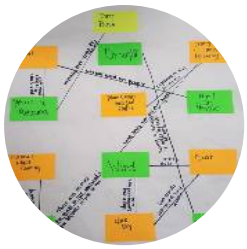


Drought and the Dust Bowl

Climate, Ecosystems, and Human Impacts

Heather Shaffery, Jacqueline Smith, Carrie Miller-DeBoer
Published by *K20 Center*

Grade Level	9th – 12th Grade	**Time Frame**	6-8 class period(s)
Subject	Science	**Duration**	325 minutes
Course	Biology, Environmental Science		

Essential Question

What factors led to the Dust Bowl? How was this event documented through the arts and science?

Summary

This extended multi-standard lesson uses the phenomena of the Dust Bowl to understand ecosystem stability and human impacts on the environment. Students examine art, plant-soil interactions, climate data, and agricultural practices to develop concept maps synthesizing the ecosystem-based causes of the Dust Bowl. These concepts are then applied to explain the Earth ecosystem in the movie "Interstellar." The lesson concludes with students writing a claim-evidence-reasoning statement about which ecosystem or human factors prevented another Dust Bowl event during the severe drought of the 1950s.

Snapshot

Engage

Students identify Oklahoma weather pattern data over time. They make predictions about which weather, biological, or human impacts contributed to the Dust Bowl.

Explore

Students view period art to understand the ecosystem and cultural effects of the Dust Bowl. They then investigate the interaction of wind, soil, and plants as ecological factors that contributed to the Dust Bowl in Oklahoma.

Explain

Students construct concept maps to explain how interactions among climate, human agriculture, and ecosystem features contributed to the Dust Bowl.

Extend

Students watch clips from "Interstellar" and create new concept maps to predict and explain which ecosystem interactions led to the movie's catastrophic dust storms.

Evaluate

Using evidence collected during the lesson, students evaluate the claim that soil conservation practices were exclusively responsible for preventing another Dust Bowl event during the drought of the 1950s.

Standards

ACT College and Career Readiness Standards - Science (6-12)

IOD202: Identify basic features of a table, graph, or diagram (e.g., units of measurement)
IOD303: Find basic information in text that describes a complex data presentation
IOD304: Determine how the values of variables change as the value of another variable changes in a simple data presentation
IOD402: Compare or combine data from a simple data presentation (e.g., order or sum data from a table)
IOD505: Analyze presented information when given new, simple information
IOD603: Perform a complex interpolation or complex extrapolation using data in a table or graph
SIN201: Find basic information in text that describes a simple experiment
SIN301: Understand the methods used in a simple experiment
SIN401: Understand a simple experimental design
SIN502: Predict the results of an additional trial or measurement in an experiment
SIN702: Predict the effects of modifying the design or methods of an experiment
EMI301: Identify implications in a model
EMI401: Determine which simple hypothesis, prediction, or conclusion is, or is not, consistent with a data presentation, model, or piece of information in text
EMI502: Determine whether presented information, or new information, supports or contradicts a simple hypothesis or conclusion, and why
EMI503: Identify the strengths and weaknesses of models
EMI505: Determine which experimental results or models support or contradict a hypothesis, prediction, or conclusion
EMI603: Use new information to make a prediction based on a model

Next Generation Science Standards (Grades 9, 10, 11, 12)

HS-LS2-6: Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.
HS-ESS3-2: Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.

Oklahoma Academic Standards (Environmental Science)

EN.LS2.6 : Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.
EN.ESS2.3.2: Motions of the mantle and its plates occur primarily through thermal convection, which involves the cycling of matter due to the outward flow of energy from Earth's interior and gravitational movement of denser materials toward the interior.

Attachments

- CER & Rubric—Drought and the Dust Bowl - Spanish.docx
- CER & Rubric—Drought and the Dust Bowl - Spanish.pdf
- CER & Rubric—Drought and the Dust Bowl.docx
- CER & Rubric—Drought and the Dust Bowl.pdf
- CER Scaffold Suggestions—Drought and the Dust Bowl.pdf
- Climate Graphs—Drought and the Dust Bowl.pdf
- Dust Bowl Poems—Drought and the Dust Bowl - Spanish.docx
- Dust Bowl Poems—Drought and the Dust Bowl - Spanish.pdf
- Dust Bowl Poems—Drought and the Dust Bowl.docx
- Dust Bowl Poems—Drought and the Dust Bowl.pdf
- Explore Graphic Organizer—Drought and the Dust Bowl - Spanish.docx
- Explore Graphic Organizer—Drought and the Dust Bowl - Spanish.pdf
- Explore Graphic Organizer—Drought and the Dust Bowl.docx

- Explore Graphic Organizer—Drought and the Dust Bowl.pdf
- Lesson Slides—Drought and the Dust Bowl.pptx
- Literature Quotes—Drought and the Dust Bowl - Spanish.docx
- Literature Quotes—Drought and the Dust Bowl - Spanish.pdf
- Literature Quotes—Drought and the Dust Bowl.docx
- Literature Quotes—Drought and the Dust Bowl.pdf
- OK Annual precipitation history.png
- OK Annual temp history.png
- OK Panhandle mean annual temp and precipitation.png
- Teacher Annotated Woody Guthrie Lyrics—Drought and the Dust Bowl.pdf
- US Dust Loading 1932-1939 model.png

Materials

- Lesson Slides (attached)
- Dust Bowl Poems (attached)
- Literature Quotes (attached)
- CER & Rubric (attached)
- Explore Graphic Organizer (attached)
- Germinated grass seeds (one pot per student group)
- Bare soil (one pot per student group)
- Straws and fans (e.g. paper or personal battery-operated fans)
- Measurement tools (e.g., scales, rulers, beakers, or graduated cylinders)
- Student science notebooks
- Video, music, graphic, and print media sources related to the Dust Bowl (See the Explore section for examples.)
- Sticky notes or index cards
- Large paper (i.e., chart or butcher)

Engage

Standards-Specific Information

This lesson was developed with the HS-LS2-6 and HS-ESS3-2 Performance Expectations in mind, but it directly addresses most of the Disciplinary Core Ideas found in standards HS-LS2-2, HS-LS2-6, HS-LS2-7, and HS-ESS3-2.

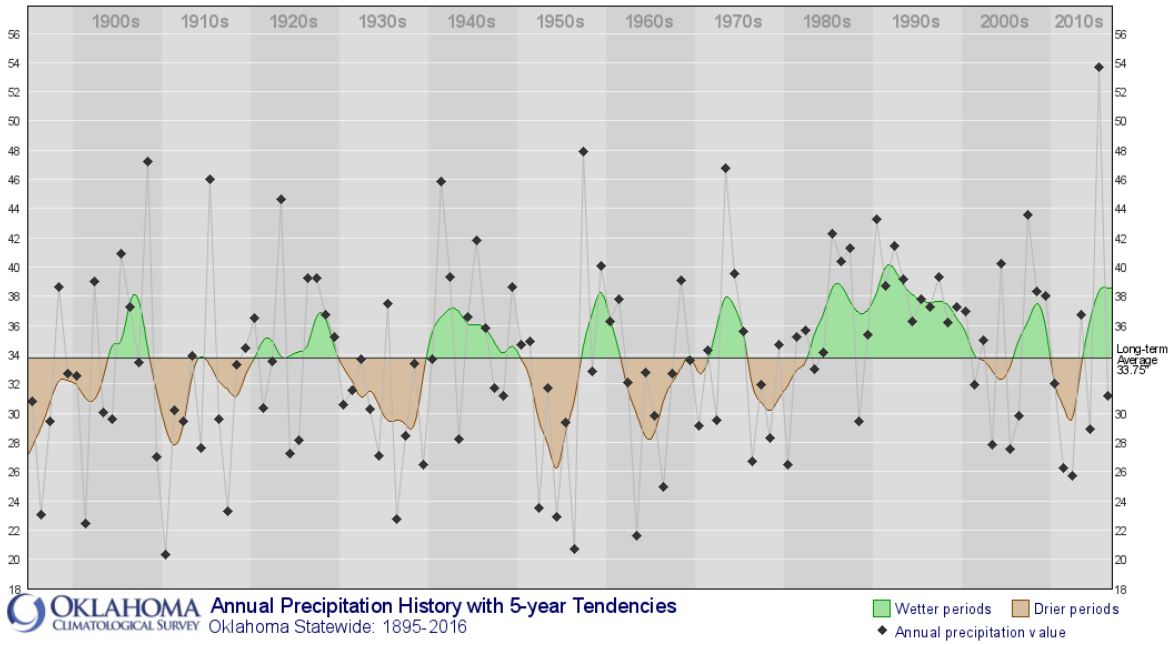
Teacher's Note: Climate Data

Effective graphical data are included as individual image files and together in the "Climate Graphs" attachment with their sources linked. You might wish to provide students alternative or additional data sets, which can be accessed through the links in the lesson resources and attachment.

Present graphical data displaying average temperatures and precipitation (e.g., Mesonet, NOAA, USDA, etc.) on **slides 4-6** of the lesson slides. Ask students to observe the data, with particular emphasis on comparing the graphs. They should report any patterns, trends, or particularly interesting features they notice, both in individual maps and among the maps. As a class, have students explain what the graphs show and how they would generally interpret them (e.g., a point is the average amount of precipitation for a specific year).

Teacher's Note: Student Observations

During discussion, encourage students to ask their own questions and make claims about what they observe in the data. Either record these in a public space for students to reference later, or have them document their questions individually. Some of the questions students have about the data may have clear answers by the end of the lesson. Others may require additional research. If possible, give students opportunities to incorporate that research into their Extend activities.



Taken from the Mesonet: [Oklahoma Rain Bellringer](). (Additional graphs are included in the multiple Facilitator attachments.)

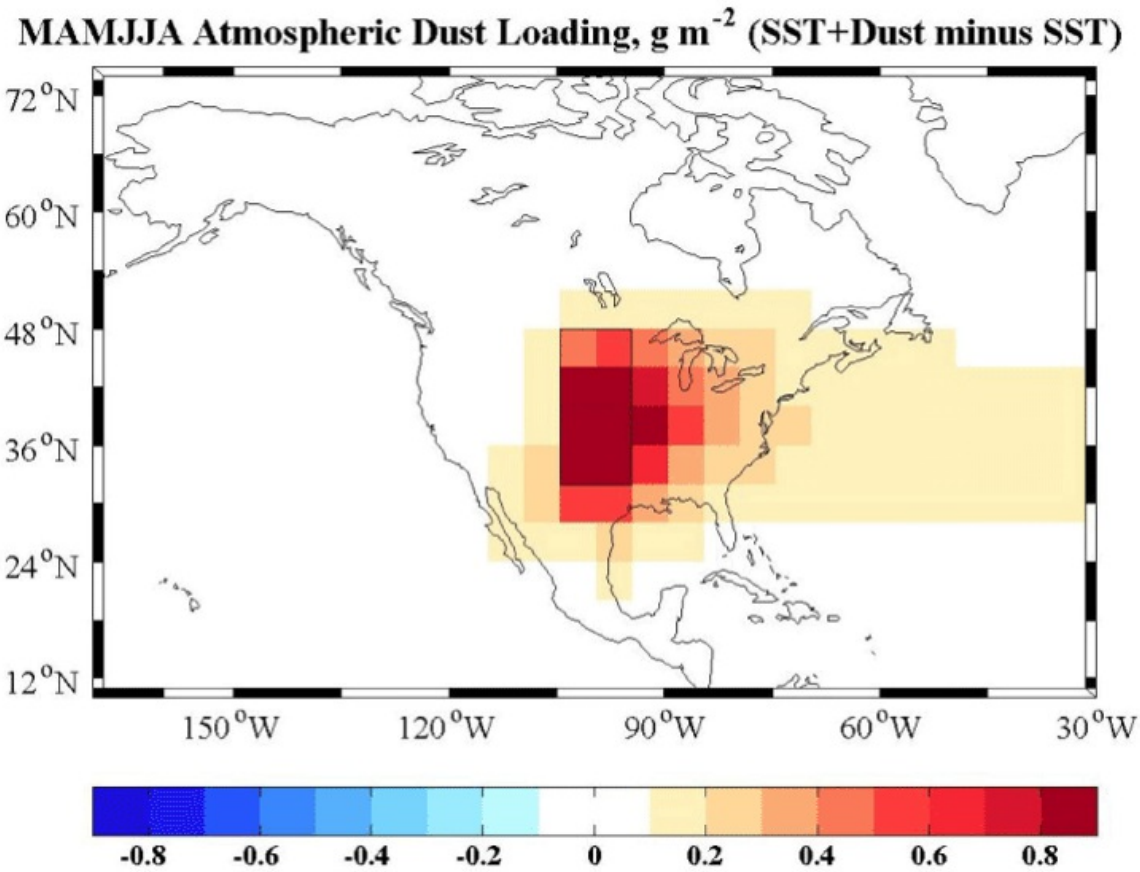
A few trends students might observe in the individual maps include:

- Consistently increasing temperatures since the mid-1990s.
- Notable above average temperatures in the 1920s, 1950s, and mid-late 1990s.
- "Record high" average temperature in 2012.
- Extremely dry periods are much drier (larger magnitude) than wetter periods are wet.
- Since the 1980s, Oklahoma has been, on average, wetter and wet for longer than in previous graph history.

Some possible comparative data trends might include:

- The most severe dry periods tend to be the hottest periods.
- The dry period in the 1950s was worse (more dry) than the period in the 1930s.
- Precipitation amounts vary among data sources, but the temperature values are consistent among graphs.

At this point share with students the NASA Atmospheric Dust Loading map on **slide 7**. Ask them how these data connect to the temperature and precipitation data. When they have noticed that the extremely high dust concentration over the middle of the United States coincides with the extremely hot, dry period in the 1930s, explain or confirm their hunch that these data are from the Dust Bowl.



NASA Model of the amount of dust in the atmosphere in g/m2 from 1932-1939. (Produced from research that tried to explain why the Dust Bowl drought was so intense and centered further north than expected.)

If student knowledge on the topic is limited, at this point they only need to know what the Dust Bowl was. If their prior knowledge extends to the causes of the Dust Bowl, simply accept their ideas without confirming or denying them. Go to **slide 8**. Wrap up by asking students to make and justify claims for each of the following prompts. A graphic organizer can be found in the **CER & Rubric** attachment.

1. *What factors caused the Dust Bowl?*
2. *How was the Dust Bowl historically documented (e.g., how did people make a record of the event)?*

Explore

Art

The resources provided relate directly to the science content of the lesson. If you would like to dig deeper into the art-science connection or just customize the content you provide, additional sources are linked in the Resources.

Cross-Curricular Opportunities

The Dust Bowl is an ideal topic for collaboration with the history and language arts teachers in your building.

Go to **slide 10**. Students will explore various media to develop: a) hypotheses about the ecosystem effects of the Dust Bowl, and b) an understanding of how the events of the Dust Bowl were documented in media arts. Be sure that students get to observe 3-4 art sources during your allotted time (about 10 minutes per source). While students are engaging with the various media, they should record two different sets of observations in the **Explore Graphic Organizer** handout: a) what they notice about the ecosystem described or shown in the media, and b) the ways people discussed or interacted with their environment.

	What I notice about the ecosystem:	How people described/interacted with the ecosystem:	

Consider having students structure their science notebooks in a two column structure to record their observations.

Scaffolding

Use songs from "Dust Bowl Ballads" by Woody Guthrie with the class to help students understand how to make observations about how people described and interacted with the ecosystem. Some possible examples are included but not limited to those highlighted in the "Teacher annotated Woody Guthrie lyrics" attachment.

Observing Ecosystems Through Art.

Use questions like the following to guide the conversation about art and the ecosystem: *"How did Woody Guthrie describe the ecosystem? Based on his lyrics, what was the ecosystem like before and after the Dust Bowl? How were people responding to the ecosystem during the storms?"*

- **Visual:** 1, 2, 3; (Photography books) *The Dust Bowl: An Illustrated History, The Dust Bowl Through Lens* (Photo Deconstruction Strategy)
- **Audio:** Woody Guthrie's "Dust Bowl Ballads," lyrics can be found on the Woody Guthrie website and most songs can be found on YouTube
- **Texts:** Passages from *Grapes of Wrath* and *Whose Names are Unknown* (found in the **Literature quotes** attachment), and the Dust Bowl poem and personal narrative (found in the **Dust Bowl Poems** attachment)
- **Newspaper Articles:** 1 (Items 4-6); 2, 3, 4, 5, 6

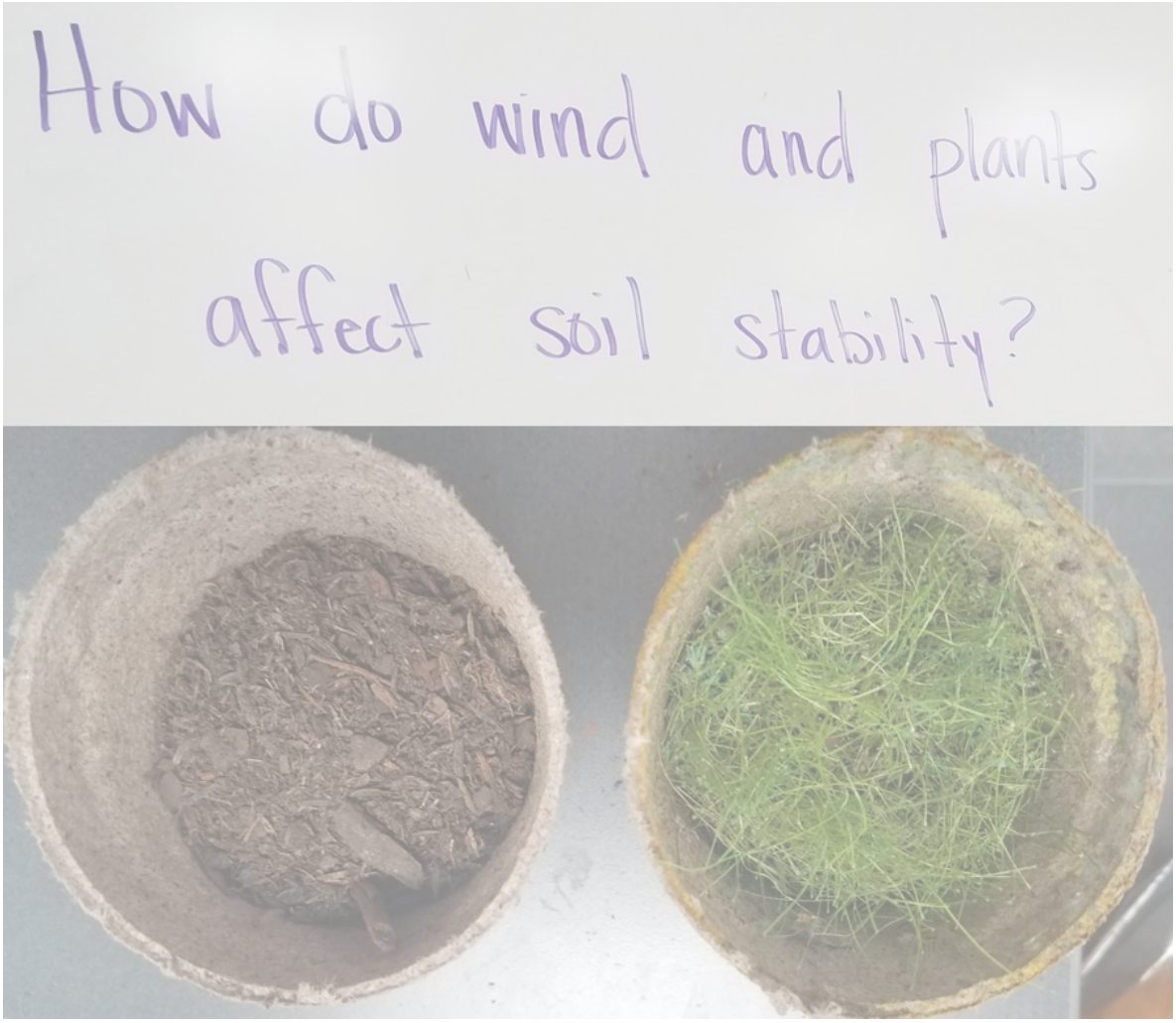
Generating Ideas

Consider using the following question to facilitate connections: "*Based on the observations you made, what questions or hypotheses do you have about what happened to local ecosystems during the Dust Bowl?*"

Science

This investigation can be modified using whatever grass types are easily available to you. The goal is for students to understand the relationships among soil, plants, and wind generally, rather than native prairie conditions specifically. Plants can be grown in individual pots or as small flats based on your convenience.

Go to **slide 12** Referring back to the NOAA Atmospheric Dust Loading data and media, guide students as a class or in small groups to develop a list of factors that contributed to the high dust content and environment they observed in the images. Help students emphasize the lack of plants in the images and the wind required to generate blowing dust. Using this as a jumping off point, students will investigate the effects of wind and plants on soil stability in groups.



Peat pots with grass (mixed species, primarily rye grass) and bare soil. (Some students cut down the edges of the pots to expose the surface of the pots' contents for wind.)

Teacher's Note: Customizing the Slides

Customize **slides 13-15** with the specific investigation instructions for your class. Depending on how much information you include, you might need more than or fewer than three slides.

All student groups must have at least a **no cover** unit (soil/sand) and a **full plant cover** unit to compare. You might also include a **partially covered** (some visible soil) or **single-species** unit, it could either be a requirement or an optional resource as you see fit. Provide groups with straws (for blowing air), fans (paper, battery-operated, rotating, etc.), as well as collection and measurement tools to conduct their investigations. Have them record what conditions they investigate, the data they collect, and what conclusions they draw from the work. Encourage them to look at a cross-section or side-view of their experimental units so they can observe the structure of the system in different conditions.

Teacher's Note: Data Collection

Allow students to freely collect data using available materials without heavily emphasizing experimental design. While this is a great opportunity to encourage best practices, including organized data collection and repeated trials, an experiment is not necessary here. The point is for students to construct a general understanding of the relationships among the soil, wind, and plant cover.

Agriculture

Before moving on to the formal explanation activities, engage students in discussion of agriculture practices. As in the science section, customize **slides 17-19** with the details specific to your class.

Source: Ken Burns the Dust Bowl Clips

You may want to see about purchasing the PBS documentary The Dust Bowl by Ken Burns. Two clips from the first episode are helpful: "The Great Plow Up" (10:10 clip) discusses the history of agriculture in the Southern Great Plains up to the advent of high-volume wheat growing. "Wheat Boom" (10:25 clip) traces the rise of industrial farming and wheat over-production preceding the Dust Bowl storms.

At this point in the lesson, make connections between the agriculture and its effects on the Southern Great Plains ecosystem. The clips noted above are highly descriptive without implicating agriculture as an explicit cause of the Dust Bowl. Students should add to their **Explore Graphic Organizer** handout, taking careful note of why some farmers and ranchers objected to The Great Plow Up, and how they described the native ecosystem and agricultural landscapes.

Explain

Students will create Concept Card Maps to help synthesize their understanding around the ideas they've developed from the art, science, and agricultural explorations. Go to **slide 20**. To generate a collection of concepts, remind students what activities they have done to this point and ask them to detail what they learned or explored in each.

Examples Of Concepts Learned

When students analyzed graphs on the first day, they identified patterns of **increased temperature**, **decreased precipitation**, and might have discussed **drought** explicitly. These three points would each be their own concept for a card.

Go to **slide 21**. Using the class set of concepts, have students create concept maps that tell the story of the Dust Bowl. This activity can be successfully executed in student groups of 3-4 using sticky notes and chart paper.

Go to **slide 22**. Have students explain how they constructed their concept maps to another student group. These discussions should include explanations of which art and science evidence students used and *how* they used it to put their concepts together.

Teacher's Note: Correcting Misconceptions

Use these discussions as an opportunity to correct misinformed student conceptions.

From here, students should also come to understand the changes in agricultural practices focused on soil conservation, in response to the Dust Bowl. Ken Burns' clips are suggested below to help provide information, but this would also be an excellent opportunity to include the local community (i.e., farmers, 4-H resources, extension agents) to teach students about sustainable farming practices.

Relevant Practices

Examples of sustainable farming practices might include any or all of the following: wind breaks and shelter belts, contour plowing, terracing, strip cropping, rest-rotate-reseed strategies, and Lister plowing.

The following clips from Ken Burns' The Dust Bowl documentary can be used at this point if needed:

- "Introduction" (to 1:52): Recaps the severity and length of the Dust Bowl
- "Memory And Hope" (from 1:35-5:11): Covers the federal dilemma about rescuing the Dust Bowl area and creation of Soil Conservation Service.
- "They Got That Right" (to 3:24): Describes FDR's soil conservation tour, the state of the Southern Great Plains, and the view of those who stayed.
- "Higher Ground" (from 5:47-9:53) & "Return of the Rain" (10:01): Details soil conservation, Great Plains restoration, and the Dust Bowl's end.

Go to **slide 23**. To conclude the Explain activity, have students construct a simple equation for the Oklahoma Dust Bowl (i.e. _____ + _____ + _____ = Dust Bowl). This mathematical representation should include factors students observed in the data, investigations, and discussions, but does not have to include actual numbers. For example, **"O*ver-plowing + Drought + Wind = Dust Bowl"*** or ***"Wind x (High Temperature + Low Rain) + Agricultural Practices = Dust Bowl"*** would both be accurate equations. The point is not complexity, but to have students intentionally synthesize their learning into a summary.

Extend

In the movie *Interstellar*, Earth experiences events which parallel the Dust Bowl. Using clips of *Interstellar* as a point of comparison, students will create new concept maps to predict the reasons for the dust storms in the movie. Use the following three clips (listed as times) to develop modified concepts:

1. 2:40-3:30 (death of wheat/crops)
2. 17:10-19:40 (dust storm)
3. 27:57-29:15 (scientific and social context)

Go to **slide 24**. Have students review their Dust Bowl concept lists to remove factors that don't apply to *Interstellar* and add new factors which do. For example, "blight" would be a new concept for the movie which did not come up in their Dust Bowl list. Go to **slide 25**. Using the new list of concepts, have student create new concept maps to address the prompt below. Afterwards, have student groups share with one another, or the entire class, as was done in the Explain portion.

Interstellar Concept Map Prompt

Based on what we are told/observe/infer about local environmental conditions in *Interstellar*, **and** based on what we know about the causes of the real-world Dust Bowl in the 1930s, ask students why there are dust storms occurring in Interstellar. Modify your Dust Bowl concept map to create a new concept map to tell the Interstellar dust storm story.

Evaluate

To conclude the lesson, students will circle back to their climate graphs from the Engage. If they did not make the connection before, help students identify the drought of the 1950s on the temperature and precipitation graphs. Go to **slide 26**. Have students evaluate the claim below, supporting their support or rejection of it using all of the evidence they have collected over the course of the lesson. A student handout and rubric are included in the **CER & Rubric** handout and possible modifications are included in the **CER Scaffold Suggestions** facilitator attachments.

Evidence sources include:

- Observations from art
- Observations and data from grass investigation
- Observations from Ken Burns clips
- Dust Bowl and *Interstellar* concept maps

Claim-Evidence-Reasoning (C-E-R) Prompt

"The use of soil conservation practices is the only reason the severe drought in the 1950s did not produce another Dust Bowl event."

Funding

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