COMPUTATIONAL THINKING & ENGINEERING JOURNAL

Unit One **Mitigating the Effects of Natural Hazards**

CODING FOR CLIMATE ACTION

Name	
Date	

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MakeCode https://makecode.microbit.org

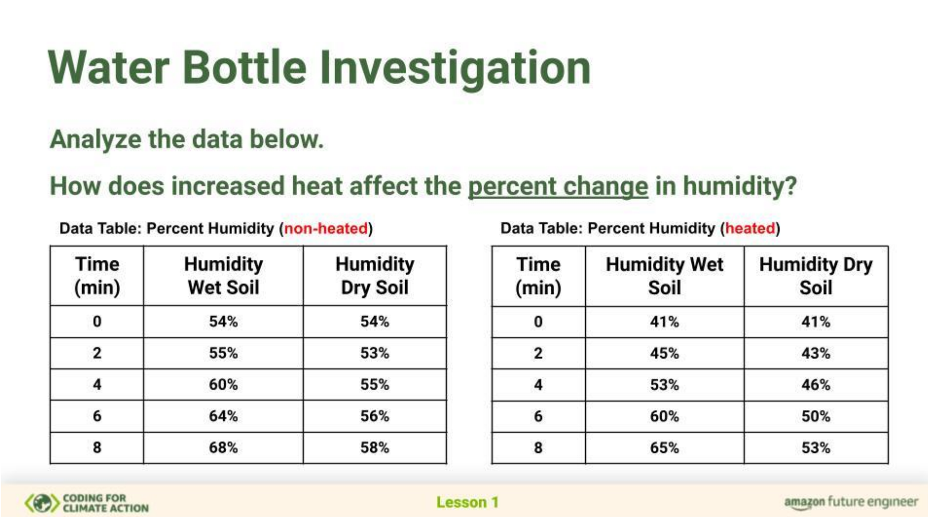
Lesson 1 **Define the Problem**

How has the impact of natural hazards on human populations changed between 1970 - 2022?

Introduce the Problem:
Write down what you notice and wonder as you watch the BBC News Report clip (1:09 - 2:38 mins)

I Notice….	I Wonder….
•	•

Investigate the problem
Analyze the data below and answer the questions to the right.



Water Bottle Investigation

Analyze the data below.

How does increased heat affect the percent change in humidity?

Data Table: Percent Humidity (non-heated)

Time (min)	Humidity Wet Soil	Humidity Dry Soil
0	54%	54%
2	55%	53%
4	60%	55%
6	64%	56%
8	68%	58%

Data Table: Percent Humidity (heated)

Time (min)	Humidity Wet Soil	Humidity Dry Soil
0	41%	41%
2	45%	43%
4	53%	46%
6	60%	50%
8	65%	53%

CODING FOR CLIMATE ACTION Lesson 1 amazon future engineer

Link to Data Tables

How does increased heat affect evaporation and the percent change in humidity?

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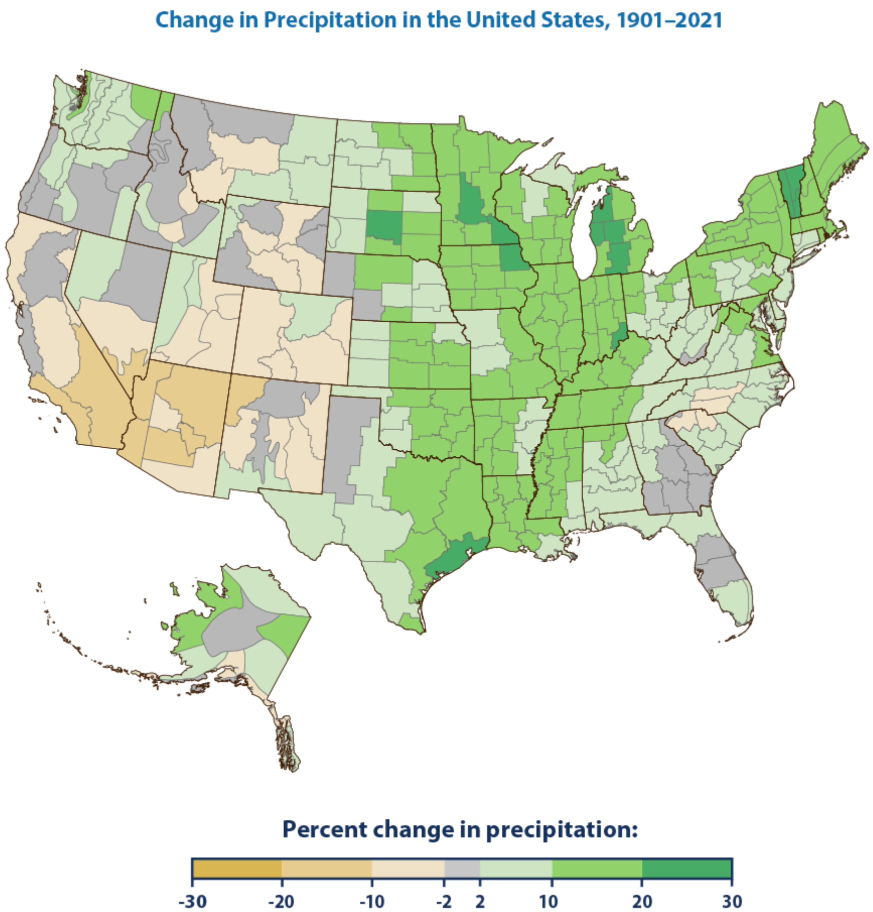
<tr><td rowspan="2">

Source: [NOAA, 2022]</td><td>How can you use the data from the bottles to explain how drier areas could experience more natural hazards that involve too little rain?</td></tr>
<tr><td>How can you use the data from the bottles to explain how wetter areas could experience more natural hazards that involve too much rain?</td></tr>
</table>

Define the Problem:
Use the key vocabulary terms to answer the questions below in order to help define the problem we are trying to solve in this unit.

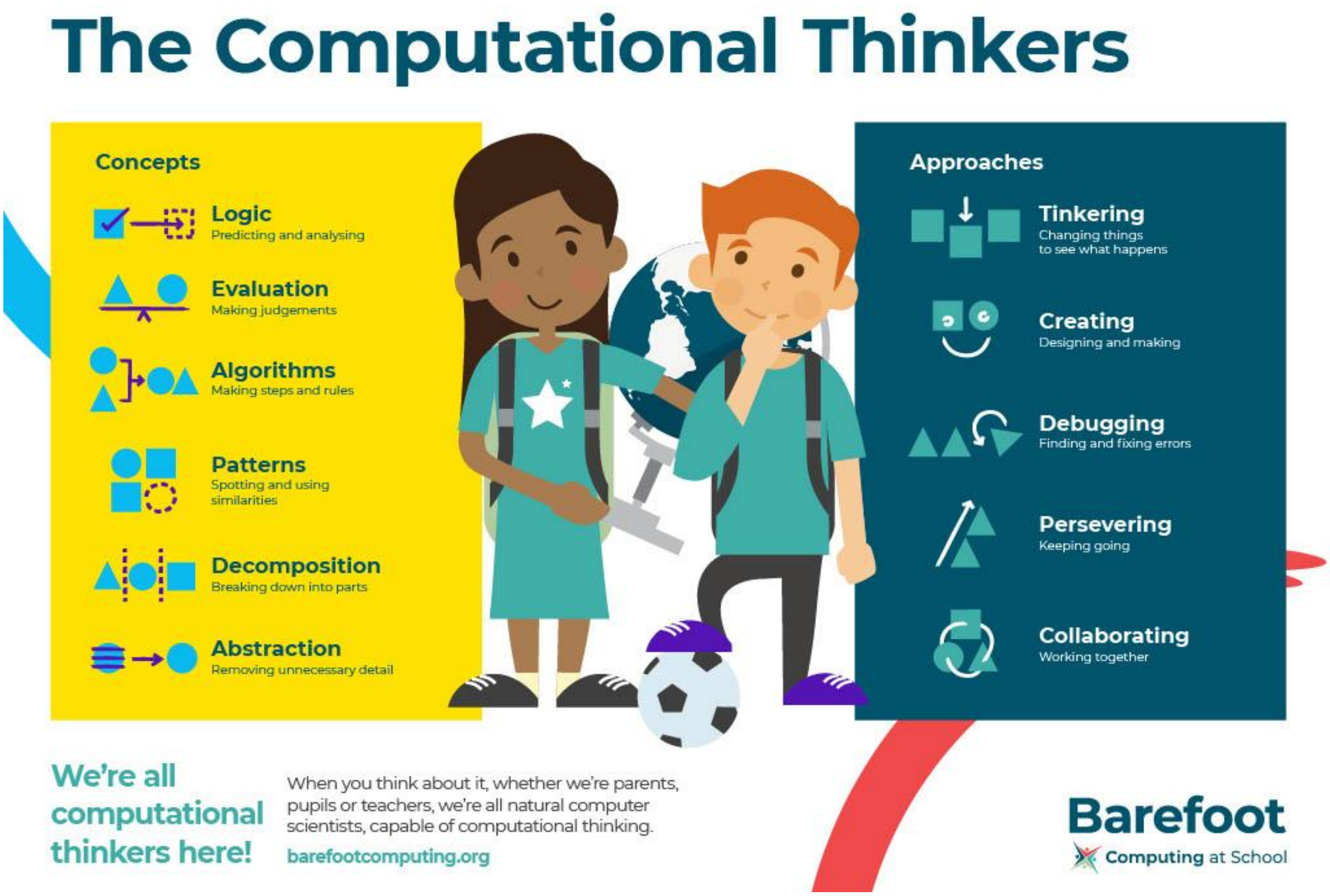
Key Vocabulary:

- ☐ **Natural Hazard:** a naturally occurring event that might have a negative impact on humans, wildlife, or the environment.
- ☐ **Mitigate:** to make less severe or less harmful
- ☐ **Precipitation:** rain, snow, sleet, or hail that falls to the ground
- ☐ **Humidity:** the amount of water vapor in the air (high humidity = a lot of water vapor!)
- ☐ **Water Vapor:** water in the form of gas found in the air
- ☐ **Early Warning System (EWS):** a technology system that monitors for natural hazards and sends communication to help communities prepare
- ☐ **Resilient:** able to withstand or recover quickly from difficult conditions

How has the impact on humans by climate related natural hazards changed between 1970 - 2022? Why?	
What are some things you learned about existing Early Warning Systems (EWS)?	
How can we use technology to design a solution to help increase community resilience and mitigate the effects of natural hazards?	

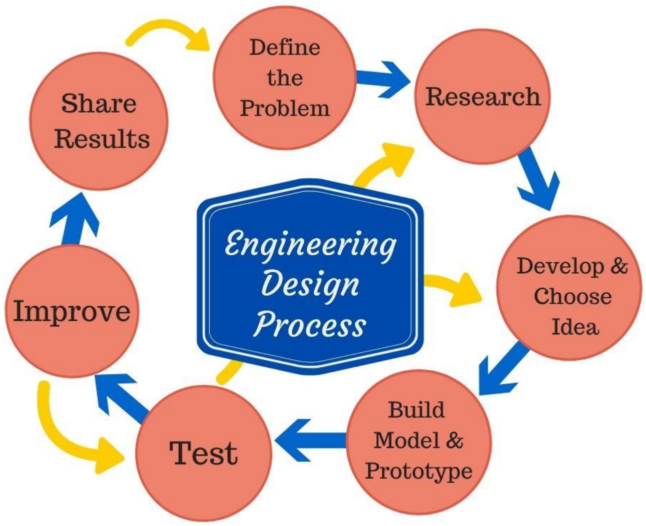
Lesson 2 **Researching Existing Solutions**

What types of EWSs already exist?



Computational thinking is the way to break down a problem into simple enough steps that even a computer would understand. When a technology device is designed to do something, computer programmers write a set of instructions to tell the technology or computer how to perform a task. In this unit, you will use your scientific knowledge to help you design a technology device to help reach the UN Sustainable Development Goal #11: Take urgent action to mitigate the effects of climate change and its impacts!

To reach this goal, you will act as computer programmers and engineers to design an Early Warning System (EWS).



The engineering design process is a series of steps used by engineers to help guide the development of a design solution. The blue arrows show the flow of steps, but often steps need to be revisited when things do not go as intended!

In this journal, you will reflect on how you are using computational thinking as well as sharing the steps of your engineering design process.

Research the Problem:
Take notes during the slideshow or click on the links for each Early Warning System to complete the table below.

Type of EWS	Parts of System	Function of Parts
Tepmachcha Stream Gauge Flood Warning System		
Grillo: Low-Cost Earthquake Early Warning System		
Bosch Wildfire Early Warning System		

<table>
<tr><td colspan="2">Reflect on the Problem:
Use the key vocabulary terms to reflect on what we learned today.</td></tr>
<tr><td colspan="2">Key Vocabulary:
☐ <u>Computational Thinking:</u> A problem solving process that computer programmers use that include a number of concepts and approaches.
☐ <u>Computer Programmers:</u> The people who write, modify and test code that allow computer software to function properly.
☐ <u>Engineering Design Process:</u> A series of steps that engineers use to solve a problem.
☐ <u>Engineers:</u> The people who design, build and maintain the machine or hardware.</td></tr>
<tr><td>Computational Thinking Concept: Patterns
What are some of the common parts and functions of the EWSs?</td><td></td></tr>
<tr><td>Engineering Design: Improve
How might you improve any of the EWSs you researched?</td><td></td></tr>
</table>

Lesson 3 **Researching micro:bit Inputs and Outputs**

How could we use the micro:bit to design an early warning system and increase accessibility?

Real World Example:
Read the article and list your questions below.

New Flood Alert System Installed

June 16, 2022

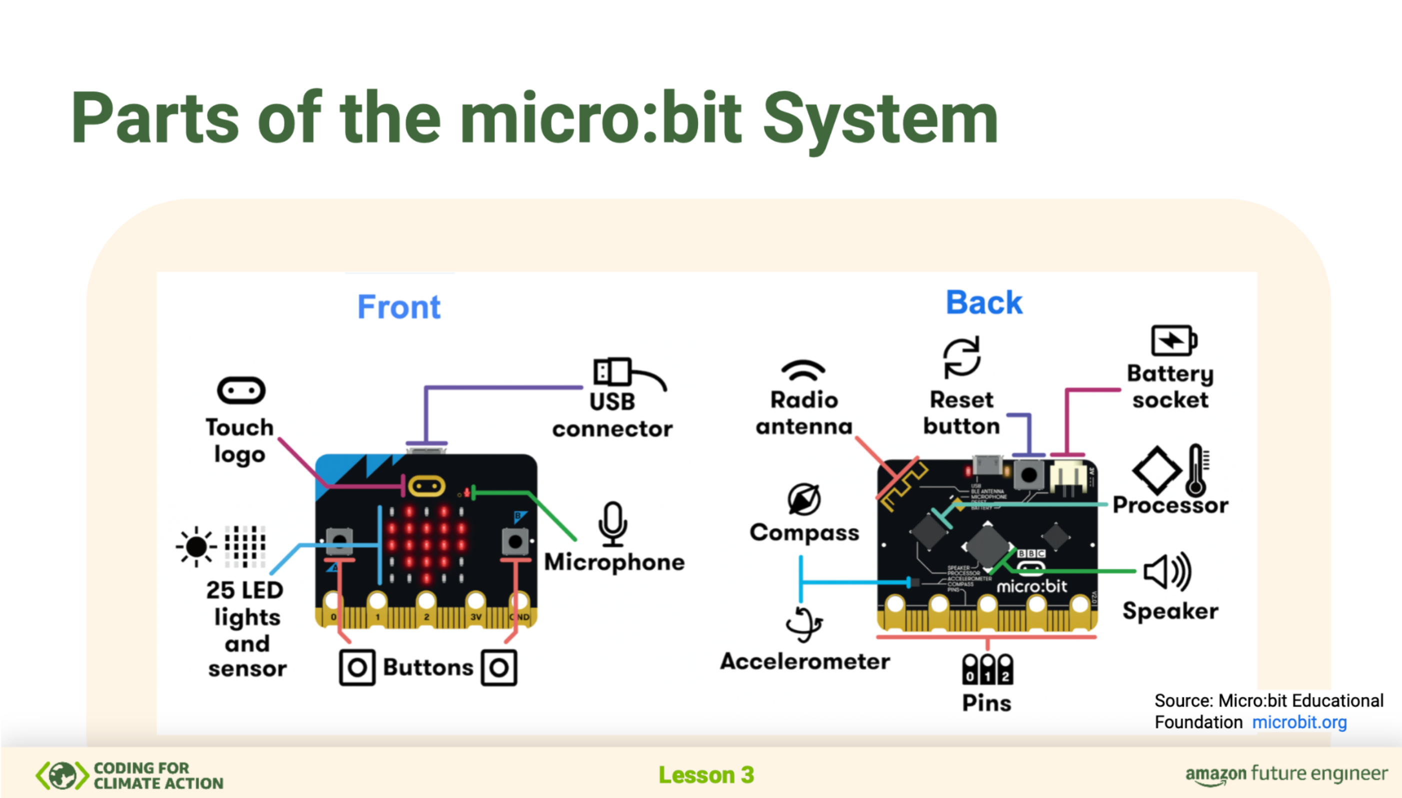
A new flood notification system to alert motorists about possible flood conditions was installed on a stretch of highway in New Jersey. The two-lane highway on County Route 542, which is also known as Pleasant Mills Road and Batsto-Bridgeport Road, runs near the Mullica River and is prone to flooding during severe storms.

More than 1,200 vehicles travel the road daily, according to an August 2019 traffic count. The alert system uses a flood gauge sensor installed on the riverbank. When water levels start to rise close to flood level, the sensor activates flashing amber lights attached to nearby "Road May Flood" signs to alert approaching motorists on the road of the possible flood danger.

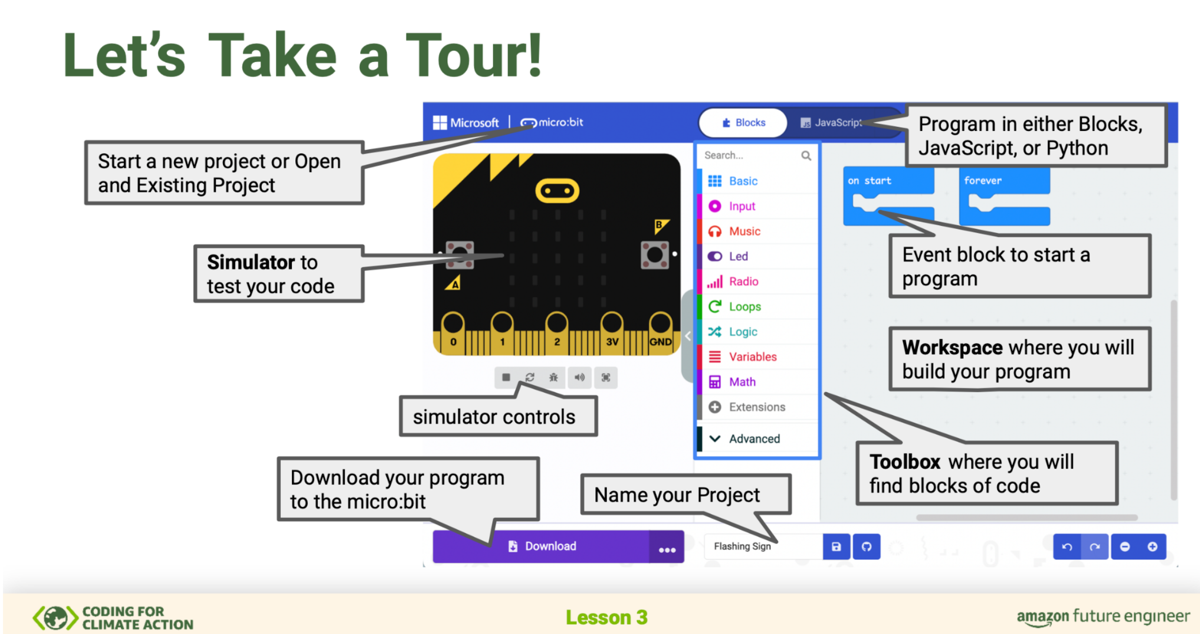
Burlington County Commissioner Deputy Director Tom Pullion said, "Flooding in this area and other parts of the county is not something we can control or prevent, but we've looked for ways to improve our response plans for when it does occur."

What questions do you have?

Research the Problem:



MakeCode Computer Programming Environment
https://makecode.microbit.org



Reflect on the Problem:
Use the key vocabulary terms to reflect on what we learned today.

Key Vocabulary

- ☐ **System:** Something that is made up of parts that work together to perform a function.
- ☐ **Hardware:** Any element of a technology system that is physical (stuff you can touch).
- ☐ **Software:** A set of instructions, data or programs that tell a computer how to work.
- ☐ **Event:** An action or occurrence detected by a computer program.
- ☐ **Loop:** Type of code that repeats a set of commands until told to stop.
- ☐ **Accessibility:** The "ability to access" and benefit from the flashing sign system you have designed.
- ☐ **Inputs:** Data or information sent to the micro:bit (or a computer) for processing.
- ☐ **Outputs:** Data or actions performed by the microbit (or a computer) after processing.
- ☐ **Processor:** Hardware that does the "thinking" for a computer.
- ☐ **Algorithm:** A set of directions or rules that the computer follows.

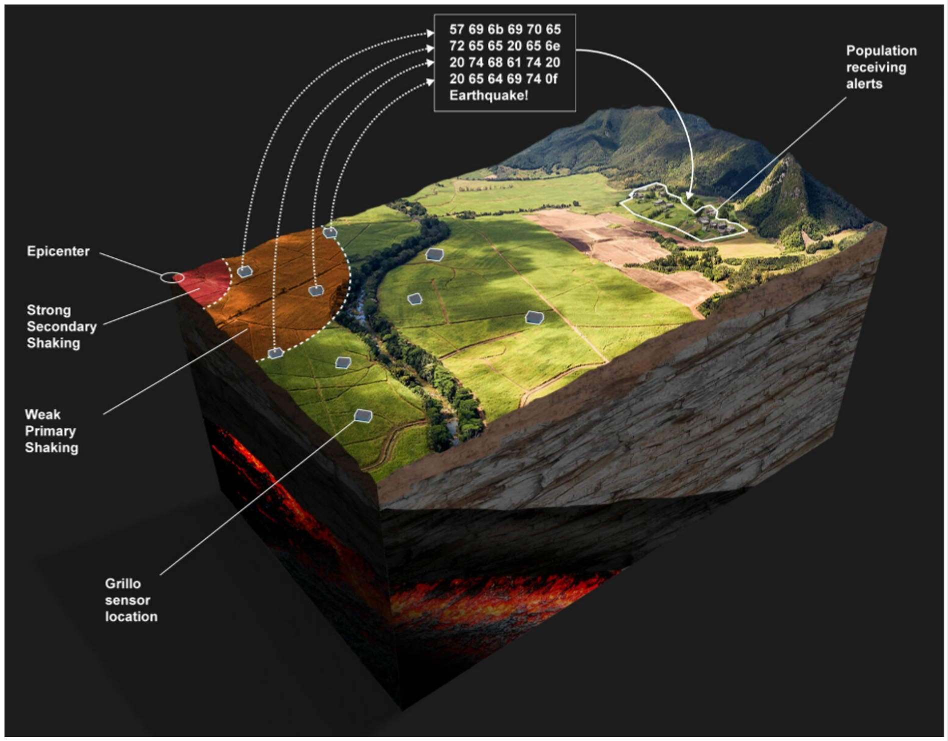
	Pros	Cons
Thinking about accessibility of the flashing sign, what are the pros and cons of each type of **output?**	**LED Lights:** • **Sound:** •	**LED Lights:** • **Sound:** •
Computational Thinking Concept: Algorithms Explain what your algorithm is telling the micro:bit to do and any problems you encountered.		
Share Link to Code:		

Lesson 4 **Researching micro:bit Sensors**

How can we build a system that continually monitors the environment to detect danger and warn communities?

Real World Example:
Read the article and list your questions below.

Grillo- Low-Cost Earthquake Early Warning System on AWS



Grillo developed a low-cost EEW system using sensors that are placed in buildings near seismically active zones. Grillo sensors cost approximately $300 USD, compared to the traditional seismometers that cost around $10,000 USD. Because of these inexpensive sensors, Grillo can offer a higher density of sensors, which reduces the time needed to issue an alert and gives people more time for action. This benefits the population because higher density increases the accuracy of the location detection, reduces false positives, and reduces times to alert.

What questions do you have?

Research the Problem:
Use the values below for coding each sensor.

Sensor functions and Values:		
Type of Sensor	**Function**	**Value Range**
Light Sensor	Measures brightness of light	0 to 225
Temperature Sensor	Measures temperature	-5℃ to 50℃
Compass	Measures magnetic fields	0°to 360° (must be calibrated)
Sound	Measures sound levels (with the microphone)	0 to 225
Accelerometer	Measures motion using gravity on x, y, z axis	When the micro:bit is lying flat on a surface with the screen pointing up, x is 0, y is 0, z is -1023, and strength is 1023

Reflect on the Problem: Use the key vocabulary terms to reflect on what we learned today.	
Key Vocabulary ☐ **Sensor:** Hardware that takes in information from the environment and triggers a response. ☐ **Debugging:** Finding and fixing problems in an algorithm or program. ☐ **Variables:** a placeholder for a piece of information that can be stored and changed in a computer. ☐ **Logic:** A type of code that is used to answer if certain conditions are met. ☐ **Conditionals:** code that only runs under certain conditions. ☐ **Accelerometer:** Sensor that uses gravity to sense when there is movement.	
EWS Design: Name three sensors we used in this lesson. How might each sensor monitor a natural hazard below? Natural Hazards: Wildfire, Drought, Flooding, Hurricane, Heat Wave, Typhoon, Tropical Cyclone	
Are there any natural hazards that would be **difficult to monitor** using micro:bit sensors? Why?	
Computational Thinking Concept: Decomposition How does breaking down the problem into parts like inputs and outputs help you solve the problem?	
Share Link to Code:	

Lesson 5 **Researching micro:bit Pins**

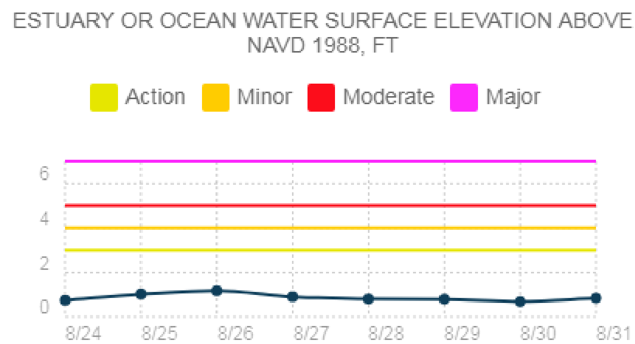
How can we measure water levels in the environment using the micro:bit?

Real World Example:
Read the article and list your questions below.

StormSense: Automated Flood Alerts

StormSense is an Early Warning System that uses over 40 sensors in the CIties of Virginia Beach (VA), Newport News (VA), and Norfolk (VA) to monitor water surface levels.

The 36-hour tidal forecasts are updated hourly and include storm surge guidance to warn communities of flooding due to increased water levels during storms. The StormSense system has been developed on the Amazon Web Services (AWS) Cloud. This provides users with access to flood-related information. This includes regularly updated interactive web maps that show StormSense's real time water levels, which are updated every six minutes. The data collected helps provide a clear picture of where flooding is happening and where it is likely to happen.



This low-cost flood monitoring solution is now being used in other communities as well and was a winner of Amazon Web Services City on a Cloud Innovation Challenge in 2017.

What questions do you have?

Reflect on the Problem: Use the key vocabulary terms to reflect on what we learned today.	
Key vocabulary: ☐ **Electric circuit:** A pathway for transmitting electricity. ☐ **Closed circuit:** Allows electricity to flow in a loop through the inputs and outputs (turns on!). ☐ **Open circuit:** Breaks the pathway and electricity is not able to flow (turns off!). ☐ **Conductor:** Type of material that passes electricity. ☐ **Insulator:** Type of material that blocks electricity.	
EWS Design: How might pins be used to monitor natural hazards?	
EWS Design: What do we still need the micro:bit to do to build an EWS?	
Computational Thinking Concept: Evaluation How can you tell whether or not your algorithm using pins worked?	
Share Link to Code:	

Lesson 6 **Researching micro:bit Radios**

How can we use live data to trigger an alert and broadcast a message to the community that the hazard is coming?

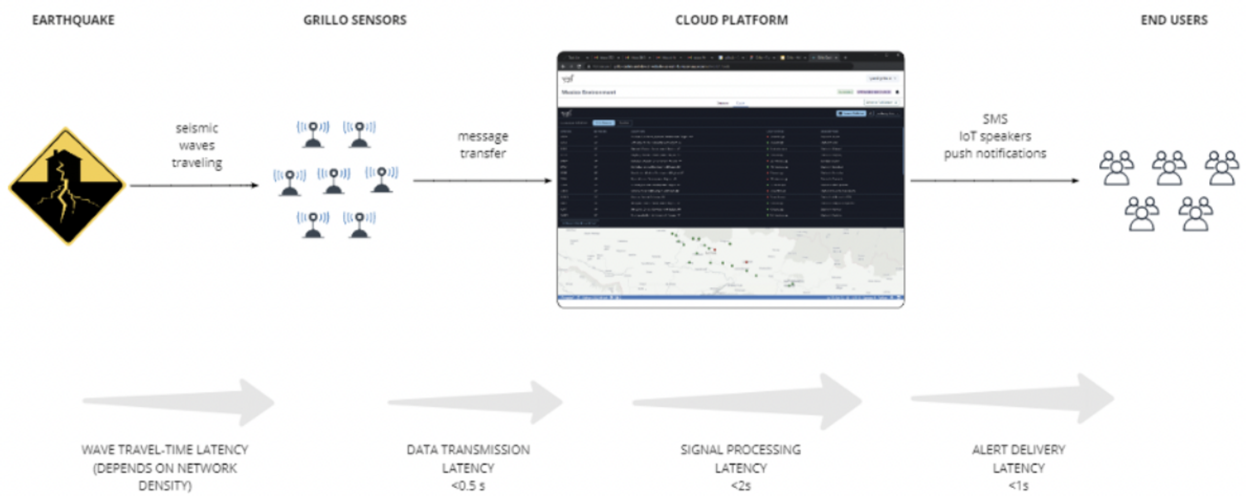
Real World Example:

Read the article and list your questions below.

Grillo- Low-Cost Earthquake Early Warning System on AWS

Let's take another look at the low-cost Grillo EWS that detects earthquakes using multiple sensors and sends warning alerts to a nearby community. Open the article to take a closer look at the model shown above. Notice the flow of information from the detection of the shaking ground to the alert notifications sent to people.

The Grillo sensors detect ground movement from seismic waves and then send this live data to a cloud platform. The cloud platform is a server or location that processes all the live data collected from the sensors and pushes out a notification to the people in the community when danger is detected. All of this happens in less than one second!



What questions do you have?

Reflect on the Problem: Use the key vocabulary terms to reflect on what we learned today.	
Key vocabulary: ☐ **Radio waves:** the largest type of wave found on the electromagnetic spectrum. They can be used to send messages over long distances through the air. ☐ **Antenna:** hardware that sends and receives radio waves	
EWS Design: Why do EWS use broadcasting? How does this improve the system?	
Computational Thinking Concept: Abstraction What big ideas can you take away from solving the radio broadcasting design challenges in this lesson and apply towards your early warning system engineering design problem?	
Share Link to Code:	

Lesson 7 **Researching a Location for your EWS**

What is the history of natural hazards in the area chosen for the EWS design solution?

Research a Location for your Early Warning System: Answer the following questions as you research the chosen location for your early warning system design solution using the **Lesson 7: Student Research Packet**	
1. What location have you chosen?	
2. Describe the history of natural hazards in this area.	
3. How has the risk of this natural hazard(s) changed overtime? What is causing this change? Use data to back up your answer.	
4. What type of early warning systems already exist in this area and how do they work?	
5.**Computational Thinking Concept: Logic** What information about your chosen area can be used to make a prediction about the type of sensor you will use in your EWS design?	

Lesson 8 **Designing and Building Your EWS**

How can we use computational thinking approaches to help build our EWS design solution?

Design Decisions:
What hardware and software will you need to include in your design?

Lesson	Hardware (micro:bit components)	Software (types of code)
3: Flashing Sign	Input (buttons) & Outputs (LEDs, speaker)	Basic Blocks (forever loops) Input Blocks (button pressed events), Music Blocks Algorithms (sequences of code)
4: Monitoring the Environment	Input Sensors (accelerometer, light, temperature)	Variables: placeholder for code that changes Logic: conditionals (if, then, else statements) & comparison blocks
5: Measuring Water Levels	Input Pins, Crocodile Clips, Conductors (creating electric circuits)	Input Blocks (Pins)
6: Broadcasting Messages	Radio (antennae to send and receive messages)	Radio Blocks (sending & receiving)

Part 1: Design your Early Warning System Answer the following questions after you have designed your system.	
What will your EWS do? Draw a model that shows how your system works. **Include Hardware:** ● Inputs ● Sensors ● Outputs **Include Software:** ● Information Flow (arrows) ● Types of Code **Show how your design reduces human vulnerability (risk) to natural hazards in your chosen area?** (Tip: Use a speech bubble!) Insert an image of your model to the right.	
Accessibility: How does your EWS address accessibility?	
Optional- How does your system improve on something that already exists?	
Did you start coding? If so, provide a link to your code.	

Part 2: Building Your EWS Design Solution Answer the following questions after you have built your system.	
Take a picture or video of your working prototype and insert to the right.	
Is your code working as you planned? Why or why not?	
ScreenShots or Links to Code:	
Computational Thinking Approach: Persevering What problems did you have with your EWS design and how did you try to overcome them?	

Lesson 9 **Sharing Your Design Solution**

How will you present your design solution to the class?

Sharing the Results of your Early Warning Systems Answer the following questions while listening to others present their design solutions.	
Learning from Others: List good ideas you heard while others presented their EWS designs.	
Improvement: If you had more time and resources, how would you improve your EWS?	

Final Project: **EWS Design Solution Rubric**

See the rubric here.

Suggestions for Improvement	Criteria and Artifact Description	Evidence that the Group met the Criterion
	SCIENCE IDEAS (Found in Computational Thinking and Engineering Journals)	
	Lesson 1: Define the Problem Students explained using data how increased global temperatures have increased climate related natural hazards.	
	Lesson 7: Researching a Location for Your EWS Students used patterns in data to describe the history of natural hazards in an area and what could cause human vulnerability to future natural hazards in that area.	
	COMPUTER SCIENCE IDEAS (Found in Computational Thinking and Engineering Journals)	
	Lesson 8: Design Your Early Warning System (Part 1) Students created a model to explain the hardware (sensors, crocodile clips, radio) and software components (inputs, outputs, flow of information) of their EWS design solution to reduce human vulnerability to a natural hazard.	
	Lesson 8: Build Your Early Warning System (Part 2) Students built a prototype of their early warning system and tested the code to improve functionality.	
	INTEGRATION OF SCIENCE, ENGINEERING, AND COMPUTER SCIENCE IDEAS (Shared in Final Presentation)	
	Lesson 9: Sharing Your Design Solution ● Students shared how they used science (understanding of natural hazards in their chosen area), engineering (models and prototypes) and computer science (software and hardware) to construct their EWS design solutions. ● Students shared how their EWS addressed accessibility. ● Students shared how they would improve their EWS design if they had more time.	