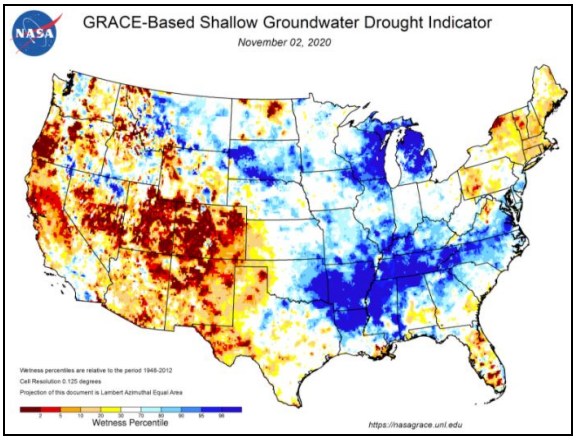
The Future of Forests

Measuring Soil Moisture From Space - Teacher Guide

Setting the Stage



Plants depend on water to produce food via photosynthesis. Drawn in through their roots, water is transported through the plant's xylem to the upper reaches of the plants where some of it is used in photosynthesis and the rest escapes through stomata, tiny holes in the leaves or needles. As such, the amount of water contained in soil (soil moisture) is an effective indicator of plant health. NASA scientists measure soil moisture conditions around the globe with Soil Moisture Active Passive (SMAP) and Gravity Recovery and Climate Experiment (GRACE) satellites. These satellite observations of soil moisture allows scientists to establish long term trends, evaluate conditions in real time, and forecast future soil moisture conditions.

Photo Credit: NASA

Lesson Overview

In this lesson, students will analyze soil moisture data gathered from NASA satellites to evaluate conditions in their communities.

- *Part 1 – (15 minutes) Plants Need Food*
  Students engage in a warm up and class discussion focused on the process of photosynthesis.
- *Part 2 – (15 minutes) Measuring Soil Moisture From Space*
  Students explore NASA satellites SMAP and GRACE, both of which measure soil moisture from space.
- *Part 3 – (20 minutes) Present Soil Moisture Conditions*
  Students analyze soil moisture data gathered from the GRACE satellite.
- *Part 4 – (10 minutes) Update Summary Table*
  Students reflect on what they learned from the lesson and how it relates to the unit driving question.

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Instructional Overview	
Grade Level	Middle/High School
Instructional Time	60 minutes *(total time needed)*
Unit Driving Question	How do landscapes recover after a wildfire?
Lesson Driving Question(s)	Why do plants need water? How do scientists measure soil moisture conditions over time?
Building Toward	Middle School: MS-LS2-4, MS-ESS3-3 High School: HS-LS2-7
Three Dimensions	**Science and Engineering Practices:** ● Analyzing and Interpreting Data ● Obtaining, Evaluating, and Communicating Information **Disciplinary Core Ideas:** *Middle School:* ● LS2.C: Ecosystem Dynamics, Functioning, and Resilience ● ESS3.C: Human Impacts on Earth Systems *High School:* ● LS2.C Ecosystems Dynamics, Functioning, and Resilience **Crosscutting Concepts:** ● Stability and Change
What Students Will Do	● Analyze and interpret soil moisture data collected by NASA satellites to evaluate the dynamic soil moisture conditions locally and globally.
Materials	❏ Measuring Soil Moisture From Space PPT ❏ Measuring Soil Moisture From Space Student Worksheet (1 per student) ❏ Answer Key ❏ Computer/Ipad (1 per student) ❏ Video: SMAP satellite ❏ Video: GRACE satellite ❏ Interactive: NASA satellites ❏ Data Interactive: Groundwater and Soil Moisture Conditions from GRACE ❏ Initial Ideas Public Record ❏ Summary Table
Material Preparation	❏ Reserve access to devices (computer/Ipad) ❏ Cue and test web links ❏ Print student worksheets ❏ Review speaker notes in the Measuring Soil Moisture From Space PPT ❏ Review Answer Key

	❏ Display summary table and initial ideas public record
Vocabulary	*Vocabulary words below are in reference to the GRACE satellite datasets (Part 3)* Surface soil - Top 2-centimeters of soil Root zone - Top 1-meter of soil Groundwater - Below upper 1-meter of soil

Part 1 - Plants Need Water (20 minutes)

Refer to Part 1 slides included in the Measuring Soil Moisture From Space PPT. See PPT presenter notes for additional information.

1. Students complete their warm-up, "Why do plants need water?" and share their ideas with the class. Refer to Slide #5 to describe the process of photosynthesis.

2. Have students discuss the following prompt, "How might a change in soil moisture (increase or decrease) impact plants ability to make food?" with their shoulder partner.

3. Segue into Part 2 by saying, *"The water contained in soil (soil moisture) is essential to plants ability to produce food for itself. Therefore, it is important that we understand soil moisture conditions around the world if we are to predict the overall health of plants, particularly as it relates to agricultural practices. Over the past few decades NASA satellites have been measuring the soil moisture around the globe from space!"*

Part 2 - Present Drought Conditions (30 minutes)

Refer to Part 2 slides included in the Measuring Soil Moisture From Space PPT. See PPT presenter notes for additional information.

1. Introduce NASA satellites as tools to measure soil moisture among other parameters. Say, *"NASA has many satellites in space that measure a variety of parameters including air temperature, carbon dioxide, sea level, soil moistures among many others. The two satellites we'll focus on today are the SMAP and GRACE, both of which measure soil moisture around the Globe. The SMAP satellite is very effective at measuring the moisture at the surface (surface soil) and the GRACE satellite is used to measure soil moisture at greater depths."*
    a. Watch the SMAP and GRACE satellite videos as a whole class.

4. Students explore the SMAP and GRACE satellites using NASA's "Satellites Now" page.

5. Students should use NASA's "Satellites Now" page to observe and record soil moisture measurements in their area.

Part 3 - Present Soil Moisture Conditions (30 minutes)

Refer to Part 3 slides included in the Measuring Soil Moisture From Space PPT. See PPT presenter notes for additional information.

1. Students use NASA's "Groundwater and Soil Moisture Conditions from GRACE" webpage to describe soil moisture conditions at different soil depths (surface, root zone, groundwater) based on measurements from the GRACE satellite.
    a. Facilitate a discussion in which students reference evidence from GRACE to evaluate soil moisture conditions in their community.

2. Facilitate a discussion focused on Part 3, Question 4 from the student worksheet, "Why is it important that we observe and keep track of soil moisture conditions over time?"
    a. Answer: Scientists can identify patterns/trends in soil moisture conditions.

3. Refer to the Measuring Soil Moisture From Space PPT (slides #11-13) and have students work in pairs to analyze and interpret graphs showing global change in soil moisture by cover type (agriculture, forest, grassland, shrubland, sparse vegetation, and urban area).
    a. Facilitate a discussion in which students share any/all patterns observed

4. Reinforce the take home points from Part 3:
    a. Plants need water to make food for themselves (photosynthesis).
    b. Over the past 40 years, the soil moisture has decreased across most land cover types around the globe.

5. Have students discuss the following prompt, "Why do you think global soil moisture conditions have decreased (drying trend) over the past 4 decades?" with their shoulder partner.
    a. Students share their ideas with the whole class. Option to create a whole class list.

Part 4 - Update Summary Table (10 minutes)

Refer to Part 4 slides included in the Measuring Soil Moisture From Space PPT. See PPT presenter notes for additional information.

1. Students work in groups to reflect on their learning and how it relates back to the unit driving question, "How do landscapes recover after a wildfire?"

2. Facilitate a discussion in which students come to a consensus about what they learned and how it helps them understand the unit driving question. Ideas/concepts agreed upon by the class should be included in the whole class summary table (see Answer Key).
    a. Students record new summary table entries onto their own summary tables.