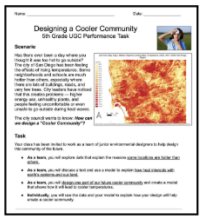
Designing a Cooler Community

Exploring the Phenomenon of Differing Land Surface Temperatures and Designing a Community Based Solution

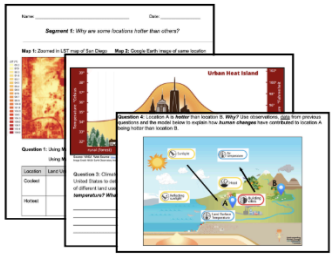
Summary of Scenario and Segments:

Students observe Land Surface Temperature data to determine causes and effects of varying temperatures affecting their community. In San Diego, some neighborhoods and school areas are much hotter than others due to differences in land use. City leaders are looking for solutions to design a "Cooler Community" that keeps people comfortable, saves energy, and supports healthy plants and ecosystems.



SEGMENT 1: ENGAGE WITH THE PROBLEM

Students connect personally by considering times they've experienced extreme heat and learn that the city faces similar challenges due to urban heat islands.



SEGMENT 2: LAND SURFACE TEMPERATURE

Students analyze maps and temperature data to identify patterns — where and why some areas are hotter (linking land use, vegetation, and surface temperature).

option for hands on investigation

SEGMENT 3: HEAT AND EARTH'S SYSTEMS

Students read about how sunlight, surfaces, plants, and air interact within Earth's systems. They use a model to explain how these factors influence temperature.

option for hands on investigation

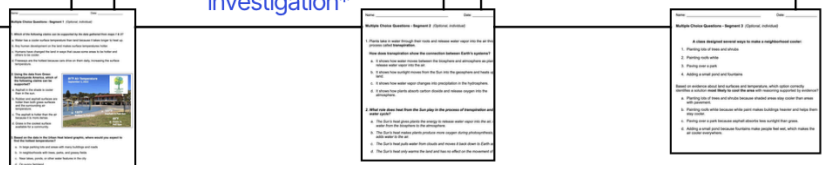
SEGMENT 4: DESIGN A SOLUTION

Students take on the role of environmental designers. They design one element of a "Cooler Community" and draw (extension option to build) a model showing how it reduces heat.

SEGMENT 5: EXPLANATION OF COOLER COMMUNITY

Each student uses evidence from the data and their model to explain how their design supports a cooler, healthier community.

Optional multiple choice questions for each segment



Grades: 5 - 7

Time: Segment 1 (15 minutes) can be done with or separate from Segment 2 (60 minutes); Segment 3 (15 minutes); Segment 4 (30 minutes, longer if you also choose to build); Segment 5 (20 minutes).

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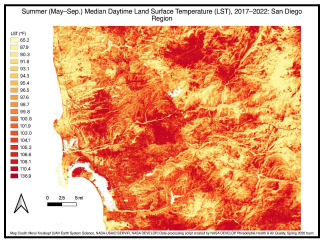
Task Implementation Context

How the task is meant to be used	**Instructional Purpose** ☑ **Curriculum-Neutral Positioning:** This performance task can be integrated into any curriculum that addresses the intended assessment targets. ☐ **Diagnostic Usage:** Understand students' initial ideas before instruction. ☐ **Formative:** Supports teachers and students with knowing where they are with their learning, where they are headed, and how to support next steps with learning. ☑ **Summative:** Useful to report on student learning across a sequence of instruction. ☑ **Assessment as Learning:** The performance task serves as a learning experience itself. **Timing for Integration into Instruction** ☐ Beginning of Unit ☐ Middle of Unit ☐ End of Unit ☑ Flexible to be used in various ways **Student Configuration for Assessment Moments** ☑ Individual work ☐ Partner work ☑ Small Group work ☐ Whole Class work
How task can be used	*This task can be used flexibly: alongside the instruction of the UGC Cooler Communities Unit, or as a standalone assessment task after Earth's Systems and energy transfer units.*

Description of Phenomenon or Problem



The surface temperature of the land differs across parts of our city. San Diego County LST map reflecting data collected by SoCal Heat Hub.

Different locations have different land surface temperatures based on a variety of factors.

NGSS Assessment Target(s)

Which performance expectation(s) is this task associated with?	
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.* ***5-ESS3-1:*** *Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.* ***MS-ESS3-3:*** *Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.* ***MS-ESS3-5:*** *Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.* ***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.* ***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.*	
Science and Engineering Practices	SEP 2: Developing and Using models SEP 4: Analyzing and Interpreting Data SEP 6: Constructing Explanations and Designing Solutions
Crosscutting Concepts	CCC1: Patterns CCC4: Systems and System Models CCC5: Energy and Matter: Flows, Cycles, and Conservation
Disciplinary Core Ideas	PS3.B: Conservation of Energy and Energy Transfer ESS2.A: Earth's Systems ESS2.C: Water in Earth's Surface Processes ESS3.C: Human Impacts on Earth Systems LS1.C: Organization for Matter and Energy Flow in Organisms PS3.D: Energy in Chemical Processes and Everyday Life

Supporting Diverse Sensemaking

What additional knowledge, skills, and/or information will students need to bring to the performance task that is not being directly assessed? (Prerequisites)
Earth Systems Basics: Understanding that Earth has major systems (geosphere, biosphere, hydrosphere, atmosphere). Understand the basic idea that **these systems interact** (e.g., sun heats Earth's surface; plants release water; materials absorb heat differently)

Energy from the Sun: The Sun is the primary source of energy for Earth's surface; surfaces absorb, reflect, and release heat differently.

Vegetation and Water Cycle Basics

Basic Map and Data Literacy Skills: Interpreting simple maps, legends, scales, and color gradients. Recognizing patterns or "hot spots" in visual data. Reading bar graphs, line graphs, or temperature maps

Scientific Practices: Identifying patterns in data, asking questions based on observations, citing evidence and using simple models.

Engineering Thinking: Understanding "criteria" and "constraints" when generating and considering multiple possible solutions.

Math Skills: Interpreting simple maps, legends, scales, and color gradients. Reading bar graphs, line graphs, or temperature maps.

Language and Information: Students should be familiar with examples of local surfaces: playground asphalt, grass fields, dirt lots, shaded vs. unshaded areas. Some of the basic differences between urban and rural areas.

What design features and scaffolds are included to help remove access barriers and support the variability of students?

- **Accessible, Relevant and Authentic Content:** All students have physical experiences with temperature in their daily lives, reflecting elements of their family and neighborhood culture. The localized maps and familiar places in their community that are discussed situate the science in **place-based learning** and gives students authentic context to explore **human impact, land use, and equity** in their own communities.
- There are strategic **language supports** and sentence frames integrated throughout the task.
- **Multiple grouping formats (partner, small group, and independent)** to support engagement, access, and expression.
- While the final product encourages the following, teachers may feel limited in choices they are able to offer given their context.
    - Optimize choice and authenticity
    - Optimize relevance, value, and authenticity
    - Nurture joy and play
    - Use multiple tools for construction, composition, and creativity

Segment 1: Task Scenario, Prompts and Scoring Guidance

Overarching Challenge:
Has there ever been a day where you thought it was too hot to go outside? The city of San Diego has been feeling the effects of rising temperatures. Some neighborhoods and schools are much hotter than others, especially where there are lots of buildings, roads, and very few trees. City leaders have noticed that this creates problems — higher energy use, unhealthy plants, and people feeling uncomfortable or even unsafe to go outside during heat waves.

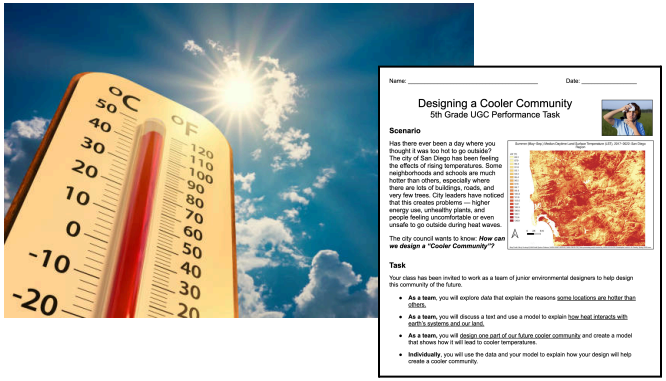
The city council wants to know: ***How can we design a "Cooler Community"?***

Segment Scenario
Setting the stage for how students will engage with the task.

Has there ever been a day when you thought it was too hot to go outside?

Where were you? What did you do?

What do you notice about the ***Land Surface Temperature Map***?
What do you wonder?



Teacher Materials

- *Teacher Slides*
- *Student Handout*

Student Prompts	Ideal Student Responses
What do you notice and wonder about the Land Surface Temperature Map?	🔴 Potential Sticking Point: Students may struggle to make initial observations and ask questions that will lead to connections with differing land surface temperature. 🟢 Teacher Move: Ask clarifying questions and with curiosity, press for reasoning. You may ask other students to repeat/rephrase what a student shares. Ask questions that guide them to share out what they know about the area the map is showing and their experiences with these types of regions.

Segment 2: Task Scenario and Prompts and Scoring Guidance

Overarching Challenge:
Has there ever been a day where you thought it was too hot to go outside? The city of San Diego has been feeling the effects of rising temperatures. Some neighborhoods and schools are much hotter than others, especially where there are lots of buildings, roads, and very few trees. City leaders have noticed that this creates problems — higher energy use, unhealthy plants, and people feeling uncomfortable or even unsafe to go outside during heat waves.

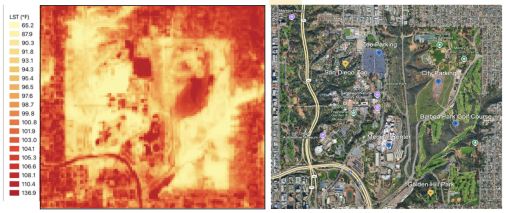
The city council wants to know: ***How can we design a "Cooler Community"?***

Segment Scenario
Setting the stage for how students will engage with the task.

Why are some locations hotter than others?

As a team, you will explore *data* and develop *models* that explain the reason that some locations are hotter than others. (With related investigation, students will explore their campus to compare LSTs, looking for patterns)

Map 1: Zoomed in LST map of San Diego **Map 2:** Google Earth image of same location

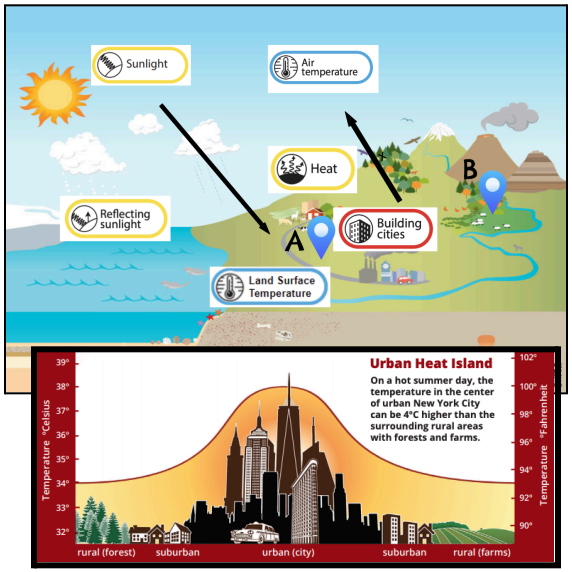


Teacher Materials

- *Teacher Slides*
- *Student Handout*
- *Scoring Rubric*

For Optional Hands-On Investigation

- *Teacher Investigation Slides*
- *Temperature Investigation Recording Sheet*
- *IR Thermometer for each group of 4*



Student Prompts	Ideal Student Responses
Launch: Have you ever noticed that some locations are hotter than others? What are some places where you feel hotter? What are some places you feel cooler?	It feels hotter outside in the direct sun and cooler when I am in the shade. On the playground it is especially hot on the blacktop, the asphalt gets really hot. The garden area is usually cooler.
Locate one of the coolest and hottest spots on the LST Map, and identify what the land in those locations is used for.	This bright yellow area on the LST map, with the coolest temperatures, are recorded on the Golf course that is covered in grass. This is also connected to the Park that also has trees and grass. The vegetation makes the land cooler. The darkest red area is the Zoo parking lot which is asphalt and gets hotter than other surfaces. 🔴 Potential Sticking Point: Students may struggle to accurately connect the locations on the LST map with the Google Earth image location or understanding why it might have extreme temperatures. 🟢 Teacher Move: With the two maps available, enlarged in color on the screen, look at some main landmarks or features that may help students navigate the Google Earth map. Point out shapes, curved lines and model using relational words to make connections between the two. Invite them to connect these extreme temperatures to the observations they have made about which locations they have felt hotter or cooler.
How does human land use affect land surface temperatures?	Areas with more buildings and pavement, like the parking lot and freeways, have higher land surface temperatures. Areas with more vegetation, like parks, golf courses and the zoo are cooler. This shows that human changes to the land can increase or decrease temperatures depending on how much vegetation is kept or added.
Which materials get hottest in the sun?	The asphalt surfaces are hotter than both grass surfaces and the surrounding air temperature.
What connections do you see between vegetation and temperature?	The rural areas that have more vegetation, such as the forest and farms, have cooler temperatures. Suburban areas that have a mix of development and trees are warmer. The hottest temperatures are in urban city centers where there are more buildings and concrete. There is less vegetation in the city.
How might human changes contribute to location A being hotter than location B on the provided model?	Location A appears to be in an urban area where humans have cleared the land to build a city. The data shows that asphalt, cement and rubber, human made materials absorb the most heat. This will lead to a higher land surface temperature. Location B is surrounded by natural landscapes, such as forests. This location will have more shade and grass/plant covered area, and will thus have cooler land surface temperatures. 🔴 Potential Sticking Point: Students may struggle to connect materials, data and visuals they have explored to the conceptual model. 🟢 Teacher Move: Invite students to describe what they notice around each location. What is different about them? How might those differences impact the LST?

Segment 3: Task Scenario and Prompts and Scoring Guidance

Segment Scenario

As a team, you will explore *data* and develop *models* to explain how heat interacts with earth's systems and our land.

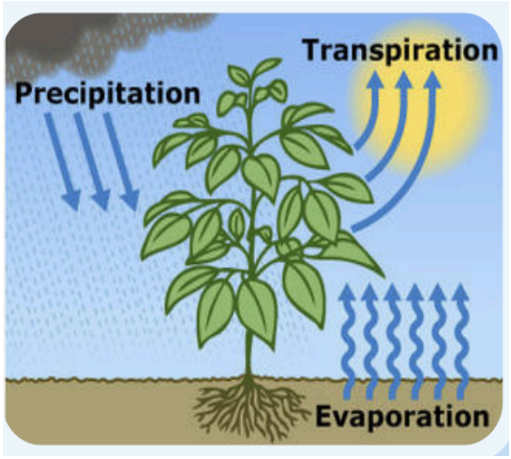
How does heat interact with Earth's systems?

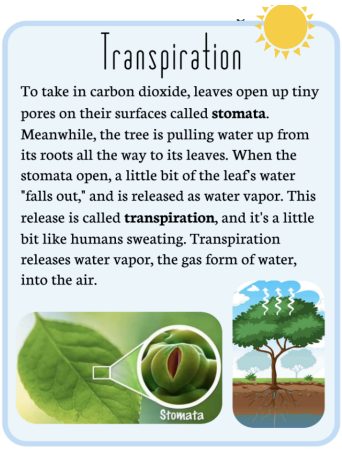
Teacher Materials

- *Teacher Slides*
- *Student Handout*
- *Scoring Rubric*

For Optional Hands-On Investigation

- *Teacher Investigation Slides*
- Temperature Investigation Recording Sheet
- *IR Thermometer for each group of 4*





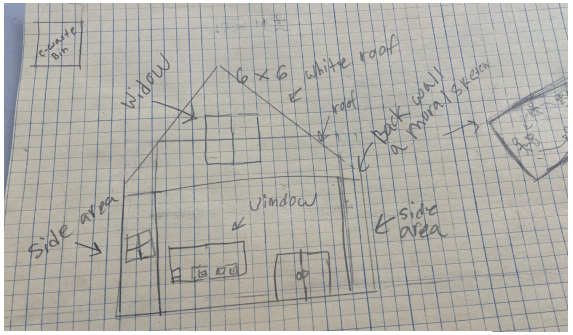
Student Prompts	Ideal Student Responses
Explain the role plants play in connecting Earth's systems.	Plants give off water vapor into the air through a process called transpiration. This shows how the biosphere and atmosphere interact with the hydrosphere, through the water cycle. The plant is part of the system that moves water between Earth's spheres. 🔴 Potential Sticking Point: Students may struggle to explain the connection between plants and each of the systems. They may also misuse the names of each sphere, or not call them out specifically. They may misuse the name of the processes as well. 🟢 Teacher Move: **Use a sentence frame that forces system-to-system connections.** *"Plants (biosphere) interact with the ___(system) by ___." Because plants do ___, it affects the ___ system by ___."* This nudges them to name systems explicitly and explain a causal connection. Refer them back to the visual model and ask them to explain what is coming INTO the process and what is coming OUT. Invite them to "zoom in" to each process.
What is the role of heat from the sun in this system?	Energy from the Sun drives the movement of water (matter) through the system. The sun's energy is absorbed by the land, which causes reradiation of heat and evaporation. The sunlight also fuels plant growth and causes plants to release water vapor through transpiration.

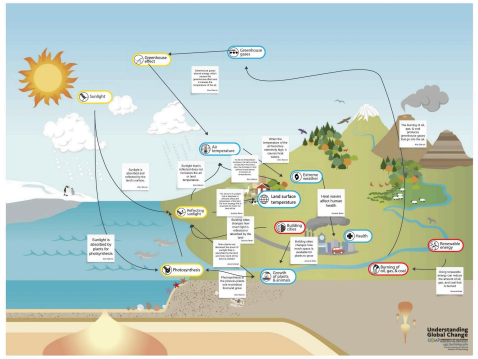
Segment 4: Task Scenario and Prompts and Scoring Guidance

Segment Scenario

Groups will design a solution that will create a cooler community in the future. They create a model that shows how this will cool the community LST.

How can you design a "Cooler community"?





Teacher Materials

- *Teacher Slides*
- *Student Handout*
- *Scoring Rubric*

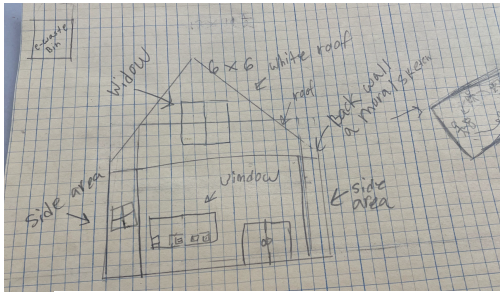
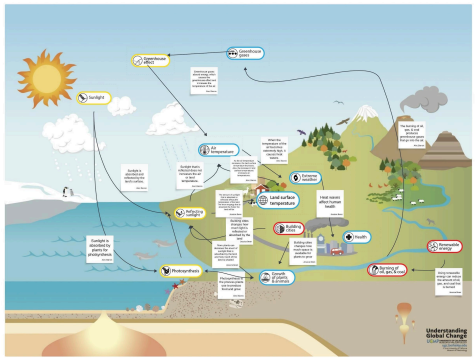
Ideal Student Responses

Students draw a model using the following icons, showing how their solution interacts with the other factors included in the model.

Segment 4 - Solution Model

Proficient	Developing	Beginning
Clearly shows the solution with how the LST decreases. Shows how the solution affects the area, using all appropriate icons.	Shows the solution with a decreased LST but missing some key icons/features.	Missing the solution or has very minimal explanation of the solution in terms of icons/concepts.

Segment 5: Task Scenario and Prompts and Scoring Guidance

Segment Scenario	
Groups will design a solution that will create a cooler community in the future. They create a model that shows how this will cool the community LST. *How can you design a "Cooler community"?*	  
Teacher Materials	
• *Teacher Slides* • *Student Handout* • *Scoring Rubric*	

Student Prompts	Ideal Student Responses
Describe your solution to the city council.	We want to plant a tree at our school. We hope to put this near the playground, where it feels the hottest on our campus. During recess, the kids want a place to cool down and rest on hot days or after playing. When we plant a tree at our school, we are changing how energy from the Sun interacts with the Earth's systems. The Sun's energy reaches the surface and can be absorbed, reflected, or used by living things.
Use the data and your model to explain *how* your design will help *create a cooler community*.	Right now, parts of our school yard have materials like concrete and blacktop that **absorb a lot of sunlight** and **heat up quickly**. These surfaces transfer that heat to the air, making the area hotter. This shows how the **geosphere (land)** and **atmosphere (air)** interact — the warm land heats the air above it. When we add a tree, we change that interaction. The **biosphere (the tree)** uses sunlight for photosynthesis, which means some of the Sun's energy is used to make food instead of

	turning into heat. The tree also gives **shade**, which blocks sunlight from hitting the ground. That means the land underneath absorbs less energy and stays cooler. The tree's **leaves release water vapor** into the air through a process called **transpiration**, which cools the air around it — this is part of the **hydrosphere** interacting with the atmosphere. The **roots** also help hold moisture in the soil, keeping the ground cooler than dry areas. Because of these changes, less energy is stored as heat in the land surface, and the air temperature near the school goes down. By planting trees, humans can make a positive change to reduce land surface temperatures and improve the balance among Earth's systems.

How the Performance Task Was Developed

This performance task comes from collaboration with the SoCal Heat Hub based at Scripps Institution of Oceanography, funded by the National Science Foundation (Award #2209058). SoCal Heat Hub education efforts focus on exploration and understanding of the causes and consequences of extreme heat, human health impacts, environmental justice and sustainable adaptation strategies.

Task Name and Version History	V1 Designing a Cooler Community
Task Developer(s)	Erin Leavitt
Institution(s)	Jefferson Elementary School, San Diego Unified School District. San Diego Science Project, UC San Diego
Image and Video Sources	Understanding Global Change **Anchor LST Map Credit:** Meryl Kruskopf (UAH Earth System Science, NASA-USAID SERVIR, NASA DEVELOP) Data-processing script created by NASA DEVELOP Philadelphia Health & Air Quality, Spring 2020 team Urban Heat Island Graphic: https://mynasadata.larc.nasa.gov/basic-page/urban-heat-islands Playground Temp. Data/Graphic: https://www.greenschoolyards.org/schoolyard-forest-rationale