Megafires: Rare Occurrences or the New Normal?
Teacher Guide

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Setting the Stage

Dr. Natasha Stavros points out wildfires happening around the United States. Image from Marketplace.

Megafires are extreme fire events characterized by their high intensity, fast speed, long duration, devastating impact, and large size. The ever-rising global temperature increase due to climate change has upset the natural balance of water within our ecosystems, leading to increased evapotranspiration and increasing periods of drought in various regions of the world - including much of the western United States. Our drought-ridden land is filled with dry fuel waiting to ignite. In addition, our history of fire suppression has led to increased fuel availability in our forests. Together with other factors, we are seeing an unprecedented increase in the number of megafires that look to continue into the future. Examining the data and discussing the causes of these megafires provides students an opportunity to explore the interaction of humans and their environment.

Lesson Overview

In this Data Puzzle, students analyze and interpret authentic data to explain how and why the number of megafires has changed over time.

Day 1

Part 1 – (20 minutes) Eliciting Students' Ideas
Access students' prior knowledge about an opening scenario.

Part 2 – (40 minutes) Identifying Important Science Ideas
Students engage with a contemporary science investigation through an interactive reading in which students are tasked with 1) making connections between the science investigation and the opening scenario, and 2) identifying an investigative question.

Day 2

Part 3 – (30 minutes) Supporting Ongoing Changes in Thinking
Students test/compare their current understandings of the investigative question against authentic data.

Part 4 – (30 minutes) Constructing Evidence-Based Explanations

Students finalize new understandings as they relate to the investigative question to create an explanatory model.

Instructional Overview	
Grade Level	Middle/High School
Instructional Time	~120 minutes
Building Toward	**NGSS Disciplinary Core Idea:** ● ESS3.C: Human Impacts on Earth Systems **NGSS Science and Engineering Practices:** ● Analyzing and Interpreting Data ● Constructing Explanations **NGSS Crosscutting Concepts:** ● Cause and Effect ● Stability and Change **Performance Expectations** ● MS-ESS2-3: Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment. ● HS-ESS3-4: Evaluate or refine a technological solution that reduces impacts of human activities on natural systems
Investigative Question	● How and Why has the number of megafires in the United States changed over time?
What Students Will Do	● Analyze and interpret data to evaluate how the number of megafires across the United States has changed over time. ● Construct a model to explain how changing climate (e.g., increased drought) and land management practices have caused the number of megafires across the United States to change over time.
Materials	❏ Slide deck ❏ Student worksheet ❏ Answer key
Material Preparation	❏ Print student worksheets ❏ Review presenter notes in Lesson slides ❏ Review Answer Key
Vocabulary	● Megafire - wildland fires that are larger than 95% of all the fire events studied during the 1984-2019 time period ● Evapotranspiration - the loss of water through soil (evaporation) and plants (transpiration)

	• Prescribed fire - fire set intentionally for purposes of forest management, farming, prairie restoration, among other reasons. • Fire suppression/exclusion - putting out a fire as quickly as possible once one has started.
Teacher Strategies	• Slow Reveal

Part 1 - Eliciting Students' Ideas
20 minutes

1. (Slide 4) Utilize the slide deck to introduce the Data Puzzle and explain that the purpose of the opening scenario is to identify times in the students' own lives where they may have experienced ideas/concepts similar to what they will explore later in the Data Puzzle.

2. Facilitate a whole-class conversation in which students share their own experiences related to building bonfires.

Create a public record of student responses to refer back to throughout the lesson to strengthen student connection to and allow students to track the revisions to their thinking throughout the lesson.	
Possible Teacher Prompts • *What are your bonfire stories?* • *What kind of fuel did you use in your bonfire?*	*Possible Student Response* • *Details might include: hot, windy, smokey, etc* • *Need dry materials to start the fire, different sized materials. Can't just start with big logs*

3. (Slide 6) Introduce students to fire ecologist Natasha Stavros, the scientist featured in the Data Puzzle, who studies the occurrence of megafires in the western United States and the factors that influence them.

Part 2 - Identifying Important Science Ideas
40 minutes

1. (Slide 8) Students read the puzzle plot text included in the student worksheet either individually, in small groups, or as a whole class. While reading, students are asked to do the following tasks:
    a. Circle the investigative question the scientists are investigating.

   b. Identify similarities between the reading and the opening scenario.
2. (Slide 9) Show the "Understanding Evapotranspiration" simulation (*33 seconds, link is also embedded in the puzzle plot text*) to help students visualize evapotranspiration.

3. (Slide 10) Facilitate a whole-class discussion to help make connections between the reading and the opening scenario by utilizing the following prompt:
   a. In what ways are the current forest conditions in the United States similar to the conditions you might want if you were asked to make a large bonfire?

Purposeful Conversation Pointer
The purpose of this whole class conversation is to relate the reading and opening scenario to each other **and** to the larger science ideas of increasing wildfire sizes, the effects of fire suppression, and drier fuels. Referring back to student ideas from the opener will enhance students' understanding of the broader phenomenon and create coherence between each part of the lesson.

4. (Slide 11) Students summarize important science ideas presented in the puzzle plot by drawing and describing why forest fuels have become drier over time.

5. Students make a prediction for the investigative question that they will test in Part 3 by analyzing real data.

Possible Prediction	*Possible Reasoning*
• *The number of megafires will increase over time*	• *Stopping all fires, means more fuel is present when fires do start* • *Drier fuels* • *Earth's rising temperatures makes more water evaporate which dries the soil and plants*

Part 3 - Supporting Ongoing Changes in Thinking

30 minutes

1. (Slide 13 - 17) Give students the opportunity to look at and discuss the graph using the **slow reveal strategy in the slide deck**. In this strategy, students are given the data without any axes labels and asked in pairs or small groups to discuss the patterns they see. On the next slide, students are given the y-axis label and asked how their thinking about the pattern has shifted. Finally, the x-axis label and graph title are revealed.

Data Sensemaking Spotlight - Describe Visual Patterns

In the "Slow Reveal" strategy, students look at one graph multiple times. Each time, more of the graph is revealed to the student. With each new reveal, students are given an opportunity to think differently about the data being presented. By trying to describe the pattern(s) you notice with words, you start building a vocabulary of common pattern types that you and others will recognize and be able to give meaning to. Things to look for in describing patterns include clumps of data values, gaps without data values, direction of data values, and comparing groups of data values.

2. (Slide 18) Students work in pairs to identify patterns in the dataset.
3. Students cite evidence from the graph to evaluate whether or not the data supported or refuted their initial prediction for the investigative question.

Listen For…
- *Megafires are increasing over time.*
- *It's likely this trend could continue.*

Part 4 - Constructing Evidence-Based Explanations
30 minutes

Final Model Construction

1. (Slides 20 - 22) Utilize the slide deck to describe what should be included in a scientific model and analyze an example of an explanatory model.

Note: If there is disagreement amongst students about what should be included in their explanatory models, consider creating a "Gotta Have Checklist", a whole-class public record in which students collaboratively identify the parts and conventions (signs/symbols connecting parts) that you just gotta have in your model.

2. (Slide 23) Students work in pairs to construct their explanatory models for the investigative question.

3. (Slide 24) Students share their explanatory models.
    a. Model sharing can be facilitated as a gallery walk, in small groups, or as a whole class.

Digging Deeper

4. (Slides 25 - 26) Students consider actions forest managers could take to reduce the number and impact of megafires.

Listen For…

- *Forest managers could collaborate with indigenous communities to learn more about traditional knowledge*
- *More, smaller, prescribed burns*
- *Reduce fuels*
- *Discussion about what we can do to reduce global climate change*

Additional Teacher Resources

Videos

- "The wicked wildfire problem and solution space" by Natasha Stavros, March 15, 2021.

Articles

- "Bringing Tech innovation to wildfires: 4 recommendations for smarter firefighting as megafires menace the US" by Natasha Stavros. June 8, 2021.

Podcast

- "Wildfire resilience, not suppression, supports the environment" by Natasha Stavros. August 10th, 2021.

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