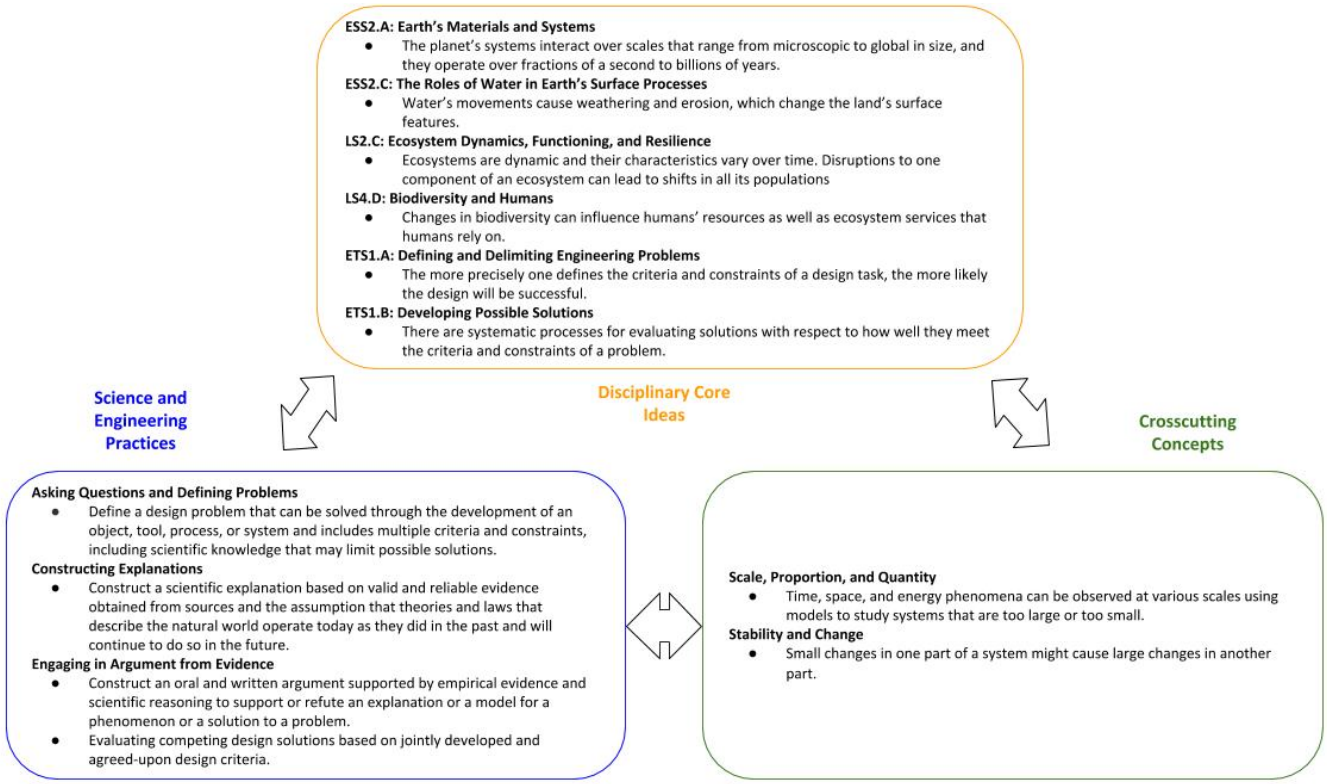
Introduction

As human beings, we depend completely on the natural resources, such as food, water, and other materials from ecosystems. Each of these ecosystems has a natural system of cycles and interactions that keeps it stable and functioning properly. When we interfere with these natural systems for our own benefits, problems often occur that are very difficult to repair. Some students may have heard of the Andes Mountains, a long chain of mountains on the southwest coast of South America. The mountain range has many different altitudes, creating a wide range of lush habitats for plants and animals. Subsequently, there is great diversity in the organisms native to the Andes region.

Unfortunately, humans as they often do, take advantage of the Andes' natural resources. In search of wood, oil, minerals, and land for farming, humans cause so much disruption in this area that many of the native plants and animals are in danger of extinction. Furthermore, human-caused climate change is shrinking the glaciers in the Andes region. As the glaciers disappear, many organisms lose their main freshwater source.

The students' task is to create a proposal to save the Andes! They begin the unit by understanding what a stable Andes ecosystem should look like, then identify the ways in which humans are altering the Andes and examine the problems associated with these human actions. After an evaluation of multiple solutions already in place to mitigate these problems, each group makes a plan to save the Andes from a problem associated with one specific human activity. Each group will create a scientific poster to present their proposal at an Environmental Science Conference. Individually, students will write and submit an article for publication in the Environmental Science Journal that discusses the science behind their proposal.

3-Dimensional Assessment



7th Grade Science Unit 4: Save the Andes!
Culminating Project

Time Needed (Based on 45-Minute Periods)

7 Days at end of unit

- Group Project: 3 periods
- Individual Project: 4 periods
    - First draft: 2 periods
    - Feedback: 1 period
    - Revision: 1 period

Materials

Scientific Poster

- Poster Paper
- Color pencils/pens or printed computer graphics
- Computers with internet capabilities for research

Journal Article

- Lined paper or computers with word processing software

Instructions for the Culminating Project

1. Introduce the Culminating Project at the end of the Lift-Off task, including both group and individual components outlined in the Challenge.

2. Read over the Culminating Project Task Card with the students. We recommend only reading the Challenge and Group Criteria for Success at this time in order to not overwhelm students with information.
    - Provide students with an opportunity to ask clarifying questions.
    - Optional: You may want to show pictures of the Andes Mountains, including the geography, animals, plants, and people you may find there.

3. Remind students that as they go through the Project Organizer, they will be planning parts of their proposal and recording information they may need for their individual project. However, there is nothing wrong with going back and changing their ideas over the course of the unit. Students won't fully design their proposal until the end of the unit, so change is acceptable and often experienced.

4. Make sure students fill out the Project Organizer after each task, which will help them think about different parts of their proposal along the way. This process allows students to both apply and document relevant scientific concepts as they move throughout the unit. This will inform both their group and individual projects.
    - We recommend that students complete the Project Organizer individually. They might discuss ideas first as a group, but should then respond individually. This allows students time to process concepts on their own and generate their own ideas, which can be used later when it comes to developing their group project.
    - You may also want to remind students that as they complete parts of the Project Organizer, they should also consider their own role in environmental degradation. Ideally, this will help them see why their proposal must represent a balance between conserving the ecosystem and garnering enough public support to make it a reality.

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Culminating Project

5. The table below summarizes how the Project Organizer guides students through developing different components of their proposal for the poster presentation and journal article.

Task	Project Organizer	Group and Individual Culminating Project
Lift Off Humans and Their Environment	• Based on what you watched in the video, how do you think humans might be impacting the Andes?	• Individual and Group Project – Both products show human impact on ecosystem.
Task 1 Sculpting Landscapes	• Background on the Andes region: What natural changes have led to the Andes region you see today? • Diagram explaining evidence of natural geoscience processes in the Andes region.	• Individual - Journal article includes a geographic map of the Andes that shows and explains the geoscience processes that have shaped the Andes.
Task 2 Disrupting Earth's Natural Systems	• Define the problem: What is one ecosystem service or resource that the Andes region provides for humans? How are humans negatively impacting the Andes region in order to benefit from this service or resource? • Identify the criteria for a solution: What problem will your solution solve? How will you determine if it is successful? • Identify the constraints: What consequences will your solution have on humans? What scientific knowledge, or lack of knowledge, may limit possible solutions?	• Group - Poster presentation identifies one specific human activity impacting the Andes region. • Individual - Journal article first defines biodiversity and explains why it's important for ecosystem health. It then describes how biodiversity in the Andes region provides important ecosystem services and natural resources for humans. Finally, it describes how one specific human activity affects these ecosystem services and natural resources, as well as other populations of organisms in the Andes region.
Task 3 Living in Harmony – Weighing the Consequences	• Based on research about ecosystem preservation solutions: ○ What are the best solutions you learned about in this task? ○ How can you combine the parts of these solutions to create a stronger proposal for your final project? ○ How might your combined proposal affect human communities at smaller (local) and larger (global) scales?	• Group - Poster presentation explains how the proposal works and its potential limitations. • Individual – Journal article evaluates benefits and drawbacks of the existing design solutions, and explains why their proposed solution works better.

6. After all the learning tasks are completed, and all sections of the Project Organizer are completed, students may begin designing their proposal to save the Andes. As part of this project, students will then create a scientific poster explaining their proposal. The Project Organizer and Group Project Criteria for Success should be used as reference to remind students of all the components of their group project.
    - We recommend the use of group roles for Culminating Project work time (See "How to Use This Curriculum" document for details). We recommend changing the roles every workday.

7. For an authentic experience, we recommend conducting the poster presentations as a modified gallery walk similar to the structure of a poster session at a scientific conference. Have each group set up their poster around the room. During the gallery walk, one individual from the group stays with their poster to explain their proposal to peers who visit their poster. We recommend rotating these individuals every few minutes, so each group member is responsible for presenting at some point.
    - We recommend that as you visit each poster, ask questions and assess groups using the Group Project Criteria for Success Checklist provided. The subjective nature of the criteria for the poster gives you the freedom to emphasize the positive aspects of each poster. Most of students' conceptual understanding will be assessed in the individual project.
    - Optional: For students visiting the posters, have them interact with the posters in some way. One option is to give them two post-its to leave questions or comments for various posters. Another option is to have them carry a notebook and take notes for a formative assessment that you design to follow the gallery walk.

8. Once the poster presentations are complete, students are ready to begin their individual project. Students will write a journal article accompanying their poster presentation to submit to the Environmental Science Conference. This is authentic to the science discipline, as most conferences require a journal article to accompany any presentation. Remind students to check that their journal article meets all the criteria in the student handout.
    - Depending on the needs of your students, you may want to provide a template to help them organize their journal article. This only provides them with a structure, so this should be used in conjunction with the Individual Project Criteria for Success checklist to ensure students include all parts required. An option is provided at the end of this teacher guide.

9. Conduct a peer review of the journal articles after students have completed a first draft.
    - Copy the Journal Article Peer Review Feedback form found in the Student Instructions. Alternatively, you may use the Student 3-Dimensional Individual Project Rubric.
    - Assign each student a partner, preferably a partner from a different group.
    - Students switch and assess drafts using the peer review feedback form.
        - Remind each student to provide one positive comment and one constructive comment for each section on the checklist.
        - Allow students time to present their feedback to their partner, and for their partner to ask clarifying questions if needed.

10. After feedback is exchanged, allow students time to complete a final draft based on the feedback they received.

Assessment

The Project Organizer can be formatively assessed using:

- *Criteria of your choice.* We recommend using the 3-Dimensional Assessment matrix from the Unit Overview to inform your criteria.

The Group Culminating Project will be summatively assessed using:

- The *Group Project Criteria for Success* Checklist

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Culminating Project

The Individual Culminating Project will be summatively assessed using:

- The *3-Dimensional Individual Project Rubric*.
- Keep in mind that the Proficient level indicates that the student has successfully demonstrated understanding of the criteria. Because we are in the early stages of NGSS adoption, it may take multiple opportunities throughout the course of the year for students to reach Proficient.
- If you wish to give students a numeric score, you could take the average score of all of their rubrics or add up rubric scores to give students a summation out of the total. Because of the note above, this scoring may not correlate to traditional grading systems.
- While we recommend scoring all of the project criteria with the rubrics for each student, we understand the burden of that level of scoring.
    - One option is to select the rubrics that you wish to focus on for this project and use those to assess each student's individual project.
    - Another option is to review the Proficient level of each of the project's rubrics and use the descriptions to generally analyze all student work for trends.

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Culminating Project

Your Article Title

Environmental Science Journal 2020

Write 2-3 catchy sentences to introduce your article, so readers will know what it is about.

Background on the Andes

Biodiversity in the Andes

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One Problem Facing the Andes

Existing Solutions Around the World

Our Proposal

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3-Dimensional Individual Project Rubric

Overview: The following rubrics can be used to assess the individual project: a journal article detailing a proposal to save the Andes. Each rubric is aligned to one section of the *Individual Project Criteria for Success*, located on the Culminating Project Student Instructions. *If student provides no assessable evidence (e.g., "I don't know" or leaves answer blank), then that student response cannot be evaluated using the rubric and should be scored as a zero.

Below we provide an alignment table that details the dimensions assessed for each criterion.

	Student Criteria for Success	Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
1	❒ A geographic map of the Andes, showing and explaining: ○ How large and small geoscience processes have resulted in specific geographic features, using evidence from Task 1 to support your explanation.	**Constructing Explanations** ● Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) 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.	**ESS2.A: Earth's Materials and Systems** • The planet's systems interact over scales that range from microscopic to global in size, and they operate over fractions of a second to billions of years. These interactions have shaped Earth's history and will determine its future. **ESS2.C: The Roles of Water in Earth's Surface Processes** • Water's movements—both on the land and underground—cause weathering and erosion, which change the land's surface features and create, underground formations.	**Scale, Proportion, and Quantity** ● Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small.
2	○ A description of biodiversity in the Andes, including: ○ What is biodiversity, and why is it important for ecosystem health? ○ How does the biodiversity in the Andes provide ecosystem services and natural resources for humans? ○ How do human changes to biodiversity affect these ecosystem services and natural resources?	**N/A**	**LS2.C: Ecosystem Dynamics, Functioning, and Resilience** ● Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations. **LS4.D: Biodiversity and Humans** ● Changes in biodiversity can influence humans' resources, such as food, energy, and medicines, as well as ecosystem services that humans rely on—for example, water purification and recycling (*secondary*).	**Stability and Change** ● Small changes in one part of a system might cause large changes in another part.

7th Grade Science Unit 4: Save the Andes!

3-Dimensional Individual Project Rubric

3	❑ The Problem ○ Define the problem: ○ Describe one human activity that is affecting the Andes and explain why humans do this activity. ○ Construct an argument for how this human activity causes large changes across populations of organisms, using evidence from Task 2 to support your argument.	**Engaging in Argument From Evidence** • Construct an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem.	**LS2.C: Ecosystem Dynamics, Functioning, and Resilience** • Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations.	**Stability and Change** • Small changes in one part of a system might cause large changes in another part.
4	○ Identify the constraints: What barriers might make it difficult to stop this problem? ○ Using what you learned in Task 3 to depict the small and large-scale consequences that any solution may have on humans.	**Asking Questions and Defining Problems** ● Define a design problem that can be solved through the development of an object, tool, process or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions.	**ETS1.A: Defining and Delimiting Engineering Problems** • The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that are likely to limit possible solutions. The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter.	**N/A**
5	❑ Existing Solutions Worldwide ○ Describe the best solutions to address this problem. ○ Identify the benefits and drawbacks for each solution. ❑ Your Proposal: ○ Describe your proposal for addressing this problem. ○ Explain why your proposal is the best option.	**Engaging in Argument from Evidence** • Evaluate competing design solutions based on jointly developed and agreed-upon design criteria.	**ETS1.B: Developing Possible Solutions** • There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem.	**N/A**

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3-Dimensional Individual Project Rubric

Rubric 1: Student identifies the geographic features of the Andes Mountains, and cites evidence to explain how large and small geoscience processes caused these features.

- Dimensions Assessed: SEP – Constructing Explanations, DCI – ESS2.A: Earth's Materials and Systems and ESS2.C: Roles of Water in Earth's Surface Processes, CCC – Scale, Proportion & Quantity

Emerging (1)	Developing (2)	Proficient (3)	Advanced (4)
Student identifies **inaccurate** geographic features of the Andes mountains. OR Student identifies the **accurate** geographic features of the Andes mountains, and **inaccurately** explains how large and small geoscience processes caused these features.	Student identifies the **accurate** geographic features of the Andes mountains, and cites **some** evidence to **generally** explain how large and small geoscience processes caused these features.	Student identifies the **accurate** geographic features of the Andes mountains, and cites **some** evidence to **partially** explain how large and small geoscience processes caused these features.	Student identifies the **accurate** geographic features of the Andes mountains, and cites **all** evidence to **completely** explain how large and small geoscience processes caused these features.
Look Fors: ● Student inaccurately identifies geographic features in the Andes Mountains. OR ● Student accurately identifies geographic features in the Andes Mountains (ie. mountain ranges, land movement, landslides/mudslides, and/or volcanic land features). Student explanation of the processes that have resulted in changes to the Andes landscape is inaccurate or irrelevant. For example, "the mountains were created from earthquakes and the volcanoes resulted in ash."	**Look Fors:** ● Student accurately identifies geographic features in the Andes Mountains (ie. mountain ranges, land movement, landslides/mudslides, and/or volcanic land features). ● In their explanation of the large and small geoscience processes that have led to these features, student cites some examples of evidence from Task 1, but only provides a general explanation that does not link the geoscience processes to specific geographic features. For example, "plate motions, earthquakes, and volcanoes lead to mountains, land movement, and new land features." .	**Look Fors:** ● Student accurately identifies geographic features in the Andes Mountains (ie. mountain ranges, land movement, landslides/mudslides, and/or volcanic land features). ● In their explanation of the large and small geoscience processes that have led to these features, student cites one example of evidence from Task 1 of a large geoscience process (i.e. plate motions, earthquakes, and volcanoes), and one example of evidence from Task 1 of a small geoscience process (i.e. erosion due to weathering). ● Student links each geoscience process above to specific geographic features of the Andes landscape. For example, "Weathering and erosion cause landslides." See Advanced	**Look Fors:** ● Student accurately identifies geographic features in the Andes Mountains (ie. mountain ranges, land movement, landslides/mudslides, and/or volcanic land features). ● In their explanation of the large and small geoscience processes that have led to these features, student cites all examples of evidence from Task 1 of large geoscience processes (i.e. plate motions, earthquakes, and volcanoes) and small geoscience processes (i.e. erosion due to weathering). ● Student links the geoscience processes above to specific geographic features of the Andes landscape. For example, "As the Nazca Plate moved toward the South American Plate, subduction occurred,

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3-Dimensional Individual Project Rubric

		Look-Fors for another example of an accurate response.	which created the fold mountains of the Andes." See Proficient Look-Fors for another example of an accurate response.

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3-Dimensional Individual Project Rubric

Rubric 2: Student describes how biodiversity is important to ecosystem health, and explains how small changes in biodiversity in the Andes lead to large effects on ecosystem services and natural resources.

- Dimensions Assessed: DCI – LS2.C: Ecosystem Dynamics, Functioning & Resilience and LS4.D: Biodiversity and Humans, CCC – Stability and Change

Emerging (1)	Developing (2)	Proficient (3)	Advanced (4)
Student **inaccurately** describes how biodiversity is important to ecosystem health, **AND/OR inaccurately** explains how small changes in biodiversity in the Andes lead to large effects on ecosystem services and natural resources.	Student **accurately** describes how biodiversity is important to ecosystem health, and **generally** explains how small changes in biodiversity in the Andes lead to large effects on ecosystem services and natural resources.	Student **accurately** describes how biodiversity is important to ecosystem health, and **partially** explains how small changes in biodiversity in the Andes lead to large effects on ecosystem services and natural resources.	Student **accurately** describes how biodiversity is important to ecosystem health, and **completely** explains how small changes in biodiversity in the Andes lead to large effects on ecosystem services and natural resources.
Look Fors: ● Student inaccurately states that biodiversity is not essential for maintaining ecosystems. For example, that instead we should focus on climate change. AND/OR ● Student inaccurately explains that changes in biodiversity have no effect on ecosystem services or natural resources. For example, "When biodiversity decreases, the amount of natural resources available remains the same because there are less animals that need the resources."	**Look Fors:** ● Student accurately states that because each organism in an ecosystem plays an integral role in natural cycles and processes of an ecosystem, greater biodiversity ensures an ecosystem's resilience to change. ● Student provides a general example of a problem threatening biodiversity in the Andes without specifically describing whether it affects one ecosystem service or one natural resource. For example, "Deforestation results in a loss of natural resources. "	**Look Fors:** ● Student accurately states that because each organism in an ecosystem plays an integral role in natural cycles and processes of an ecosystem, greater biodiversity ensures an ecosystem's resilience to change. ● Student accurately describes one specific example of how a change in biodiversity in the Andes affects one ecosystem service or one natural resource. For example, "The construction of hydroelectric power plants involves dams that block important fish migration patterns, thus reducing the variety and number of fish in the region and threatening biodiversity. In the end, fewer fish means less food for the people in the region."	**Look Fors:** ● Student accurately states that because each organism in an ecosystem plays an integral role in natural cycles and processes of an ecosystem, greater biodiversity ensures an ecosystem's resilience to change. ● Student accurately describes one specific example of how a change in biodiversity in the Andes affects one ecosystem service and one natural resource. For example, "Deforestation destroys many trees and plants in the Andes forest, thus decreasing biodiversity. This decreases the amount of carbon removed from the atmosphere (an important ecosystem service) and removes natural resources used to make medicines for people."

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3-Dimensional Individual Project Rubric

Rubric 3: Student writes an argument for how one human activity leads to large effects on populations of organisms in the Andes ecosystem, supporting with evidence and reasoning.

- Dimensions Assessed: SEP – Engaging in Argument from Evidence, DCI – LS2.C: Ecosystem Dynamics, Functioning, and Resilience, CCC – Stability and Change

Emerging (1)	Developing (2)	Proficient (3)	Advanced (4)
Student writes an **inaccurate** argument for how one human activity leads to large effects on populations of organisms in the Andes ecosystem.	Student writes an **accurate** argument for how one human activity leads to large effects on populations of organisms in the Andes ecosystem, supporting with **no** evidence and reasoning.	Student writes an **accurate** argument for how one human activity leads to large effects on populations of organisms in the Andes ecosystem, supporting with **partial** evidence and reasoning.	Student writes an **accurate** argument for how one human activity leads to large effects on populations of organisms in the Andes ecosystem, supporting with **complete** evidence and reasoning.
Look Fors: ● Student inaccurately argues that their chosen human activity affects the Andes region by not causing large changes across populations of organisms. Thus any supporting evidence and reasoning is also inaccurate or irrelevant. For example, "In the Andes region, people need electric power, so they use hydroelectric power plants. This doesn't affect organisms that live on the land."	**Look Fors:** ● Student accurately argues that their chosen human activity affects the Andes region by causing large changes across populations of organisms. ● While a claim is present, the supporting evidence and reasoning are missing, inaccurate, or too general to truly support the claim. For example, "Hunting chinchillas makes animals go extinct."	**Look-Fors** ● Student accurately argues that their chosen human activity affects the Andes region by causing large changes across populations of organisms. ● In their argument, a student includes partial evidence and/or reasoning to support their claim. For example, "In the Andes region, people need electric power, so they use hydroelectric power plants. This blocks fish migration in the Andes, thus decreasing the number of fish." This does not include the intermediate effect of how the dam changes water flow and temperature and also how land organisms and other organisms down the food chain are affected by the decrease in fish.	**Look Fors:** • Student accurately argues that their chosen human activity affects the Andes region by causing large changes across populations of organisms. • In their argument, a student includes detailed evidence and reasoning to support their claim. For example, "In parts of the Andes where it is cold, people need fur to keep warm and survive. They often obtain this fur by hunting chinchillas. However, since chinchillas are also food for birds and foxes in the Andes, the hunting of chinchillas not only reduces the population of chinchillas but also the populations of birds and foxes."

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3-Dimensional Individual Project Rubric

Rubric 4: Student describes a human-related limitation to solving an environmental problem in the Andes, and explains the small- and large-scale consequences any solution may pose.

- Dimensions Assessed: SEP – Asking Questions and Defining Problems, DCI – ETS1.A: Defining and Delimiting Engineering Problems

Emerging (1)	Developing (2)	Proficient (3)	Advanced (4)
Student **inaccurately** describes a human-related limitation to solving an environmental problem in the Andes, and **does not** explain the small- and large-scale consequences any solution may pose.	Student **accurately** describes a human-related limitation to solving an environmental problem in the Andes, and **does not** explain the small- and large-scale consequences any solution may pose.	Student **accurately** describes a human-related limitation to solving an environmental problem in the Andes, and **partially** explains the small- and large-scale consequences any solution may pose.	Student **accurately** describes a human-related limitation to solving an environmental problem in the Andes, and **completely** explains the small- and large-scale consequences any solution may pose.
Look Fors: ● Student inaccurately identifies one human-related limitation to solving an environmental problem. For example, "To stop deforestation, we must stop cutting trees, but this is hard because it opens up land for new populations to grow."	**Look Fors:** ● Student accurately identifies one human-related limitation to solving an environmental problem. For example, "To stop deforestation, we must stop cutting trees, but this is hard because we rely on the trees for so many things." ● No accurate explanation of consequences is given.	**Look Fors:** ● Student identifies one human-related limitation to solving an environmental problem. For example, "To stop deforestation, we must stop cutting trees, but this is hard because we rely on the trees for so many things." ● Student explains either a small- or large-scale consequence of their chosen solution. For example, "If we stop cutting down trees, this may lead to a shortage of wood to build homes in the local Andes region."	**Look Fors:** ● Student identifies one human-related limitation to solving an environmental problem. For example, "To stop deforestation, we must stop cutting trees, but this is hard because we rely on the trees for so many things." ● Student explains both a small- and large-scale consequence of their chosen solution. For example, "If we stop cutting down trees, this may lead to a small-scale problem of a shortage of wood to build homes in the local Andes region. It may also have the large-scale consequence of increasing the price of paper-based products globally because wood is more limited."

7th Grade Science Unit 4: Save the Andes!

3-Dimensional Individual Project Rubric

Rubric 5: Student explains why their solution to an environmental problem facing the Andes region best meets the criteria and constraints of the problem by comparing to other solutions.

- Dimensions Assessed: SEP – Engaging in Argument From Evidence, DCI – ETS1.B: Developing Possible Solutions

Emerging (1)	Developing (2)	Proficient (3)	Advanced (4)
Student provides an **irrelevant** explanation of why their solution best meets the criteria and constraints of the problem.	Student provides a **general** explanation of why their solution best meets the criteria and constraints of the problem by **not** comparing to other solutions.	Student provides a **detailed** explanation of why their solution best meets the criteria and constraints of the problem by **implicitly** comparing to other solutions.	Student provides a **detailed** explanation of why their solution best meets the criteria and constraints of the problem by **explicitly** comparing to other solutions.
Look Fors: ● Student explains how their proposed solution meets the criteria and constraints, but the solution is irrelevant to the problem. For example, "To combat the problem of deforestation, I will take shorter showers and recycle."	**Look Fors:** ● Student explains how their proposed solution meets the criteria or constraints in a general sense. "To combat the problem of deforestation for agriculture, our solution works best because plants and animals will go extinct." ● Student does not compare to other solutions.	**Look Fors:** ● Student explains how their proposed solution meets the criteria and constraints. For example, "To combat the problem of deforestation for agriculture, our solution best meets criteria because it reduces the effects of deforestation by taxing large farming corporations to use the land and puts these taxes towards habitat restoration. It also meets constraints because local populations will support the plan for their financial and environmental benefit." ● Student implicitly compares to other solutions. For example, "Our solution preserves habitats more than the other solutions we saw."	**Look Fors:** ● Student explains how their proposed solution meets the criteria and constraints. For example, "To combat the problem of deforestation for agriculture, our solution best meets criteria because it reduces the effects of deforestation by taxing large farming corporations to use the land and puts these taxes towards habitat restoration. It also meets constraints because local populations will support the plan for their financial and environmental benefit." ● Student explicitly compares to at least one other solution. For example, "Our solution is better than a similar solution which completely bans any new farming in the region. This may meet the criteria, but does not consider the large effects on human communities and thus does not meet the constraints of the problem."

7th Grade Science Unit 4: Save the Andes!

3-Dimensional Individual Project Rubric

Additional Notes:

- An additional rubric is provided in Task 1 to assess the Performance Expectation MS-ESS3-2 (including the corresponding dimensions); this PE is not assessed explicitly in this Culminating Project.
- Two additional rubrics are provided in Task 2 to assess the Performance Expectation MS-PS1-3 (including the corresponding dimensions); this PE is not assessed explicitly in this Culminating Project.

7th Grade Science Unit 4: Save the Andes!
Project Organizer

Unit Essential Question: *How can we sustain biodiversity in a modern, changing world?*

You have been tasked with creating a proposal to save the Andes. After each task, you will return to the table below to organize what you learn as you go through the unit. By the end of the four tasks, you will have all this information to use for your culminating project. For each activity, be sure to include answers to **ALL** the questions provided.

Lift-Off Task: Humans and Their Environment	Based on what you watched in the video, how do you think humans might be impacting the Andes?
Task 1: Sculpting Landscapes	First, you need to give your audience some background on the Andes region itself. ❑ What natural changes have led to the Andes region you see today? ❑ Draw diagrams with labels to explain your evidence.

7th Grade Science Unit 4: Save the Andes!

Project Organizer

Task 2: Disrupting Earth's Natural Systems	As part of this proposal you will need to define a problem in the Andes region, and identify the criteria and constraints for solving the problem. To help you plan this, follow the steps below: ❒ Define the problem: ○ What is one ecosystem service or resource from the Andes region that humans rely on? ○ How are humans negatively impacting the Andes region in order to benefit from this ecosystem service or resource? ❒ Identify the criteria for a successful solution to one problem in the Andes region: ○ What problem will your solution solve? ○ How will you determine if a solution is successful? ❒ Identify the constraints (limitations) of solving this problem: ○ What consequences will your solution have on humans in the Andes and around the world? To better explain this, make a flowchart (see *Elaborate*) to trace your plan backwards and see the potential effects it will have on people's daily lives. ○ What scientific knowledge, or lack of knowledge, may limit possible solutions?

7th Grade Science Unit 4: Save the Andes!

Project Organizer

Task 3: Living in Harmony – Weighing the Consequences	In this task, you have researched and evaluated solutions currently used to address some of the environmental problems caused by human activity in the Andes region. By now, you also realize that developing a conservation plan is often a balancing act that involves helping the environment on one hand, but also getting public support in order to accomplish this plan. To help you with this, use your new knowledge from this task to answer the following questions: ❒ What are the best solutions you heard about or researched in this task? ❒ How can you combine the parts of these solutions to create a stronger proposal for your final project? ❒ How might your combined proposal affect human communities at smaller (local) and larger (global) scales?

7th Grade Science Unit 4: Save the Andes!
Lift-Off Task: Humans and the Environment

Unit Essential Question: *How can we sustain biodiversity in a modern, changing world?*

Introduction

Many times it is hard for students to see the real impact they have on the world around them. They go throughout their daily lives, riding in their parents' cars to school, writing on endless pieces of paper, and creating endless amounts of waste. However, most don't stop to think about where these products come from or where this waste is going. In this Lift-Off Task, students watch a video that caricaturizes the ways in which humans interact with their environment in order to help students make an emotional connection to the themes of this unit. Based on what they see, students then generate questions about the phenomenon of human interactions with the environment. As students investigate these questions throughout the rest of the unit, they will begin to see their own impact on global and local biodiversity, which will inform their plan to preserve the biodiversity of the Andes region—their culminating project for this unit.

Alignment Table

Because the Lift-Off tasks focus on student-generated questions, we do not identify specific Disciplinary Core Ideas or Science and Engineering Practices in this table.

Crosscutting Concepts (*depending upon student-generated questions)

- Scale, Proportion, and Quantity
  - Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small.
- Patterns
  - Graphs, charts, and images can be used to identify patterns in data.
- Stability and Change
  - Small changes in one part of a system might cause large changes in another part.
- Structure and Function
  - Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used.

Equity and Groupwork

- Share and listen to broad and diverse student contributions.
- Make connections between each other's ideas.
- Work together to co-construct a concept map.

Language

- Use connector words to link ideas.
- Generate and write questions about the phenomenon.
- Organize key questions in a concept map.

Learning Goals

This learning task introduces students to the phenomenon of how humans interact with the environment and asks them to begin generating questions that will guide them through the unit. More specifically, the purpose is to:

- Watch a video and generate a list of questions about the phenomenon of human interaction with the environment.
- Make connections between related questions.

7th Grade Science Unit 4: Save the Andes!
Lift-Off Task: Humans and the Environment

- Generate possible answers to questions, using prior knowledge.
- Apply prior knowledge from the video to generate a list of ways in which humans impact the Andes.

Content Background for Teachers

In this unit, students will be thinking about Earth's natural systems as they should normally function and what happens when human activities disrupt these natural processes. They will not only explore the negative ways humans are impacting the environment, but also the positive steps humans have since taken to minimize this impact and restore Earth's systems to an ealier state. This opening task focuses on the severity of many human interactions with the environment and fosters an emotional connection to the issues.

As living things, we all have an impact on the environment. Unlike many other living things, we have the capacity to greatly overburden our environment with the technology we have created. Perhaps one of the most important issues to start with is overpopulation. Human population is exponentially increasing, causing a huge strain on Earth's natural resources. Because of Earth's growing population, this requires much more food, putting a large demand on agriculture and livestock. With the demand for more food has come an increase in chemical fertilizers, which produces runoff that kills off aquatic animals downstream. Consequently, an increase in monoculture has occurred, which while more efficient, hugely reduces biodiversity and often depletes soil of necessary nutrients. Furthermore, just clearing all this land for agriculture causes massive habitat loss and threatens many plant and animal species. Lastly, even aside from the negative impact on climate change, the increase in the livestock industry has caused a dramatic increase in waste generation and demands more water than Earth's systems can naturally replenish.

In addition to population growth, human levels of consumption are also accelerating rapidly. With new technologies and comforts comes an increase in demand on environmental resources. Today we drive and fly more, rapidly depleting fossil fuels and adding to air pollution. In our search for constant comfort, we also rely more heavily on air-conditioning and heating, thus using up greater energy resources throughout the year. Finally, humans within consumerist cultures seek to amass more products, thus creating more waste. This waste contributes to the worsening pollution of natural resources such as soil and water, and further contributes to global warming. While this all naturally paints a bleak picture, the future is not hopeless. Current efforts are under way to stop environmental degradation—efforts that students will focus on later in this unit.

In this task, students create a concept map, which is a graphical tool that helps to organize and represent knowledge and questions and is a successful academic language instruction tool. As students learn more about their impact on the environment and biodiversity, they will add more questions and ideas to this concept map. If your students have not had previous experience making concept maps, please see the instructions in Part B below for strategies on teaching this skill.

7th Grade Science Unit 4: Save the Andes!

Lift-Off Task: Humans and the Environment

Academic Vocabulary

- Environment
- Biodiversity
- Ecosystem
- Natural Cycles
- Natural Resource
- Natural Habitats

*Additional academic vocabulary will vary by class

Time Needed (Based on 45-Minute Periods)

2 Days

- Introduction, Part A and Part B: 1 period
- Class Concept Map, Project Overview, and Project Organizer: 1 period

Materials

- Unit 4, Lift-Off Task Student Version

Part A

- Projector and Speaker for Video

Part B

- Poster paper and markers
- Post-Its (Optional)

Part C

- Class Poster Paper and markers
- *See Instructions below for other optional materials to use for the class concept map

Connecting to the Culminating Project

- Culminating Project Handout
- Project Organizer Handout

Instructions

1. Introduce students to the unit by reading or projecting the Unit Essential Question aloud.

2. Have students watch the video entitled, “Man”.

Part A

1. In this Lift-Off task, students will be generating questions to help them make sense of the phenomenon.

2. Have students complete this section individually in their student guide.
    - For students who need more support, encourage them to revisit the video. You might pause the video at various moments and ask the students what they notice.
    - Here is a list of some potential questions students might generate: “What is the human doing to the environment? What are the different things (resources) that the human uses from his environment? How does the human interact with the living things in the environment? Do I use

some of the same things the human uses in the video? Do humans from all over the world behave in this same way? Is this human behavior something that needs to change? Why or why not? What are the aliens doing to the human at the end of the video? What does the aliens' action mean?"

Part B:

1. In this part of the task, students create a concept map as a group.
   - Remind students to refer to the directions on their student guide to help them make their concept map. First, students should compare each member's list of questions and record/connect key questions on a piece of poster paper. They will then draft possible answers to the questions, using prior knowledge.
   - Remind students that there are no right or wrong questions or predictions, so students feel encouraged to contribute any and all questions and ideas they think of.
   - Because this is a collaborative task, it is recommended that you remind students of group work norms and assign group roles, such as Resource Manager, Facilitator, Recorder, and Harmonizer (See "How to Use this Curriculum" for more details).

2. Students will post their posters on a wall and then walk around and look at each group's ideas. One suggestion for gallery walks is for students to interact with the posters in some way. For example, students are required to initial or leave post-its on three questions that they are also excited about on other posters.

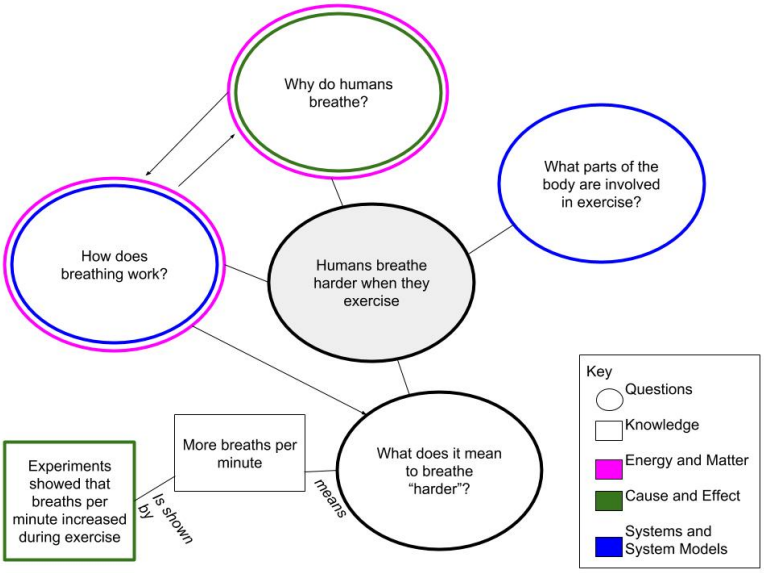
How to Concept Map

For students who have not had a lot of experience making concept maps, we have detailed a strategy below for introducing concept mapping using more familiar content. An example is also provided, but this will vary depending on what your students come up with as you make your own model.

1. Write the phenomenon in the middle of the poster, in this case "Humans breathe harder when they exercise."

2. Ask students to share questions they might ask to make sense of this phenomenon and make a list of these questions on the board.

3. Model the process of reviewing the list and finding similarities amongst the questions.
   - Place these key questions on the concept map poster, modeling how to put similar



questions near each other on the poster. Circle these to signify that these are questions, not content knowledge.

4. Ask students to look at the key questions and see if any of the questions are connected: Would answering one question lead to one of the other questions? Model making these connections by drawing arrows between the circles.

5. In this Lift-Off task, students will only be drafting possible answers to the questions, not actually gathering and recording learned concepts. However, throughout the unit, they will be adding content they have learned. Model this by recording a student's prior knowledge to one of the questions, using boxes to signify that these are pieces of content knowledge rather than questions.
    - Use connector words to identify the relationships between the content boxes (See image above for an example).

6. Optional: To emphasize crosscutting concepts using a concept map, make a key of different colors for the crosscutting concepts emphasized in this unit. Identify questions that clearly show evidence of the different crosscutting concepts and circle them with the corresponding colors. Explain to students how you made that choice by pointing out the language that hints at that crosscutting concept. *Note: not all boxes and circles will necessarily have a crosscutting concept.

Part C

1. Construct a whole-class concept map that begins to help students make sense of the phenomenon of human interaction with the environment.
    - Start with the phenomenon in the middle.
    - Then ask students to share out the questions that were most common across all the posters in the classroom. As you record questions on the poster, organize them based on connections you see. Draw circles around each question (as you add to the concept map throughout the unit, you'll also be adding concepts learned, which can be written in boxes to distinguish them from the questions).
    - Ask students to identify any connections they see between the questions and record these as lines between the questions.
        - Recommended: Give pairs of students think time to come up with 1-2 connections to add to the class concept map and call on pairs using equity sticks. This encourages more equitable participation in this class-wide activity.
    - The purpose of this concept map is to facilitate generation of student questions, promote language development, and support understanding of the science content throughout the unit. Allowing students to ask their own questions and use their own words to make meaning of the concepts will not only help them make deep connections about science content, but will also help their oral and written language development.
    - This whole class concept map will be revisited at the end of each subunit, asking students questions like: Are there any new questions you have about the phenomenon? Are there any connections you want to add or change? What is your reason for that addition/revision? Are there

more connections we can make between the questions/ideas already on the map? Do you want to add any new ideas/concepts to the map?

2. Because this concept map will be added to and revised throughout the unit, here are some practical options for implementation.
    - If you have access to white board paper, we encourage you to use these for class posters since it will allow you and your students to make revisions throughout the unit.
    - Another option is to use smaller pieces of paper for each class and project using a document camera; this will save space as opposed to doing large class posters.
    - We highly recommend students keep their own version of this concept map in their notebooks, adding questions and concepts as they go through the unit.

3. Once the draft concept map is complete, introduce students to the crosscutting concepts for this unit. We recommend posting posters of each crosscutting concept in your classroom (See beginning of teacher guide for templates).
    - The crosscutting concepts for this unit are: Patterns; Scale, Proportion, and Quantity; Structure and Function; and Stability and Change. Assign a color for each crosscutting concept that can be used throughout the unit.
    - Have students analyze the class concept map for as many examples of the crosscutting concepts as they can find. Depending on the questions they have, they may be able to find an example of each of the crosscutting concepts or perhaps just some.
    - We recommend modeling this process by picking a question, identifying the crosscutting concept, and tracing the circle in the corresponding color. Explain the key words that helped you identify the crosscutting concept in this question. Some identifying words that students might look for are:
        - **Patterns**: These could be phrases such as, “is the same as”, “has in common with”, “is similar to”, “shares” etc.
        - **Scale, Proportion, and Quantity**: These could be phrases such as, “is proportional to,” “compared to,” “has a ratio of,” “is bigger/smaller than,” “is longer/shorter than,” etc.
        - **Structure and Function**: These could be phrases such as, “its shape affects its function by,” “structure causes it to,” “functions this way because of,” etc.
        - **Stability and Change**: These could be phrases such as, “remains the same”, “is changed by”, “is disrupted by”, “changes”, “disrupts,” etc.

Connecting to the Culminating Project

1. Hand out the Culminating Project Task Card and read the Challenge and Group Project Criteria for Success aloud as a class.
    - Take questions for clarification.

2. Optional: Display a map of the Andes region and ask students to discuss what geographic features they notice.

7th Grade Science Unit 4: Save the Andes!
Lift-Off Task: Humans and the Environment

3. Pass out their Project Organizer and explain that they will complete a section of this after each task in class. Students should independently complete the Lift-Off Task section of the Project Organizer in class. Revisions can be done for homework, depending upon student's needs and/or class scheduling.
    - Students have been tasked with developing a plan to save the Andes. Their prompt is as follows: You will be creating a plan to save the Andes. Based on what you watched in the video, how do you think humans might be impacting the Andes?

Reflection

1. At the end of the task, ask students to reflect on what they have learned over the course of this task by answering the following three questions in their student guide:
    - At the beginning of this task, you made a list of all the questions you have about how humans interact with their environment. Look back at your list: think about the questions your peers asked that you did not initially write down. How are their questions different from the ones you originally asked?
    - In this unit, we will be focusing on four crosscutting concepts: **Patterns**: graphs, charts, and images can be used to identify patterns; **Scale, Proportion, and Quantity**: phenomena can be observed at various scales using models; **Structure and Function**: the properties of materials affect the function of a design; **Stability and Change**: small changes in one part of a system can cause large changes in another part. Looking at your class concept map, give one example of how one of the crosscutting concepts came up in today's task.
    - Now that you understand what project you'll be working on over the course of this unit, what else do you need to know? What additional questions do you have?

2. There are no right answers, but encourage students to look back at their initial list of questions and their class concept map. They should not change their initial responses, but rather use this reflection space to add to their questions and ideas based on what they have learned through this task. By generating more of their own questions, students continue to engage in sense-making of the phenomenon and the gathering of knowledge and skills for their final project.

7th Grade Science Unit 4: Save the Andes!

Task 1: Sculpting Landscapes

Unit Essential Question: *How can we sustain biodiversity in a modern, changing world?*

Introduction

In the last task, students saw how humans are interacting with the environment in a broader sense. This task begins to help students relate this general phenomenon introduced in the Lift-Off Task to the context of the project—how humans threaten the current biodiversity in the Andes Mountains. However, before students can think about how humans negatively impact the Andes, they must first consider how the Andes ecosystem functions naturally. In this task, students explore evidence of geoscience processes to help them understand which processes formed the Andes Mountains, across varying time and spatial, or geologic scales. This serves as a foundation for students to later consider which ecosystem services the Andes Mountains provide to humans, how each is impacted negatively by humans, and the effects of that impact. Students will then use their new knowledge to envision a potential plan, for their culminating project, to help mitigate the human impact on the Andes Mountains.

Alignment Table

Performance Expectations	Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
MS-ESS2-2. Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales. [Clarification Statement: Emphasis is on how processes change Earth's surface at time and spatial scales that can be large (such as slow plate motions or the uplift of large mountain ranges) or small (such as rapid landslides or microscopic geochemical reactions), and how many geoscience processes (such as earthquakes, volcanoes, and meteor impacts) usually behave gradually but are punctuated by catastrophic events. Examples of geoscience processes include surface weathering and deposition by the	**Constructing Explanations** • Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) 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.	**ESS2.A: Earth's Materials and Systems** • The planet's systems interact over scales that range from microscopic to global in size, and they operate over fractions of a second to billions of years. These interactions have shaped Earth's history and will determine its future. **ESS2.C: The Roles of Water in Earth's Surface Processes** • Water's movements—both on the land and underground—cause weathering and erosion, which change the land's surface features and create, underground formations.	**Scale, Proportion, and Quantity** • Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small.

movements of water, ice, and wind. Emphasis is on geoscience processes that shape local geographic features, where appropriate.]			
MS-ESS3-2. Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects. [Clarification Statement: Emphasis is on how some natural hazards, such as volcanic eruptions and severe weather, are preceded by phenomena that allow for reliable predictions, but others, such as earthquakes, occur suddenly and with no notice, and thus are not yet predictable. Examples of natural hazards can be taken from interior processes (such as earthquakes and volcanic eruptions), surface processes (such as mass wasting and tsunamis), or severe weather events (such as hurricanes, tornadoes, and floods). Examples of data can include the locations, magnitudes, and frequencies of the natural hazards. Examples of technologies can be global (such as satellite systems to monitor hurricanes or forest fires) or local (such as building basements in tornado-prone regions or reservoirs to mitigate droughts).]	**Analyzing and Interpreting Data** • Analyze and interpret data to determine similarities and differences in findings.	**ESS3.B: Natural Hazards** • Mapping the history of natural hazards in a region, combined with an understanding of related geologic forces can help forecast the locations and likelihoods of future events.	**Patterns** • Graphs, charts, and images can be used to identify patterns in data.

7th Grade Science Unit 4: Save the Andes!

Task 1: Sculpting Landscapes

Supplementary Crosscutting Concepts • **Stability and Change**   ○ Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and processes at different scales, including the atomic scale.
Equity and Groupwork • Discuss visual and textual evidence on geoscience processes. • Come to consensus on when to predict a volcanic eruption.
Language • Connect observations from graphs to information gathered from text. • Write an explanation supported by evidence and reasoning.

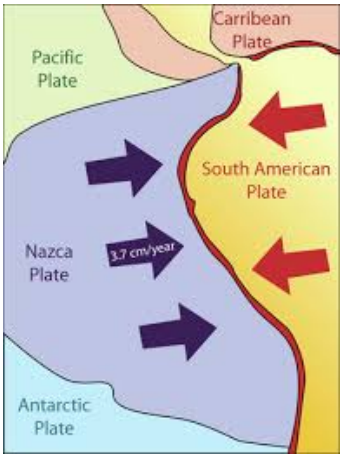
Learning Goals

This learning task explores evidence of how geoscience processes have changed Earth's surfaces and looks at data to predict one of these geoscience processes. More specifically, the purpose is to:

- Engage prior knowledge of natural changes on Earth.
- Explore evidence on the geoscience processes that have made the Andes Mountains what they are today.
- Explain how natural earth processes have contributed to changes to the Andes Mountains.
- Analyze data to forecast a volcanic eruption.
- Apply knowledge of geoscience processes to inform an audience with background information on the natural Andes region.

Content Background for Teachers

The Andes Mountains are one of the longest mountain ranges on Earth, stretching over 7,000 km along the west coast of South America, and spanning across seven different countries. Many of the peaks in the Andes are active volcanoes, and thus this area is part of what is known as "the ring of fire." The climate in this region varies greatly. In the north, it is typically rainy and warm. The western, central Andes is extremely dry and mostly desert-like, while the eastern, central Andes is much wetter. In the south, the western side is wet while the eastern plains tend to be very dry. Most of the peaks in the Andes experience heavy snowfall and contain glaciers, which provide much of the drinking water for surrounding regions.

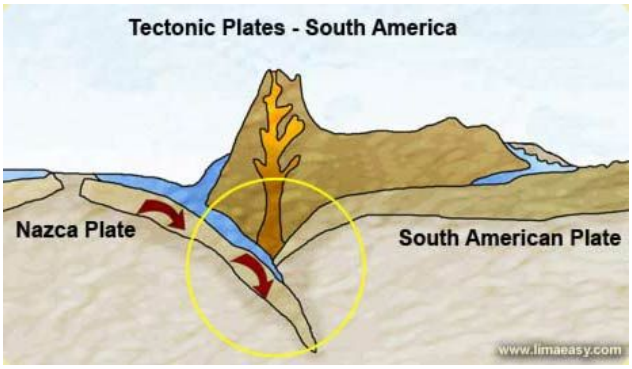


This task focuses on the geoscience processes that helped to form the Andes Mountains, some of which are long-term and others short-term. Central to this story is the motion of earth's tectonic plates. The Andes Mountains are located at the boundary of the Nazca Plate and the South American Plate. The Nazca Plate is moving eastwards, towards the South American Plate, at 37mm per year. Where the two plates meet, the denser oceanic Nazca Plate is forced down and under the more buoyant continental South American Plate, descending at an angle in a process called subduction. As this process continues, some of the sediments are forced onto the South American Plate. As the plates collide, the leading edge of the South American Plate becomes deformed, pushing the crust upward (imagine a car hitting a solid wall). This produced the folded mountains of the Andes.

7th Grade Science Unit 4: Save the Andes!

Task 1: Sculpting Landscapes

This subduction, in turn, causes a lot of friction, which prevents the plates from sliding smoothly. As the Nazca Plate descends, it rubs against the South American Plate, causing both to fracture (break) and deform. This in turn causes frequent earthquakes, which can also alter the geography of the region. For example, after an earthquake in the Andes in 2010, much of the land actually shifted towards the Pacific Ocean, moving some cities as much as 4.7 meters to the west. Scientists have discovered that earthquakes have been a major source of erosion in the history of the Andes Mountains—causing most landslides and mudslides in the area. Because of the steepness of much of the land, soil in the Andes Mountains is very susceptible to erosion. Of course, weathering factors, such as wind and water, can also cause erosion in the Andes, as in any area exposed to similar elements. Erosion changes the landscape of the Andes Mountains, often destroying habitats for many plant and animal species. Finally, erosion can also contaminate bodies of water with excess sediment, remove nutrient-rich soil from an area, and cause greater runoff of needed water.



The subduction of the Nazca Plate also produces magma, which rises and may erupt explosively at the surface. Volcanoes in the Andes, such as the stratovolcano Láscar, in northern Chile, are a good example of this type of activity. Láscar erupted ash and pyroclastic flows in 1993 and was still active as recently as 2012. As the volcanoes around the Andes are very active due to plate movement, they are part of a region on Earth often referred to as the "Ring of Fire" – a place with frequent earthquakes and volcanoes.

Academic Vocabulary

- Plate Motions
- Earthquakes
- Volcanoes
- Erosion
- Weathering
- Landslides
- Mudslides
- Geoscience
- Magma
- Thrusts
- Tiltmeter
- Subduction
- Fracture
- Eruption

Time Needed (Based on 45-Minute Periods)

4 Days

- Engage: 0.5 period
- Explore: 1 period

7th Grade Science Unit 4: Save the Andes!

Task 1: Sculpting Landscapes

- Explain: 0.5 period
- Elaborate: 1 period
- Evaluate and Reflection: 1 period

Materials

- Unit 4, Task 1 Student Version

Explore

- Resource Cards: laminate or put in sheet protectors (Recommended: put multiple copies of each resource card at the station OR create multiple of the same station so that there is more participation).

Elaborate

- Computers (1-2 per group)

Evaluate

- Project Organizer Handout

Instructions

Engage

1. Introduce Task 1: In the Lift-Off Task, you watched a video and asked questions to begin to make sense of how humans interact with their environment. Think about what you were still wondering about at the end of the last task (look back if you need to). What questions do you still have?
    - Before you pass out their student guide, give students time to reflect individually or with a partner about the questions they recorded at the end of the last task. Share a few of these out as a class, using facilitating questions to guide students toward questions that relate to this task.

2. Transition to Task 1: In the Lift-Off Task, many of you asked, "What is the human doing?" and, "How do the human's actions affect the natural environment?" In order to better understand the effect of humans on the environment, we must first understand how the environment undergoes certain natural changes on its own. In this task, you will explore geoscience processes, a set of naturally occurring changes that affects the environment.
    - Now pass out their Task 1 student guide.

3. In pairs, students brainstorm some examples of natural changes that can happen to environments on Earth. Give a hint that some of these changes can be long-term as well as short term.
    - Share out a few different possibilities that students come up with, using equity sticks for a more equitable discussion (See "How to Use This Curriculum" for more details).
    - There are no right answers at this point, but students will most likely come up with things like erosion of river banks, excess rainfall causing rise in water levels, creation of mountains or valleys, growth of plants/trees, etc.

Explore

1. The introduction in the student guide highlights the importance of understanding how the Andes naturally functions before they think about how humans are disrupting this natural function. To accomplish this,

students will visit each of the four stations to collect evidence on the geoscience processes that have shaped the Andes Mountains into what we see today.

2. Assign roles to each group. You may use your own preferred roles, or, we recommend the use of the Materials Manager, Facilitator, Harmonizer, and Recorder.
    - Ask the Materials Manager to gather the station cards needed to complete the task and read them aloud.
    - Ask the Facilitator to read the directions and to make sure everyone understands the task and what the data collection chart is asking.
    - Ask the Harmonizer to make sure that everyone contributes their ideas and that everyone's voice is heard.
    - Ask the Recorder to make sure each person in the group is correctly recording the information.

3. As each station, students should discuss and record the geoscience processes that helped to shape the Andes, and what the effects of those geoscience processes have been (see sample student data chart below).
    - The question in the righthand column encourages students to analyze the evidence through the lens of **Scale, Proportion, and Quantity**—by considering whether these geologic processes, or changes, seem to happen on a large or small scale and whether they occur suddenly or gradually.

Sample Student Data Collection Chart

	Explanation of **Cause**	**Effect** on the Andes	**Scale, Proportion, and Quantity:** Do these changes seem large scale or small scale? Sudden or gradual?
Plate Motions	*The Andes Mountains are located at the boundary of the Nazca Plate and the South American Plate. Where the two plates meet, the denser oceanic Nazca Plate is forced down and under the more buoyant continental South American Plate, descending at an angle in a process called subduction. As the plates collide, the leading edge of the South American Plate becomes deformed, pushing the crust upward (imagine a car hitting a solid wall).*	*This produced the fold mountains of the Andes.*	*These changes seem very large scale since they affect things like whole mountain ranges. Because plates move so slowly, it seems this change is gradual.*

7th Grade Science Unit 4: Save the Andes!

Task 1: Sculpting Landscapes

Earthquakes	*As the oceanic Nazca Plate subducts underneath the continental South American Plate, it causes a lot of friction, which prevents it from sliding smoothly. As the Nazca Plate descends, it drags against the other plate, causing both to fracture (break) and deform.*	*This causes frequent earthquakes, which can actually change the geography of the region. For example, after an earthquake in the Andes in 2010, the land actually moved toward the Pacific, moving some cities as much as 4.7 meters to the west (pictured on the right). Earthquakes can also cause tsunamis and landslides.*	*Earthquakes seem large scale since they have a big effect and they happen very suddenly.*
Volcanoes	*Subduction of the Nazca plate also produces magma, which rises and may be erupted explosively at the surface.*	*This causes volcanic eruptions. Volcanoes in the Andes, such as the stratovolcano Láscar, in northern Chile, are a good example of this type of activity. Láscar erupted ash and pyroclastic flows in 1993 and was still active in 2012. Because of this kind of activity, this area is often referred to as "the ring of fire."*	*Volcanic eruptions also seem large scale and happen very suddenly.*
Weathering and Erosion	*Erosion in the Andes can be caused by weathering factors, such as wind and water. Earthquakes have been the major source of erosion in the history of the Andes mountains-- causing most landslides and mudslides in the area.*	*Erosion changes the landscape of the Andes mountains, often destroying habitats for many plant and animal species. It can also contaminate bodies of water with excess sediment, removing nutrient-rich soil from an area, and cause greater runoff of needed water.*	*Erosion seems much more gradual and small scale for the most part, affecting little bits of land at a time. However, when caused by an earthquake, erosion can be sudden.*

7th Grade Science Unit 4: Save the Andes!

Task 1: Sculpting Landscapes

Explain

1. Based on the evidence gathered at each station, students are ready to construct an explanation that answers the following prompt: *How have natural geoscience processes changed the Andes Mountains over time?*
    - Students are reminded to use evidence from their data chart to help support their claim, thus performing the SEP of **Constructing Explanations.**
    - This activity also highlights the supplementary CCC of **Stability and Change**, as students focus on how the stability of the Andes region has naturally changed throughout Earth's history because of a series of short-term and long-term changes.
    - Optional scaffold: You might come to a class consensus on a claim, and then brainstorm an example of evidence that supports the claim.

Optional Sentence Stems to Provide:

Claim	Based on the evidence, it seems that natural geoscience processes…
Evidence	There are many different sources of evidence, such as… First, we can see that… Another piece of evidence is… Secondly, the geography of the region has changed by… Lastly, _____ has led to…
Reasoning	All of these pieces of evidence stem from… When this happens, _____ happens… _____ also causes _____... _____ also leads to _____...

Sample Student Explanation:
There is countless evidence for natural geoscience processes that have changed the Andes Mountains over time. For example, we can see a large mountain range along the boundary of the Nazca and South American plates. Also, the geography of the region has changed with a great majority of the land mass in the area actually moving towards the Pacific Ocean. Additionally, the eruption of magma from various volcanoes in the region supports our claim. Lastly, erosion has led to many changes in the landscape, some of which have destroyed habitats and caused other negative effects. All of these pieces of evidence relate to the fact that the Andes region is located at the boundary of the Nazca Plate and the South American Plate. When these two plates collide, subduction occurs, thus forming a mountain range. The friction resulting from this plate collision also causes earthquakes and produces magma that is brought to the surface through volcanoes. Earthquakes can also speed up the erosion process affecting the geography further.

2. Optional peer review - Have table partners switch explanations and suggest revisions.
    - This paragraph can also be a good option for formative assessment. Collect student work to identify trends in students' ability to use evidence of geoscience processes to support their explanation of the Andes region. See "How to Use This Curriculum" for strategies on utilizing formative assessment data to provide feedback to students and inform classroom instruction.

7th Grade Science Unit 4: Save the Andes!

Task 1: Sculpting Landscapes

Elaborate

1. This part of the task links two Performance Expectations for the unit, MS-ESS2-2 with MS-ESS3-2, highlighting how humans can use data to forecast one natural geoscience process (volcanic eruptions), thus mitigating its effects.
    - Since this PE is not assessed as part of the culminating project, we recommend examining this section of the student guide as a form of assessment, using the rubric in the assessment section at the end of this teacher guide.

2. The introduction frames the task within the context of a specific volcano in the Andes Mountains, the Sabancaya volcano, which experienced nearly constant eruptions between 1990 and 1998. Natural processes, like the volcanic eruptions occurring in the Andes, can cause catastrophic loss of human life and property. Luckily humans now understand how to more accurately predict when volcanic eruptions may occur in order to mitigate their negative effects.
    - Here, students use graphs to identify patterns that inform predictions, thus emphasizing the CCC of **Patterns**.
    - Students also engage with the SEP of **Analyzing and Interpreting Data** as they compare sets of data to determine similarities and differences that would imply a volcanic eruption in the future.

3. Assign roles to each group. We recommend assigning students new roles within their group.

4. Students first examine three different types of data used when trying to predict when a volcano may erupt. This is shown in Table #1. We recommend reviewing the different types of data as a class and giving students an opportunity to ask clarifying questions regarding the data.

5. As a group, students then visit the USGS website https://volcanoes.usgs.gov/vsc/predict/EP_look_800.html to engage in the "Exercise" simulation to make their own prediction of a volcanic eruption.
    - Students record their data in the table on their student guide, specifically responding to the following prompts:
        - *What **patterns** do you notice when examining the graphs?*
        - ***Analyzing and Interpreting Data:** Based on this data and the information from Table #1, what should you do at this date, and why?*
    - The final question that follows their data analysis prompts students to think about why it is important to be able to predict natural hazards using data. This is based on the general notion that accurate predictions give people an opportunity to potentially mitigate the negative effects of imminent natural hazards.

6. We recommend sharing out students' decisions based on the data in a class-wide discussion, using equity sticks for a more equitable discussion.

7. Return to the whole-class concept map from the Lift-Off Task.
    - In small groups, have students brainstorm new concepts and new connections that they have learned in this task, as well as any new questions that have come up for them. Then have groups share these aloud in a class-wide discussion and add to the class concept map. The use of equity

sticks is encouraged for more equitable participation in class-wide discussions (See "How To Use This Curriculum" for more details).
    - Some facilitating questions to ask students are: What new ideas/concepts do you want to add to the map? What connections do you want to add or change? What is your reason for that addition/revision? What connections can we make between the questions/ideas already on the map? What new questions do you have about the phenomenon?
    - Draw circles around each question and boxes around each concept.
    - Write connector words to describe connections between the concept boxes.
    - For this task, students may begin to connect some of their previous question circles to concept boxes about the following: geographic features that result from natural processes.
- Have students analyze the additions to the class concept map for as many examples of this task's crosscutting concept as they can find. Once a student has identified the crosscutting concept, you can trace the circle in the corresponding color (decided on in the Lift-Off task). We recommend asking students to share key words that helped them identify the crosscutting concept for that concept or question. Some identifying words students might look for are:
    - **Scale, Proportion, and Quantity**: These could be phrases such as, "is proportional to," "compared to," "has a ratio of," "is bigger/smaller than," "is longer/shorter than," etc.
    - **Patterns**: These could be phrases such as, "is the same as", "has in common with", "is similar to", "shares" etc.
- Once again, the purpose of this concept map is to facilitate generation of student questions, promote language development, and support understanding of the science content throughout the unit. Allowing students to ask their own questions and use their own words to make meaning of the concepts will not only help them make deeper connections about the science content, but this will also help their oral and written language development.

Evaluate: Connecting to the Culminating Project

1. Students independently complete the Task 1 section of the Unit 4 Project Organizer in class. Revisions can be done for homework, depending upon student's needs and/or class scheduling.

2. Students have been tasked with creating a proposal to save the Andes. Their prompt is as follows: First, you need to give your audience some background on the Andes region itself.
    - What natural changes have led to the Andes region you see today?
    - Draw diagrams with labels to explain your evidence.

Reflection

1. At the end of the task, ask students to reflect on what they have learned over the course of this task by answering the following three questions in their student guide:
    - At the beginning of this task, you were asked to brainstorm some natural changes you think can happen to environments on Earth. Look back at your brainstorm: after collecting all the evidence today, how would you add to your brainstorm? Use evidence from the task to justify your changes or additions and record below.
    - In this task, we focused on the crosscutting concepts of **Scale, Proportion, and Quantity** or how

time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small; and **Patterns**, or how we can use graphs, charts, and images to identify patterns in data. Where did you see us looking at **Scale, Proportion, and Quantity,** and **Patterns** in this task?
- Now that you have learned more about how environments can change through natural processes, what questions do you still have?

2. There are no right answers, but encourage students to look back at their student guides and their class concept map. They should not change their initial responses, but rather use this reflection space to add to their ideas and questions based on what they have learned through this task. By generating more of their own questions, students continue to engage in sense-making of the phenomenon and gathering knowledge and skills for their final projects.

Assessment

1. You may collect students' Project Organizer and assess using:
   - *Criteria of your choice.* We recommend using the 3-Dimensional Assessment matrix at the beginning of this document to inform your criteria.
   - This can be a formative tool to periodically look for trends in student understanding after the completion of a task. You can then use this formative data to inform any re-teaching as necessary.

2. You may also give students time to make revisions with one of the two options:
   - Students may make changes to their Project Organizer according to your comments OR
   - Ask students to exchange Project Organizers with a partner and give partners 5 minutes to give written feedback. Then allow students time to make changes to their work according to the feedback.

3. Collect students' Task 1 Student Versions and assess the *Elaborate* using the 3-Dimensional Task 1 Rubric below.

7th Grade Science Unit 4: Save the Andes!

Task 1: Sculpting Landscapes

Task 1 Rubric: Student analyzes and interprets data to identify patterns in geoscience processes and forecast a volcanic eruption.

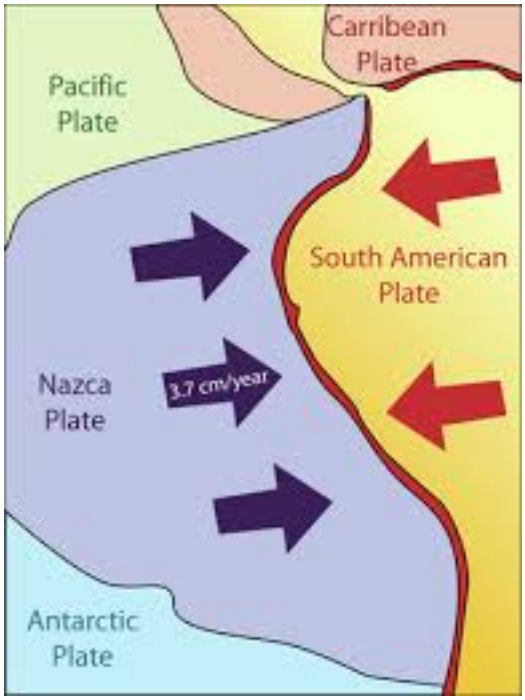
- Use to assess student responses for any one row of #3 of the Elaborate.
- Dimensions Assessed: SEP – Analyzing and Interpreting Data, DCI – ESS3.B Natural Hazards, CCC – Patterns

Emerging (1)	Developing (2)	Proficient (3)	Advanced (4)
Student analyzes and interprets data **but identifies no** patterns in geoscience processes and **accurately** forecasts a volcanic eruption. OR Student analyzes and interprets data **but identifies no** patterns in geoscience processes and **inaccurately** forecasts a volcanic eruption.	Student analyzes and interprets data to identify **partial** patterns in geoscience processes and **inaccurately** forecasts a volcanic eruption.	Student analyzes and interprets data to identify **partial** patterns in geoscience processes and **accurately** forecasts a volcanic eruption.	Student analyzes and interprets data to identify **all** patterns in geoscience processes and **accurately** forecasts a volcanic eruption.
Look Fors: ● Forecast for the selected date can be accurate or inaccurate, but there is no clear reference to data. ● For example, for February 21st: "I would not issue an alert because the data says nothing will happen." Here, though the forecast in accurate, there is no clear reference to patterns in the data. This is essentially a guess. ● *See Advanced Look-Fors to use correct responses as comparisons.	**Look Fors:** ● Forecast for the selected date is inaccurate, but forecast accurately references data from at least one graph. ● For example, for February 21st: "I would issue an alert because I notice a change in the thrust plot and an increase in earthquake activity." ● *See Advanced Look-Fors to use correct responses as comparisons.	**Look Fors:** ● Forecast for the selected date is accurate, but the forecast accurately references data from only 1-2 graphs. ● For example, for February 21st: "I would not issue an alert, but would make more measurements of the volcano. I would do this because I see a slight increase in earthquake activity." ● *See Advanced Look-Fors to use correct responses as comparisons.	**Look Fors:** ● Forecast for the selected date is accurate, and the forecast accurately references data from all the graphs. ● For example, for February 21st: "I would not issue an alert, but would make more measurements of the volcano. I would do this because the thrust plot shows only slight movement, the earthquakes plot indicates that there is only a slight change in earthquake activity, and the tiltmeter readings indicate that only small signs that magma is rising into the volcano crater."

Station Cards

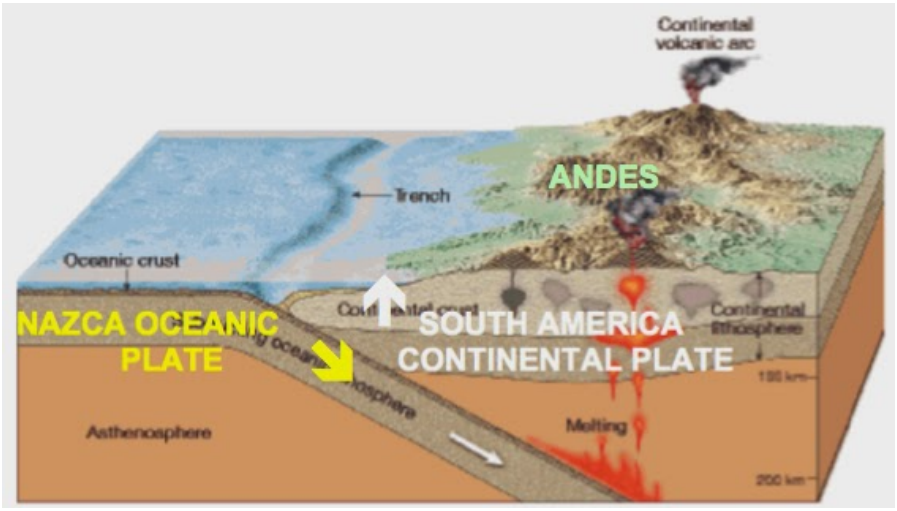
Explore

Plate Motions



The Andes Mountains are located at the boundary of the Nazca Plate and the South American Plate. The Nazca Plate is moving eastwards, towards the South American Plate, at about 37mm per year. That's about the size of a penny and a dime next to each other.

Where the two plates meet, the denser oceanic Nazca Plate is forced down and under the more buoyant continental South American Plate, descending at an angle in a process called *subduction*. As this process continues, some of the sediments are forced onto the South American Plate. As the plates collide, the leading edge of the South American Plate becomes deformed, pushing the crust upward (imagine a car hitting a solid wall). Over millions of years, this process slowly created the mountains of the Andes.



Optional: To see more about plate motions, watch the video shown on the website link below:

https://www.geolsoc.org.uk/Plate-Tectonics/Chap3-Plate-Margins/Convergent/Oceanic-continental

Station Cards

Explore

Earthquakes

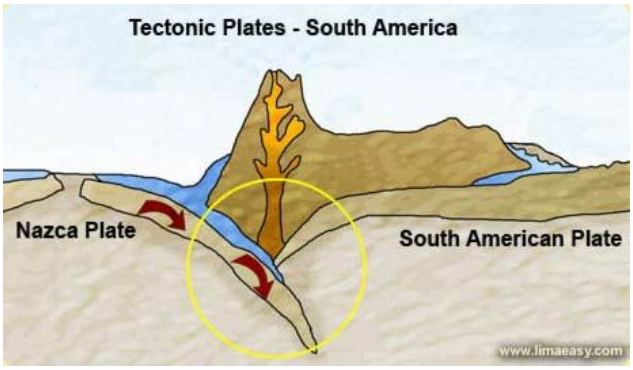
As the oceanic Nazca Plate subducts, or moves underneath the continental South American Plate, it causes a lot of friction, which prevents it from sliding smoothly. As the Nazca Plate descends, it drags against neighboring plates, causing them to fracture (break) and deform. This then causes sudden and frequent earthquakes, which can actually change the geography of the region. For example, after an earthquake in the Andes in 2010, the land actually moved toward the Pacific, moving some nearby cities as much as 4.7 meters to the west (pictured on the right). Sometimes, earthquakes can also cause tsunamis and landslides.

http://en.mercopress.com/2010/05/12/chile-gained-1.2-square-kilometres-following-the-earthquake

Station Cards

Explore

Volcanoes



As the Nazca Plate subducts, or moves beneath neighboring plates, magma is produced which rises and may erupt explosively at the Earth's surface. This flow of lava creates new land features. Volcanoes in the Andes, such as Láscar in northern Chile, are a good example of this type of activity. Láscar's eruption in 1993 produced pyroclastic flows (hot ash), and the volcano was active as recently as 2012. As the volcanoes around the Andes are very active due to plate movement, they are part of a region on Earth often referred to as the "Ring of Fire" – a place with frequent earthquakes and volcanoes.

Lascar Eruption (1993)

https://www.geolsoc.org.uk/Plate-Tectonics/Chap3-Plate-Margins/Convergent/Oceanic-continental

Station Cards

Explore

Weathering and Erosion

As in other areas of the world, weathering factors, such as wind and water, can cause erosion in the Andes. Because of the steepness of much of the land, soil in the Andes Mountains is very susceptible to erosion. Interestingly, however, the same force that created the Andes (plate tectonics) is actually destroying the Andes as well!

http://www.alamy.com/stock-photo/erosion-landslide-mud.html

Earthquakes are caused by the fracturing of rock as tectonic plates slide past, over, or underneath one another. In the case of the Andes, the Nazca plate slides underneath the South American plate. Scientists have discovered that earthquakes have been the major source of erosion in the history of the Andes mountains-- causing many landslides and mudslides in the area.

Erosion changes the landscape of the Andes mountains, often destroying habitats for many plant and animal species. It can also contaminate bodies of water with excess sediment, removing nutrient-rich soil from an area, and cause greater runoff of essential water. This process happens at a smaller scale than other processes you have learned about today, and can be sudden or gradual depending on the cause of the erosion.

http://www3.imperial.ac.uk/newsandeventspggrp/imperialcollege/newssummary/news_14-11-2014-8-51-53

7th Grade Science Unit 4: Save the Andes!

Task 2: Disrupting Earth's Natural Systems

Unit Essential Question: *How can we sustain biodiversity in a modern, changing world?*

Introduction

The Earth has always naturally provided the ecosystem services and resources essential for human survival. Phrases such as "the Stone Age," "hunter/gatherers," 'the Bronze Age," "Agricultural Revolution," "watershed," and "fishing village," all highlight the dependence of humans on natural materials, and on the food and water from ecosystems. In the last task, students explored how past and current geoscience processes have shaped the beautiful natural landscape of the Andes Mountains as we see it today. What students will discover in this unit is that humans' reliance on the Earth for services is causing major disruptions of these natural processes, leading to physical and biological changes that are affecting natural populations and much more. By the end of this task, students will be better equipped to examine their own role in the disruption of natural processes in places like the Andes Mountains, and to determine how seemingly small changes can lead to larger changes in the Andes ecosystem. This prepares students for the culminating project where they will propose potential solutions to the problem of human reliance on ecosystem services and resources in the Andes.

Alignment Table

Performance Expectations	Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
MS-LS2-4. Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. [Clarification Statement: Emphasis is on recognizing patterns in data and making warranted inferences about changes in populations, and on evaluating empirical evidence supporting arguments about changes to ecosystems.]	**Engaging in Argument From Evidence** • Construct an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem.	**LS2.C: Ecosystem Dynamics, Functioning, and Resilience** • Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations.	**Stability and Change** • Small changes in one part of a system might cause large changes in another part.
MS-PS1-3. Gather and make sense of information to describe that synthetic materials come from natural resources and impact society. [Clarification Statement: Emphasis is on natural resources that undergo a chemical process to form the synthetic	**Obtaining, Evaluating, and Communicating Information** • Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and	**PS1.A: Structure and Properties of Matter** • Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it.	**Structure and Function** • Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used.

material. Examples of new materials could include new medicine, foods, and alternative fuels.] [Assessment Boundary: Assessment is limited to qualitative information.]	possible bias of each publication and methods used, and describe how they are supported or not supported by evidence.	**PS1.B: Chemical Reactions** • Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules and these new substances have different properties from those of the reactants.	
MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.	**Asking Questions and Defining Problems** • Define a design problem that can be solved through the development of an object, tool, process or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions.	**ETS1.A: Defining and Delimiting Engineering Problems** • The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that are likely to limit possible solutions.	**N/A**
Equity and Groupwork • Participate in group roles to explore how humans are changing the natural ecosystem of the Andes region. • Gather and discuss Internet research about the use of petroleum for man-made products.			
Language • Construct an argument from evidence. • Read and discuss information on ecosystem services and resources.			

7th Grade Science Unit 4: Save the Andes!

Task 2: Disrupting Earth's Natural Systems

Learning Goals:

This learning task asks students to explore how the overconsumption of ecosystem services and resources from the Andes region causes dramatic biological and physical changes, affecting local populations. More specifically, the purpose is to:

- Engage prior knowledge of ecosystem services and resources that nature provides to humans.
- Explore how humans are physically and biologically affecting the Andes region.
- Explain how human changes to the Andes ecosystem affect local populations.
- Research and determine how one's own behaviors contribute to the degradation of the Andes ecosystem.
- Apply knowledge of the human impact on ecosystem services and resources to identify criteria and constraints of a problem in the Andes region.

Content Background for Teachers

Humans have always relied on the environment for ecosystem services and resources, even more so now than ever before. In this task, students begin to think about what these ecosystem services and resources are, and why they are important for human survival and comfort. Then they look at how overreliance on certain ecosystem services and resources disrupts Earth's natural processes, causing physical and biological changes that significantly affect the environment. The aim is for students to notice and understand their own role in this process, so they can begin to hold themselves accountable and act as informed citizens when considering how humans impact the environment.

Throughout the world, humans are changing the Earth around them in a myriad of ways. For this task, eight specific human actions were selected that center around the Andes region in order to maintain a cohesive storyline and provide students with a focused set of resources for their culminating project. Each of the human actions chosen benefit humans, but negatively impact other natural populations either directly or indirectly.

Some stations focus on the direct human effects on local populations—for example, the hunting of a single species, a common global problem. In the Andes region, the most prominent example of this is the Chinchilla, which is hunted for its soft and warm fur used to make coats and hats. Not only does hunting directly affect the chinchilla, but also indirectly affects populations of foxes and birds who prey on the chinchillas. Furthermore, many fruit-bearing plants in the region depend on the chinchilla for seed dispersal and survival. Similarly, deforestation to harvest lumber directly destroys numerous tree species, which thus also affects other plant populations.

Other stations highlight some of the indirect ways in which humans affect local populations. Rather than directly removing animals and plants, humans often destroy habitats, thus affecting populations of organisms that live there. For example, deforestation destroys animal habitats as trees are removed for lumber. Deforestation also occurs to clear land for agriculture and mining, so this destroys habitats and affects populations in a similar way. If we examine how humans build roads in order to improve

transportation around the region, the roads often fragment habitats, blocking movement of many species and causing many deaths by motor accidents. Finally, the building of hydroelectric plants dam up valuable water resources and blocks fish migration patterns, both of which negatively impact local populations.

Students also examine certain industrial processes that negatively affect ecosystems. For example, mining and agriculture cause major water pollution, as mining releases toxic chemicals and agriculture releases excess fertilizer into the local ground and water. Petroleum, a highly desirable resource used for making synthetic materials like plastics, is extracted from the Andes region in vast quantities. Unfortunately, drilling for petroleum results in water pollution that damages habitats for many plant and animal species.

Lastly, students examine how global climate change, caused by burning fossil fuels, affects the Andes region. Due to the increase in temperature associated with climate change, many glaciers in the Andes region are melting, resulting in a reduced freshwater supply for millions of people, animals, and plants. Additionally, deforestation exacerbates this problem as it destroys a major natural storage system, or natural reservoir for carbon, that could help slow the effects of climate change.

Academic Vocabulary

- Ecosystem Service
- Resource
- Disrupt
- Populations
- Petroleum
- Extraction
- Pollution
- Mining
- Agriculture
- Habitat
- Hydroelectric Power
- Deforestation
- Synthetic Material
- Carbon Emission

Time Needed (Based on 45-Minute Periods)

5 Days

- Engage: 0.5 periods
- Explore: 1 period
- Explain: 1 period
- Elaborate: 1.5 period
- Evaluate and Reflection: 1 period

7th Grade Science Unit 4: Save the Andes!

Task 2: Disrupting Earth's Natural Systems

Materials

- Unit 4, Task 2 Student Version

Explore

- Station Cards in sheet protectors for each station (multiple copies at each station)

Elaborate

- Computers for research

Evaluate

- Project Organizer Handout

Instructions

Engage

1. Introduce Task 2: In the last task, you explored how past and current geoscience processes have shaped the beautiful natural landscape of the Andes Mountains. The natural ecosystem cycles and processes in the Andes provide benefits that humans often take advantage of. Scientists call these "ecosystem services" because the natural ecosystem is providing services that humans need. Before we move forward, think about what you were still wondering about at the end of the last task (look back if you need to). What questions do you still have?
    - Before you pass out their student guide, give students time to reflect individually or with a partner about the questions they recorded at the end of the last task. Share a few of these out as a class, using facilitating questions to guide students toward questions that relate to this task.

2. Transition to Task 2: In Task 1, you all thought about how the environment undergoes natural changes on its own, and without human intervention. In this task, you will now explore different ways in which humans impact the Andes region, and how the changes caused by humans affect the Andes region both directly and indirectly.
    - Now pass out their Task 2 student guide.

3. In pairs, students brainstorm any ecosystem service or resource they can think of that nature provides, explaining why each is important for human survival and comfort.
    - Share out a few different possibilities that students come up with, using equity sticks for a more equitable discussion (See "How to Use This Curriculum" for more details).
    - There are no correct answers at this point. However, you may want to model with one example or encourage them to use the visual for support if they are stuck.
    - The purpose of this task is for students to connect personally with problems centered on the environment and natural resources, and for students to think about how they personally benefit from the environment. This sets the stage for students to eventually see how their personal decisions may negatively impact the environment.

Explore

1. The introduction in the student guide highlights the notion that humans rely upon and often abuse the ecosystem services and resources that natural ecosystems, like the Andes region, provide. In this activity, students will read information about eight different human activities that negatively impact the Andes region.

2. Assign roles to each group. You may use your own preferred roles, or, we recommend the use of the Materials Manager, Facilitator, Harmonizer, and Recorder.
    - Ask the Materials Manager to gather the station cards needed to complete the task and read them aloud.
    - Ask the Facilitator to read the directions and to make sure everyone understands the task and what the data collection chart is asking.
    - Ask the Harmonizer to make sure that everyone contributes their ideas and that everyone's voice is heard.
    - Ask the Recorder to make sure each person in the group is correctly recording the information.

3. In groups, students visit stations which describe how humans are changing the natural ecosystem of the Andes region, and what effect this has on the physical and biological characteristics of the region.
    - As students visit each station, they will take notes in the data collection table in their student guide, highlighting the **Stability and Change** relationships they see—specifically considering how each human activity leads to large changes to the Andes ecosystem.

Sample Station Data Collection Chart

Station	Human Action	Effect on the Andes
1	Hunting of Chinchillas	This depletes the Chinchilla population, which also affects the population of wild foxes and birds who eat chinchillas. It also affects plant life because chinchillas help spread plant seeds when they ingest fruit and excrete the seeds.
2	Mining for Minerals	Mining destroys habitats for many plants and animals, putting animals like the Yellow Tailed Woolly Monkey and the Andean Mountain Cat in danger of extinction. It also contaminates water sources with toxic chemicals, like lead and cyanide. This causes drinking water shortages and contamination of some agriculture fields.
3	Building Roads	This splits up habitats, so that animals like Pumas and Bears don't have the space they need to move around and search for food. Also roads often lead to more deaths by vehicle accidents.
4	Agriculture – growing food and raising cattle	This destroys habitats for many plants and animals. Excess fertilizer also contaminates the water, harming aquatic animals that live in the streams.
5	Hydroelectric power plants	They dam up the water, which blocks fish migration and affects their populations. It also changes the water temperature and flow, which harms native plants and animals in the river and on land.
6	Deforestation	This destroys habitats for many plants and animals. It also removes a major carbon reservoir, which helps combat climate change by

		removing significant amounts of carbon dioxide from the atmosphere.
7	Synthetic Material Production (Ex: Plastics from Petroleum)	Drilling for Petroleum results in water pollution, damaging habitats for humans, fish, and animals alike. The deforestation that must occur to free up these sites also causes habitat loss.
8	Human Carbon Emissions	This is causing rising temperatures that are melting the glaciers, thus shrinking a water source for millions of people, plants, and animals, as well as agriculture and power.

Explain

1. This section asks students to put together all the evidence gathered during the Explore in order to support or refute the argument that human disruptions to the Andes ecosystem result in large changes to natural populations.
    - Students are reminded to use evidence from the *Explore* to support or refute the claim, thus giving them an opportunity to practice **Engaging in Argument From Evidence.** They are also continuing to emphasize the CCC of **Stability and Change** as stated in the *Explore*.
    - We recommend this be done individually so it may be used as a form of formative assessment for this performance expectation.
    - Optional scaffold: Should you notice a significant portion of the class struggling with this activity, consider providing students with the sentence stems below.

Optional Sentence Stems to Provide

Claim	The evidence supports/refutes the claim that human changes to the Andes ecosystem are resulting in large negative changes to natural populations.
Supporting Evidence	• In the stations, we learned that… • We also learned… • …which is also affecting populations of plants and animals. • Lastly, populations are affected by… • Humans are decreasing natural populations both directly and indirectly because… • One way that humans are directly affecting populations is… • For example,… • Humans are also indirectly affecting populations by… • One example of this is… • Another way humans affect populations in the Andes is…

Sample Student Response: *The evidence supports the claim that human changes to the Andes ecosystem are resulting in large negative changes to natural populations. At each station, we learned that plant and animal species are decreasing in population, many almost to the point of extinction. We also learned physical parts of the environment, like streams, are being changed, which is also affecting populations. Lastly, populations are affected by water pollution caused by human activities in the Andes. Although humans benefit from services and resources provided by the Andes region, their actions often decrease natural populations both directly and indirectly. One*

way that humans are directly affecting populations is by actually killing plants and animals. For example, they are hunting chinchillas nearly to extinction for their fur and are killing thousands of trees for lumber. Humans are also indirectly affecting populations with activities that pollute the water and harm many organisms. For example, agriculture pollutes the water with fertilizer, and mining for minerals and drilling for petroleum pollutes the water with toxic chemicals. Humans are also affecting populations in the Andes by contributing to climate change, which is melting glaciers, and shrinking an important water source for millions of humans, plants, and animals.

2. Optional scaffold: Conduct a Critique, Correct, and Clarify language exercise in pairs before students write their own paragraphs. We recommend using equity sticks to share out a few pair's critiques as a class before they move on to independently writing an improved paragraph in their student guides. An example protocol and graphic organizer is provided below:

Critique, Correct, and Clarify

Prompt: Individually, construct an argument that supports or refutes the following claim: Human disruptions to the Andes ecosystem result in large changes to natural populations of organisms. Use information from the *Explore* as evidence to justify your argument.

In pairs:

1. Critique: Analyze the response below. Identify the error(s) or things that aren't clear. Share your ideas with a partner.

   *The data (resource card) indicates that mining **does** destroy habitats for many plants and animals, putting animals like the Yellow Tailed Woolly Monkey and the Andean Mountain Cat in danger of extinction. Mining also contaminates water sources with toxic chemicals, like lead and cyanide, causing drinking water shortages and contamination of some agriculture fields.*

2. Correct: Individually write an improved argument in your student guide.

3. Clarify: Describe how and why you corrected the response.

3. Optional peer review - Have table partners switch arguments and suggest revisions.
   - This paragraph can also be a good option for formative assessment. Collect student work to identify trends in students' ability to support an argument with evidence or demonstrate understanding of Stability and Change. See "How to Use This Curriculum" for strategies on utilizing formative assessment data to provide feedback to students and inform classroom instruction.

Elaborate

1. At this point, students understand that humans negatively impact the Andes region through their actions. The purpose of this Elaborate is for students to think less about "humans" in the abstract sense, and to

consider their own role in this environmental problem. Here they are faced with the question, "Am I part of the problem?"
    - This activity engages students in the practice of **Obtaining, Evaluating, and Communicating Information** as they are tasked with using the Internet to gather information about various synthetic products made from one natural resource (petroleum) found in the Andes.
    - As students compile and analyze information in their chart, the crosscutting concept of **Structure and Function** becomes clearer as they are asked to consider how the properties of a synthetic product contributes to its function.

2. Assign roles to each group. We recommend assigning students different roles within their group from the *Explore*.

3. Students first research petroleum (one of the resources extracted from the Andes) and its chemical and physical properties.

4. Next, students research the types of synthetic products that are made from petroleum. Once they compile their list, students should circle any products they have used before and star the ones they use at least once a week. This helps students begin to think about how they may be part of the problem.

5. Next, students research one chemical reaction that involves the use of petroleum. Here the reactants and products for the reaction must be described.

6. **Structure and Function**: Lastly, students consider how the properties of petroleum differ from the synthetic product it creates, and how these new properties contribute to the synthetic product's function.

7. **Obtaining, Evaluating, and Communicating Information:** The final part of the data chart involves students describing each Internet source used during research, as well as evaluating the accuracy and reliability of each source. Students will continue to practice this SEP in Task 3 and during their Culminating Project work time.

8. Using information from the data chart, students will then construct a flowchart tracing one of the petroleum-based products they use back to its source. Based on what they learned from Station Card #7 in the *Explore,* students should also include an explanation for how the use of petroleum to make this product affects the Andes region.

9. Finally, ask students to revisit and discuss with a partner their answer to the original question—"Am I part of the problem?"
    - We recommend sharing out students' ideas about the final prompt in a class-wide discussion, using equity sticks for a more equitable discussion. You might consider asking the following prompts to facilitate the discussion:
        - Ask, "Do you think that you personally are part of the problem?"
        - Ask, "Can you think of ways to make these items without using petroleum?"
        - Ask, "Can you think of possible alternatives to using these items?"

10. Return to the whole-class concept map from the Lift-Off Task.
    - In small groups, have students brainstorm new concepts and new connections that they have learned in this task, as well as any new questions that have come up for them. Then have groups share these aloud in a class-wide discussion and add to the class concept map. The use of equity sticks is encouraged for more equitable participation in class-wide discussions (See "How To Use This Curriculum" for more details).
        - Some facilitating questions to ask students are: What new ideas/concepts do you want to add to the map? What connections do you want to add or change? What is your reason for that addition/revision? What connections can we make between the questions/ideas already on the map? What new questions do you have about the phenomenon?
        - Draw circles around each question and boxes around each concept.
        - Write connector words to describe connections between the concept boxes.
        - For this task, students may begin to connect some of their previous question circles to concept boxes about the following: human impact on natural ecosystems.
    - Have students analyze the additions to the class concept map for as many examples of this task's crosscutting concept as they can find. Once a student has identified the crosscutting concept, you can trace the circle in the corresponding color (decided on in the Lift-Off task). We recommend asking students to share key words that helped them identify the crosscutting concept for that concept or question. Some identifying words students might look for are:
        - **Structure and Function**: These could be phrases such as, "its shape affects its function by," "structure causes it to," "functions this way because of," etc.
        - **Stability and Change**: These could be phrases such as, "remains the same", "is changed by", "is disrupted by", "changes", "disrupts," etc.
    - Once again, the purpose of this concept map is to facilitate generation of student questions, promote language development, and support understanding of the science content throughout the unit. Allowing students to ask their own questions and use their own words to make meaning of the concepts will not only help them make deeper connections about the science content, but this will also help their oral and written language development.

Evaluate: Connecting to the Culminating Project

1. Students independently complete the Task 2 section of the Unit 4 Project Organizer in class. Revisions can be done for homework, depending upon student's needs and/or class scheduling.

2. Students have been tasked with creating a proposal to help save the Andes. The student prompt is as follows: As part of this proposal you will need to define a problem in the Andes region, and identify the criteria and constraints for solving the problem. To help you plan this, follow the steps below:
    - Define the problem:
        - What is one ecosystem service or resource from the Andes region that humans rely on?
        - How are humans negatively impacting the Andes region in order to benefit from this ecosystem service or resource?
    - Identify the criteria for a successful solution to one problem in the Andes region:
        - What problem will your solution solve?
        - How will you determine if a solution is successful?
    - Identify the constraints (limitations) of solving this problem:

- What consequences will your solution have on humans in the Andes and around the world? To better explain this, make a flowchart (see *Elaborate*) to trace your plan backwards and see the potential effects it will have on people's daily lives.
- What scientific knowledge, or lack of knowledge, may limit possible solutions?

Reflection

1. At the end of the task, ask students to reflect on what they have learned over the course of this task by answering the following three questions in their student guide:
    - At the beginning of this task, you thought about different ecosystem services and resources humans get from nature. Looking back at your earlier response (*Engage*), and using all your knowledge from this unit, which ecosystem service or resource do humans seem to be using most? Do you think humans are abusing this ecosystem service or resource, or using it irresponsibly? Explain your response.
    - In this task, we focused on the crosscutting concepts of: **Stability and Change**, or how small changes in one part of a system might cause larger changes in another part; and **Structure and Function**, or how structures can be designed to serve particular functions by taking into account properties of different materials. Where did you examples of **Stability and Change** and **Structure and Function** in this task?
    - Now that you have learned more about how humans use ecosystem services and resources from the Andes region, and the resulting environmental impacts, what questions do you still have?

2. There are no right answers, but encourage students to look back at their student guides and their class concept map. They should not change their initial responses, but rather use this reflection space to add to their ideas and questions based on what they have learned through this task. By generating more of their own questions, students continue to engage in sense-making of the phenomenon and gathering knowledge and skills for their final projects.

Assessment

1. You may collect students' Project Organizer and assess using:
    - *Criteria of your choice.* We recommend using the 3-Dimensional Assessment matrix at the beginning of this document to inform your criteria.
    - This can be a formative tool to periodically look for trends in student understanding after the completion of a task. You can then use this formative data to inform any re-teaching as necessary.

2. You may also give students time to make revisions with one of the two options:
    - Students may make changes to their Project Organizer according to your comments OR
    - Ask students to exchange Project Organizers with a partner and give partners 5 minutes to give written feedback. Then allow students time to make changes to their work according to the feedback.

3. Collect students' Task 2 Student Versions and assess the *Elaborate* using the 3-Dimensional Task 2 Rubrics below.

7th Grade Science Unit 4: Save the Andes!

Task 2: Disrupting Earth's Natural Systems

Task 2 Rubric 1: Student gathers and synthesizes information to describe how petroleum undergoes a chemical process to produce synthetic materials.

- Use to assess student responses for rows #3 and #5 of the Elaborate.
- Dimensions Assessed: SEP – Obtaining, Evaluating, and Communicating Information, DCI – PS1.B Chemical Reactions

Emerging (1)	Developing (2)	Proficient (3)	Advanced (4)
Student gathers and synthesizes information, but **does not** describe how petroleum undergoes a chemical process to produce synthetic materials.	Student gathers and synthesizes information to **partially** describe how petroleum undergoes a chemical process to produce synthetic materials.	Student gathers and synthesizes information to **completely** describe how petroleum undergoes a chemical process to produce synthetic materials.	Student gathers and synthesizes **reliable** information to **completely** describe how petroleum undergoes a chemical process to produce synthetic materials.
Look Fors: ● In describing the chemical process that begins with petroleum, a student states one synthetic product that is made from petroleum. ● For example, "Nylon is made from petroleum."	**Look Fors:** ● In describing the chemical process that begins with petroleum, a student clearly states some of the reactants and products involved in one part of the chemical process. ● For example, "Making nylon involves many chemical processes starting with petroleum. During the process, several molecules of ethylene become pentane."	**Look Fors:** ● In describing the chemical process that begins with petroleum, a student clearly states all of the reactants and products involved in one part of the chemical process. ● For example, "Making nylon involves many chemical processes starting with petroleum. During the process, several molecules of ethylene (C_2H_4) are combined to form molecules of pentane (C_5H_{12}) and water (H_2O)."	**Look Fors:** ● In describing the chemical process that begins with petroleum, a student clearly states all of the reactants and products involved in one part of the chemical process. For example, "Making nylon involves many chemical processes starting with petroleum. During the process, several molecules of ethylene (C_2H_4) are combined to form molecules of pentane (C_5H_{12}) and water (H_2O). ● In assessing the accuracy and reliability of their source information, a student includes the url for the webpage on petroleum, and briefly describes who created the webpage. For example, "The information for this chemical

			process comes from a webpage titled, Plastics: How Plastics Are Made, and the source is the American Chemical Society. This is considered to be a reputable source in the scientific community and therefore I think this information is reliable and accurate."

7th Grade Science Unit 4: Save the Andes!

Task 2: Disrupting Earth's Natural Systems

Task 2 Rubric 2: Student compares the properties of a synthetic material and the natural resource it comes from, and explains how its properties contribute to a specific function.

- Use to assess student responses for #4 of the Elaborate.
- Dimensions Assessed: DCI – PS1.A Structure and Properties of Matter, CCC – Structure and Function

Emerging (1)	Developing (2)	Proficient (3)	Advanced (4)
Student **does not** compare the properties of a synthetic material and the natural resource it comes from, and **inaccurately** explains how its properties contribute to a specific function.	Student **does not** compare the properties of a synthetic material and the natural resource it comes from, and **accurately** explains how its properties contribute to a specific function.	Student **partially** compares the properties of a synthetic material and the natural resource it comes from, and **accurately** explains how its properties contribute to a specific function.	Student **completely** compares the properties of a synthetic material and the natural resource it comes from, and **accurately** explains how its properties contribute to a specific function.
Look Fors: ● A student does not compare the chemical or physical properties of the materials, or describes non-comparable properties such as the chemical property of one and a physical property of the other. ● The student incorrectly explains how at least one property of the synthetic material contributes to its function. For example, the low melting point of nylon makes it stable under normal conditions.	**Look Fors:** ● A student does not compare the chemical or physical properties of the materials, or describes non-comparable properties such as the chemical property of one and a physical property of the other. For example, in comparing the properties of nylon to ethylene (a component of petroleum), a student says that ethylene melts at -272.5F, while nylon has a density of 1.13g/cm^3. ● The student also explains how at least one property of the synthetic material contributes to its function. For example, the higher melting point of nylon as compared to ethylene makes it far more stable than ethylene under normal conditions, thus making it ideal for many products used	**Look Fors:** ● A student compares one chemical or physical property. For example, in comparing the properties of nylon to ethylene (a component of petroleum), a student says that ethylene melts at -272.5F, while nylon melts between 190-350F, but makes no mention of any chemical properties of either. ● The student also explains how at least one property of the synthetic material contributes to its function. For example, the higher melting point of nylon as compared to ethylene makes it far more stable than ethylene under normal conditions, thus making it ideal for many products used under normal conditions.	**Look Fors:** ● A student compares multiple chemical or physical properties. For example, in comparing the properties of nylon to ethylene (a component of petroleum), a student first says that ethylene is found in nature, is composed of carbon and hydrogen, and it melts at -272.5F. By contrast, nylon is not found in nature, is composed mainly of carbon, hydrogen, and oxygen, and melts between 190-350F. ● The student also explains how at least one property of the synthetic material contributes to its function. For example, the higher melting point of nylon as compared to ethylene makes it far more stable than ethylene under normal conditions, thus

	under normal conditions.		making it ideal for many products used under normal conditions.

Station Cards

Explore

Station 1 – Hunting of a Single Species

Chinchillas are small rodents that live in the Andes Mountains, mostly in Chile. In the last 15 years, their population has decreased by 90%, mostly due to human hunting. Chinchillas are hunted for their very soft fur, which is used to make coats and hats.

Not only does the hunting harm the Chinchillas themselves, it also harms the Andes ecosystem as a whole. Chinchillas provide food for the wild foxes and birds, so loss of chinchillas can affect the populations of foxes and birds. Also, when chinchillas eat the local fruit in the Andes, they excrete the seeds from the fruit and spread those seeds around the region. Thus, chinchillas play an important role in supporting plant life in the Andes.

https://treemusketeers.org/learn/wildlife/the-endangered/the-endangered-chinchilla/

Station Cards

Explore

Station 2- Mining

The Andes Mountains contain many different minerals that are very valuable and useful to humans. Some examples of these minerals include: gold, silver, coal, oil and natural gas, iron ore, tin, and copper. In order to get, or extract, these minerals from the Earth, however, miners need to first blast the rocks with dynamite to dig deep into the Andes Mountains. Then, engineers spray the extracted minerals with chemicals, like toxic lead and cyanide, in order to begin processing them for use by humans.

As you can see, mining not only destroys parts of the mountain habitats for many plants and animals, but it also contaminates water sources with toxic chemicals, like lead and cyanide. This contamination can lead to shortages of clean drinking water and contamination of the farms located below the mines. Some animals, like the Yellow-Tailed Woolly Monkey and the Andean Mountain Cat are in danger of extinction because they are losing their habitats in the Andes due to mining.

http://www.coolgeography.co.uk/GCSE/AQA/Restless%20Earth/Andes/Andes%20Case%20study.htm

Station Cards

Explore

Station 3- Roads

In order to travel more quickly through the Andes Mountains, humans have built many roads. Often as a result of building roads, critical habitats are split, thus decreasing the amount of space and resources available to organisms in that habitat. As you can imagine, this causes major problems for many animal species in the Andes. For example, animals like pumas and bears rely on large stretches of land to move around and hunt for food. Roads, and the traffic on the roads, block this critical movement, and often lead to many animal deaths by vehicle accidents.

http://andesbiome.weebly.com/endandered-species.html

Station Cards

Explore

Station 4- Agriculture

Due to the increase in human population in the Andes region (as in the rest of the world), the demand for food has increased as well. In order to provide more food, much of the Andes natural landscape has been converted into farms and cattle ranches.

This change in the Andes landscape not only destroys natural habitats for organisms, but the farms themselves cause problems for the environment. Often new farms in this region grow only one type of crop, rather than rotating different crops. As a result, many of the nutrients in the soil get used up without the presence of other plants to help recycle and replenish those essential nutrients. Eventually this means fewer and fewer types of plants can survive in those regions. Also, as farmers use chemical fertilizers to help crops grow, the excess fertilizer flows through the ground soil and into local streams. Eventually this contaminates the freshwater in the region, greatly harming the animals that rely on this water like the local fish in the rivers and streams.

http://rainforests.mongabay.com/0811.htm

Station Cards

Explore

Station 5 – Hydroelectric Plants

In the Andes Mountains, snowmelt and steep slopes provide an ideal landscape for hydroelectric power plants. Hydroelectric power plants work by changing the energy of moving water into electricity, as it falls down a cliff or dam. The electricity is then moved through power lines to people living nearby.

While hydroelectric power plants do not pollute the water or the air directly, they do still alter the Andes ecosystem. Often, hydroelectric power plants are part of a dam and a reservoir system (see picture above). The construction of a dam blocks fish migration, which affects their ability to find mates and reproduce. Thus, many fish populations near dams are affected dramatically. Also, as dams open and close, they change the water temperature and water flow in the region. This frequently disrupts the ecosystem of plants and animals in the area, thus harming the native plants and animals in and near rivers in the Andes.

http://environment-ecology.com/energy-and-environment/100-hydropower-and-the-environment.html

Station Cards

Explore

Station 6 – Deforestation

The Andes Mountains contain forests that are a very important carbon reservoir for our planet. What does it mean to be a carbon reservoir? As you likely know, carbon dioxide is expelled into the air by animal respiration and the burning of fossil fuels. However, trees and plants need carbon dioxide to do photosynthesis! Thus, the trees take in significant amounts of this carbon dioxide and remove it from the air. That is why we call forests a carbon reservoir—they hold much of the carbon that would otherwise be in the atmosphere.

Trees' removal of carbon dioxide is essential for controlling the local and global climate. Therefore, deforestation, or cutting down a forest of trees, has a significant effect on climate change as it destroys one of the most important ways that Earth naturally removes carbon dioxide from the atmosphere.

Currently, humans are cutting down forests in the Andes Mountains at an alarming rate. The wood from these forests is used for building materials around the world, while the flat land left behind is then used for more farming and mining. So, not only does deforestation increase the amount of carbon dioxide left in the atmosphere, but it also contaminates and destroys local habitats for animals like the Andean Tit Monkey.

http://www.rainforestinfo.org.au/projects/jefferson.htm

Station Cards

Explore

Station 7 – Synthetic Material Production

Deposits of petroleum are commonly found on the eastern side of the Andes Mountains. Petroleum is a non-renewable fossil fuel (meaning it cannot be replenished for at least one million years). It is used to make gasoline, and other synthetic materials, like plastic. As you imagine, petroleum is used to make hundreds of products you probably use and throw away every day.

The process of drilling for petroleum results in water pollution because numerous hazardous chemicals are used to extract it from the Earth. Thus, drilling often damages habitats not just for humans, but also for fish and many other animals alike. Additionally, building a petroleum drilling station requires the deforestation of land, which leads to habitat loss for many plant and animal species.

http://www1.american.edu/ted/projects/tedcross/xoilpr15.htm

Station Cards

Explore

Station 8 – Human Carbon Emissions

As you have already learned, humans are releasing large amounts of carbon dioxide into the atmosphere. This unnatural process is leading to excess global warming and increased climate change today. In the Andes Mountains, the effects of climate change are particularly visible. A once large glacier has completely disappeared near Peru (see photos above). Many other glaciers in the Andes region are also melting and shrinking as you read this.

The water trapped in this ice, which is essential for millions of people for farming and to produce electricity, is melting faster than it can be stored or used. Therefore, the supply of fresh water will decrease dramatically as temperatures continue to rise, which also puts extra stress on the plants and animals in the region that rely on this water.

http://www.worldviewofglobalwarming.org/peru/

7th Grade Science Unit 4: Save the Andes!

Task 3: Living in Harmony – Weighing the Consequences

Unit Essential Question: *How can we sustain biodiversity in a modern, changing world?*

Introduction

In Task 2, students explored how human actions negatively impact the Andes region mainly for their own benefit, and without regard for the environment. While knowing that human actions are ultimately destroying the delicate ecosystems in the Andes region, this engages students on mostly an emotional level. This task requires students to move beyond their emotional reaction to this problem, and instead asks that students consider why saving the Andes region makes logical sense. In other words, beyond feeling a sense of loss or shame over destroying one of Earth's most beautiful ecosystems, one must also consider how losing the biodiversity of the Andes may also affect global economies, cultures, and livelihoods.

In this task, students learn why preserving biodiversity is essential to maintaining ecosystems as a whole, creating an imperative to design solutions to maintain it. Here, students have an opportunity to practice Internet research as they search for environmental solutions already in place around the world. Then, students attempt to apply this knowledge of potential solutions to the Andes region. As part of their research for potential solutions, students will consider how conservation plans also impact local and global human populations. They will likely find that though some solutions help resolve local environmental problems (for example, deforestation), they may also introduce other problems that are less directly related to the environment (for example, less wood to be used for building homes). Ultimately, students will weigh the advantages and disadvantages of any conservation plan in order to determine whether it will gain enough public support to become a reality.

Alignment Table

Performance Expectations	Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
MS-LS2-5. Evaluate competing design solutions for maintaining biodiversity and ecosystem services.* [Clarification Statement: Examples of ecosystem services could include water purification, nutrient recycling, and prevention of soil erosion. Examples of design solution constraints could include scientific, economic, and social considerations.]	**Engaging in Argument from Evidence** • Evaluate competing design solutions based on jointly developed and agreed-upon design criteria.	**LS2.C: Ecosystem Dynamics, Functioning, and Resilience** • Biodiversity describes the variety of species found in Earth's terrestrial and oceanic ecosystems. The completeness or integrity of an ecosystem's biodiversity is often used as a measure of its health. **LS4.D: Biodiversity and Humans** • Changes in biodiversity can influence humans' resources, such as	**Stability and Change** • Small changes in one part of a system might cause large changes in another part.

7th Grade Science Unit 4: Save the Andes!

Task 3: Living in Harmony – Weighing the Consequences

		food, energy, and medicines, as well as ecosystem services that humans rely on—for example, water purification and recycling (*secondary*).	
MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.	**Engaging in Argument from Evidence** • Evaluate competing design solutions based on jointly developed and agreed-upon design criteria.	**ETS1.B: Developing Possible Solutions** • There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem.	**N/A**
Supplementary Science and Engineering Practices • **Obtaining, Evaluating, and Communicating Information** ○ Communicate scientific and/or technical information (e.g. about a proposed object, tool, process, system) in writing and/or through oral presentations. ○ Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods used, and describe how they are supported or not supported by evidence.			
Equity and Groupwork • Work together to gather, conduct, and evaluate Internet research, and present solutions. • Share feedback on peers' solutions.			
Language • Summarize Internet research on a poster. • Orally communicate ideas in a presentation to peers.			

Learning Goals

This learning task asks students to evaluate competing design solutions for maintaining biodiversity and ecosystem services globally. More specifically, the purpose is to:

- Build an understanding of biodiversity, and why it is important.
- Research and compare different global conservation plans/solutions currently in use.
- Present the potential benefits and drawbacks of various conservation plans/solutions.
- Consider that conservation plans/solutions yield both small-scale (community) and large-scale (global) changes.
- Design a conservation plan/solution that considers preserving biodiversity in the Andes region, as well as ways to garner public support for the plan.

7th Grade Science Unit 4: Save the Andes!

Task 3: Living in Harmony – Weighing the Consequences

Content Background for Teachers

The Andes region is a hotspot for biodiversity because its varied habitats and climates allow for a large range of animal and plant species to thrive. Because each organism in an ecosystem plays an integral role in natural cycles and processes, greater biodiversity ensures natural sustainability for all life forms within a local region. As the world inevitably changes due to natural and human processes, ecosystems rely to a greater extent upon biodiversity to maintain their resiliency to change. This is particularly relevant with global climate change. With increasingly chaotic weather patterns, seemingly small parts of local ecosystems become damaged or are removed, leading to larger downstream effects in the same or related ecosystems, eventually threatening the overall biodiversity of larger systems like the Earth itself.

In Task 2, students learned that due to specific actions, humans negatively impact biodiversity in the Andes region, thus threatening the health and survival of local ecosystems. Many of the human activities discussed in the previous task either kill or endanger individual species directly, destroy habitats that then threaten more species, or pollute once-pristine water sources that are essential for species's survival.

Though bleak, the situation is not hopeless. Some conservation efforts around the world have proved successful in combatting a number of the environmental problems in the Andes region. In this task, students research some of the design solutions/plans currently in use to help preserve biodiversity around the world, and then apply one of those as a potential solution/plan to combat one specific environmental problem in the Andes region. The solutions researched and proposed will likely force students to consider the scientific, economic, and/or social implications at both the local and global scale.

As an example, some current plans to end deforestation involve: (1) boycotts of products produced using resources from the Andes, (2) recycling programs for paper products to reduce reliance on wood from the Andes, and (3) health literacy programs that help people make more environmentally-informed food choices. Alternatively, students researching better agricultural practices might describe crop rotation or other natural ways to enrich soil and deter pests. Also, for extinct or endangered species, students might research how reintroducing the once extinct wolves back into Yellowstone National Park helped to restore the natural balance of the ecosystem there. Regarding harmful mining practices and petroleum drilling, students may research which products they should purchase less frequently, how they could recycle more of what they use, and which companies to boycott. Finally, as related to combating greenhouse gas emissions, though many of the solutions rely on the use or production of specific scientific technologies, such as solar power or electric cars, students may also find information related to political, economic, or social solutions, such as reducing the production of or reliance upon certain synthetic materials like plastics.

Academic Vocabulary

- Ecosystem
- Habitat
- Biodiversity
- Environmental Problem
- Conservation
- Communities
- Scale

7th Grade Science Unit 4: Save the Andes!

Task 3: Living in Harmony – Weighing the Consequences

Time Needed (Based on 45-Minute Periods)

5 – 6 Days

- Engage: 0.5 period
- Explore: 2 periods
- Explain: 1-2 periods
- Elaborate: 0.5 period
- Evaluate and Reflection: 1 period

Materials

- Unit 4, Task 3 Student Version

Engage

- Projector and Speakers for Video

Explore

- 1-2 computers per group for research
- Internet Research Resource Card

Explain

- Poster Paper or Digital Presentation Software
- Markers, Crayons, or Colored Pencils

Evaluate

- Project Organizer Handout

Instructions

Engage

1. Introduce Task 3: In the last task, you explored how human actions often alter the natural ecosystem of the Andes region in harmful ways. For example, we saw that human activities such as mining and deforestation eliminate or endanger many plant and animal species, destroy natural habitats, and pollute once-clean freshwater sources. Before we move forward, think about what you were still wondering about at the end of the last task (look back if you need to). What questions do you still have?
    - Before you pass out their student guide, give students time to reflect individually or with a partner about the questions they recorded at the end of the last task. Share a few of these out as a class, using facilitating questions to guide students toward questions that relate to this task.

2. Transition to Task 3: In Task 2, you all thought about the ways in which humans impact the Andes region, and how the changes caused by humans affect the Andes region both directly and indirectly. In this task, you will have an opportunity to first research some of the solutions currently used to combat specific environmental problems, and then to weigh the advantages and disadvantages of those solutions based on their potential impact on the local and global communities.
    - Now pass out their Task 3 student guide.

3. As students watch a short video about biodiversity in the Amazon, encourage them to consider the question: “Why should we care?”

- Allow students to watch the following video about biodiversity: https://www.youtube.com/watch?v=GK_vRtHJZu4
- On their student guides, students individually answer the question, "Why might the survival of ALL the plant and animal species in the Andes region matter?"

4. Once students have an idea of why preserving biodiversity in the Andes is essential, they can do their own brainstorm of possible solutions.
    - Students will pick one issue from Task 1 and brainstorm what they think can be done to solve the problem. These ideas will be recorded on their student guide.
    - If you choose to have students share ideas with the class, we recommend first doing a think-pair-share and then sharing out using equity sticks (See "How to Use This Curriculum" for more details).

Explore

1. In Task 2, students explored eight human activities that negatively impact the Andes region: hunting, mining, deforestation, agriculture, increased carbon emissions, reliance on hydroelectric power, building roads, and developing synthetic materials. These activities can be categorized based on the following environmental problems they contribute to: endangering species, destruction of habitats, and water pollution. Knowing that these human activities cause environmental problems now might lead students to consider the question, "What can be done to help resolve these problems?"
    - This activity gives students a chance to practice **Engaging in Argument From Evidence** as they use information gathered during Internet research as evidence to evaluate the potential benefits and drawbacks of solutions to environmental problems.
    - This activity also allows students to engage in the supplementary practice of **Obtaining, Evaluating, and Communicating Information** as they conduct their own research on solutions to combat the negative impact on the environment associated with a specific human activity in the Andes region.
    - In addition, this activity emphasizes the crosscutting concept of **Stability and Change** as students use their research to later consider how even a seemingly small-scale change, or solution, can cause large-scale effects in other communities.

2. In this *Explore*, groups of students will research current conservation plans/solutions to combat one selected environmental problem that the Andes region faces. Students will become experts in at least two plans/solutions that they think applies to a selected problem in the Andes region. Refer students back to Task 2 for a list of the possible negative human impacts. To ensure diversity in later presentations, we recommend that topics be spread across groups.

3. Assign roles to each group. You may use your own preferred roles, or, we recommend the use of the Materials Manager, Facilitator, Harmonizer, and Recorder.
    - Ask the Materials Manager to gather the station cards needed to complete the task and read them aloud.
    - Ask the Facilitator to read the directions and to make sure everyone understands the task and what the data collection chart is asking.

- Ask the Harmonizer to make sure that everyone contributes their ideas and that everyone's voice is heard.
- Ask the Recorder to make sure each person in the group is correctly recording the information.

4. As groups conduct their research, prompt them to consider the guiding questions in their student guides, which are also listed below:
   - How does this human activity negatively affect the Andes region?
   - What environmental problems does this human activity cause?
   - How do these environmental problems threaten biodiversity?
   - What are at least two solutions to combat these environmental problems?
     - How does each solution work?
     - Where have they tried each solution?
     - How successful was each solution?
     - If a solution was not successful, why didn't it work?
   - What are the potential benefits, or advantages, of each solution?
   - What are the potential drawbacks, or disadvantages, of each solution?

5. We recommend providing students with the *Internet Research Tips Resource Card* as they do their research. If they are completely new to computer research, you may want to model some of these strategies as a class before they begin in groups.
   - Research notes can be recorded in their science notebooks or a digital document.
   - This activity engages students in the practice of **Obtaining, Evaluating, and Communicating Information** as they gather and synthesize information from Internet research, using the *Internet Research Tips Resource Card* to assess the credibility and reliability of each source.

Explain

1. This section asks groups of students to create a poster or digital presentation describing the conservation plans/solutions they researched.
   - Students are reminded to use information from the *Explore* as evidence to evaluate the benefits and drawbacks of each solution, thus giving them an opportunity to practice **Engaging in Argument From Evidence.** Students are also engaged in another element of **Obtaining, Evaluating, and Communicating Information** as they communicate scientific information through an oral presentation.
   - Encourage groups to plan their poster first in their student guide before constructing their final poster or presentation.
   - Assign roles to each group. We recommend assigning students different roles within their group from the *Explore*.

2. Presentation tips:
   - Groups may present the posters in a standard front-of-the-class presentation OR groups can present in a gallery walk format.
   - Regardless of presentation format, we recommend that after each presentation, the rest of the students discuss the advantages and disadvantages of the solution, and vote on which solutions

might work best for the problems facing the Andes region and explain why. This may help students with their own evaluation of the solutions.

Elaborate

1. In the Elaborate, students are reminded that even the best conservation plans often involve compromise, and that every plan has benefits and drawbacks. It may be easy for students to think about dramatic conservation plans; for example, to completely stop cutting down trees in the Andes. However, in reality, people still rely on wood as an essential resource for many activities. Encourage students to think about the following:
    - What are the potential negative impacts of the plans/solutions you researched?
    - Will the plan/solution cause harm or difficulty to local and global communities?
    - Will the plan/solution be able to garner enough public support to make it a reality?

2. Prompt students to discuss and record how they think each of the solutions they researched can lead to small scale (local communities) and large scale (global communities) changes. This emphasizes the crosscutting concept of **Stability and Change**, as they consider how small changes in one part of a system can result in large changes in another part of the system.
    - This will provide them with the lens they need to analyze the potential plans/solutions with a more balanced perspective.

    Sample Student Response:

Solution	Small Scale Effects (Local community)	Large Scale Effects (Global community)
Stop Cutting Down Trees to Combat Deforestation	• Shortage of wood to build homes • Shortage of material used to heat homes • Restoration of natural habitats for plant and animal species • Restoration of ecosystem services	• Shortage of wood to build homes • Shortage of material to make paper • Increase in cost for alternative building materials • Increase cost of paper-based products • Reduction in carbon dioxide in the atmosphere • Possible restoration of global climate patterns

3. Return to the whole-class concept map from the Lift-Off Task.
    - In small groups, have students brainstorm new concepts and new connections that they have learned in this task, as well as any new questions that have come up for them. Then have groups share these aloud in a class-wide discussion and add to the class concept map. The use of equity sticks is encouraged for more equitable participation in class-wide discussions (See "How To Use This Curriculum" for more details).
        - Some facilitating questions to ask students are: What new ideas/concepts do you want to add to the map? What connections do you want to add or change? What is your reason

for that addition/revision? What connections can we make between the questions/ideas already on the map? What new questions do you have about the phenomenon?
    - Draw circles around each question and boxes around each concept.
    - Write connector words to describe connections between the concept boxes.
    - For this task, students may begin to connect some of their previous question circles to concept boxes about the following: advantages and disadvantages of plans/solutions to environmental problems.
- Have students analyze the additions to the class concept map for as many examples of this task's crosscutting concept as they can find. Once a student has identified the crosscutting concept, you can trace the circle in the corresponding color (decided on in the Lift-Off task). We recommend asking students to share key words that helped them identify the crosscutting concept for that concept or question. Some identifying words students might look for are:
    - **Stability and Change**: These could be phrases such as, "remains the same", "is changed by", "is disrupted by", "changes", "disrupts," etc.
- Once again, the purpose of this concept map is to facilitate generation of student questions, promote language development, and support understanding of the science content throughout the unit. Allowing students to ask their own questions and use their own words to make meaning of the concepts will not only help them make deeper connections about the science content, but this will also help their oral and written language development.

Evaluate: Connecting to the Culminating Project

1. Students independently complete the Task 3 section of the Unit 4 Project Organizer in class. Revisions can be done for homework, depending upon student's needs and/or class scheduling.

2. Students have been tasked with creating a proposal to help save the Andes. The student prompt is as follows: You have researched and evaluated solutions currently used to address some of the environmental problems caused by human activity in the Andes region. By now, you also realize that developing a conservation plan is often a balancing act that involves helping the environment on one hand, but also getting public support in order to accomplish this plan. To help you with this, use your new knowledge from this task to answer the following questions:
    - What are the best solutions you heard about or researched in this task?
    - How can you combine the parts of these solutions to create a stronger proposal for your final project?
    - How might your combined proposal affect human communities at smaller (local) and larger (global) scales?

Reflection

1. At the end of the task, ask students to individually reflect on what they learned over the course of this task by answering the following three questions in their student guide:
    - At the beginning of this task, you brainstormed a possible solution to an environmental issue in the Andes. Look back at your initial response: after learning everything you have in this task, does this solution still seem realistic? Would you be able to get support from local and global communities? If not, how would you change your proposal to gain more support?

- In this task, we focused on the crosscutting concept of: **Stability and Change**, or how small changes in one part of a system might cause larger changes in another part. Where did you see us looking at **Stability and Change** in this task?
- Now that you have learned more about different solutions to preserve the Andes region, what questions do you still have?

2. There are no right answers, but encourage students to look back at their student guides and their class concept map. They should not change their initial responses, but rather use this reflection space to add to their ideas and questions based on what they have learned through this task. By generating more of their own questions, students continue to engage in sense-making of the phenomenon and gathering knowledge and skills for their final projects.

Assessment

1. You may collect students' Project Organizer and assess using:
   - *Criteria of your choice.* We recommend using the 3-Dimensional Assessment matrix at the beginning of this document to inform your criteria.
   - This can be a formative tool to periodically look for trends in student understanding after the completion of a task. You can then use this formative data to inform any re-teaching as necessary.

2. You may also give students time to make revisions with one of the two options:
   - Students may make changes to their Project Organizer according to your comments OR
   - Ask students to exchange Project Organizers with a partner and give partners 5 minutes to give written feedback. Then allow students time to make changes to their work according to the feedback.

Resource Card: Tips for Conducting Internet Research

Explore

How to Use the Search Bar

- The key is to put the right words in the search bar so you get the material you need without too many or too few responses.
- Before you search, write down exactly what you are looking for and what you are not looking for. This will help you identify the **keywords** of your search. Search engines don't read sentences like you do…they look at your keywords and find websites that contain the same keywords. So pick your keywords wisely!

Making Your Search More Specific

- Put your most important keywords first.
- Use double quotation marks if you want to make sure the words are searched exactly as is. For example, if you want to search peanut butter, not peanut or butter, then write "peanut butter" in the search bar.

Limiting Your Search

- Use the minus (-) sign in front of words that you don't want to include (NO space between the sign and the keyword). For example, if you want peanut butter recipes that aren't cookie recipes you could write "peanut butter" recipe –cookie.
- If you are only searching for images or videos, use the tabs at the top to direct you to those sources.

Searching Within a Site

- When searching within a document or website for the location of your keyword(s), use the "find" command on that page. This depends on the computer, but is often done by pressing "control" and "f" at the same time or "command" and "f" at the same time. Ask your teacher what works best for your computer.

Website Credibility

- Some websites have more reliable information than others. One easy check is to see whether the URL ends in a .com, .org, .gov, or .edu. These are often more reputable websites.
- If not, check if the website includes sources at the bottom of their page and if these are reputable websites.

Source:

- http://www.sc.edu/beaufort/library/pages/bones/lesson7.shtml