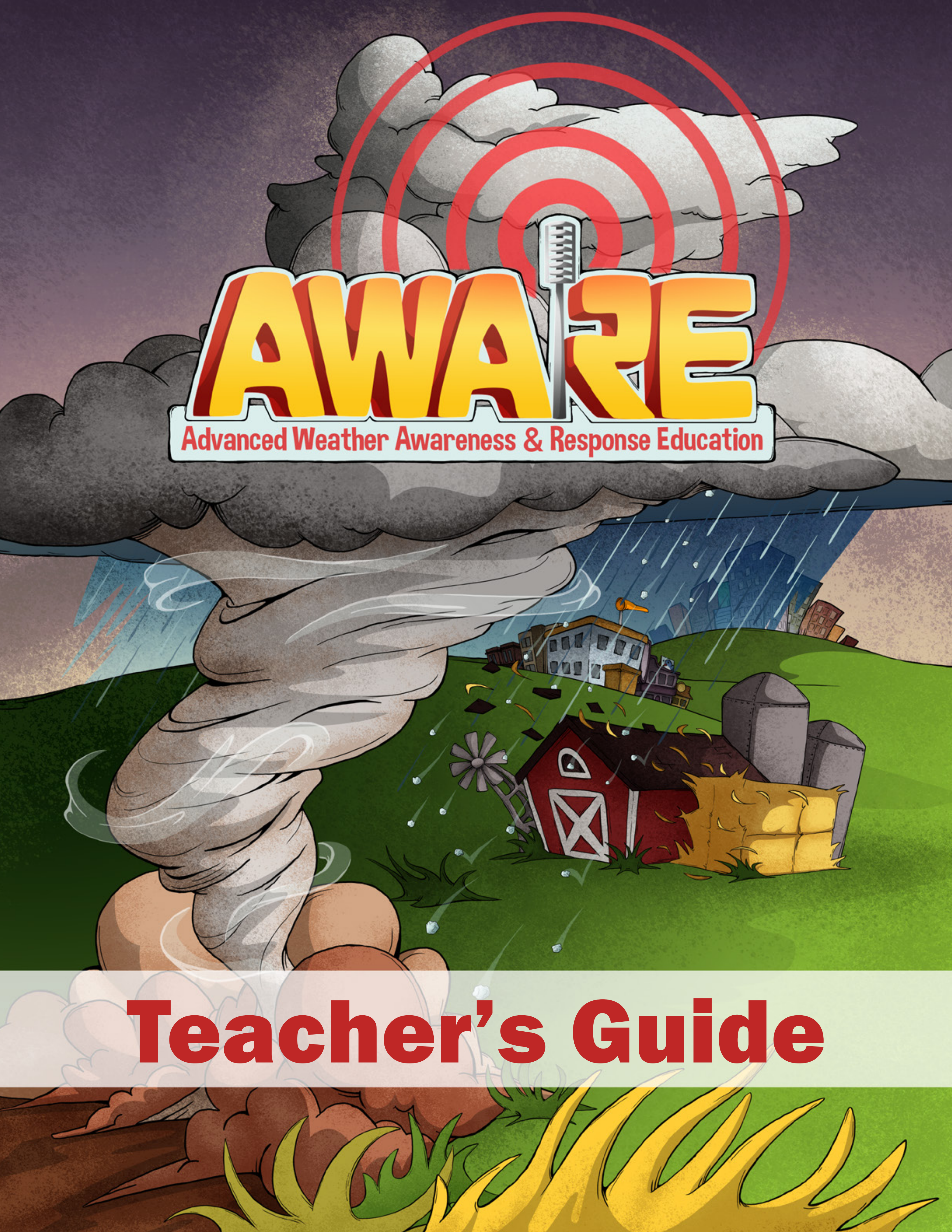

AWARE

Advanced Weather Awareness & Response Education

Teacher's Guide

About K20 Center and GBL

The K20 Center for Educational and Community Renewal is a statewide education research and development center that promotes innovative learning through school-university-community collaborations. The K20 Center's mission is to cultivate a collaborative network engaged in research and outreach that creates and sustains innovation and transformation through leadership development, shared learning, and authentic technology integration.

The K20 Center's Game-Based Learning team designs and develops engaging, research-based, interactive learning experiences for a variety of audiences.

AWARE (Advanced Weather Awareness and Response Education) is funded through a GEAR UP (Gaining Early Awareness and Readiness for Undergraduate Programs) grant sponsored by the U.S. Department of Education, which was awarded to the K20 Center in 2018.

The purpose of this guide is to support integrating *AWARE* into your classroom as an effective tool to enhance awareness of severe weather and STEM careers. This guide provides an overview of the game's objectives, narrative, and mechanics.

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About the Game

Purpose

AWARE (Advanced Weather Awareness and Response Education) is a game-based learning application that aims to teach severe weather and STEM career awareness to middle and high school students.

Common misconceptions about severe weather include "natural disasters are chaotic events that cannot be predicted," and "human activity does not affect the susceptibility of a region to the impacts of a natural catastrophe" (California Department of Education, June 2019).

AWARE addresses these incorrect assumptions by granting the student a dynamic role and providing opportunities for them to make decisions concerning the welfare of citizens in a fictional region.

By interacting with authentic, in-game representations of tools and data streams, the student gains an understanding of weather-based systems, which they can apply to the real world.

About the Game

Learning Objectives

By the time the student completes *AWARE*, they will be able to accomplish the following objectives:

	Objective	Game Mechanic
1	Given scaffolded data and information, the student can interpret that data to **make predictions** about possible **natural hazard events.**	The student will be presented with authentic weather maps. By interpreting the data from these maps, the student can make predictions about upcoming natural hazard events. These predictions can include the type of hazard and its location. Based on these predictions, the student can take mitigating actions.
2	Given an emergency scenario and a set of possible emergency management decisions, the student can balance the **economic** and **safety** repercussions of their decisions.	The student will be given a certain amount of money each era, which they can use to hire staff, upgrade technologies, expand research, and pay for hazard damage. The student will be evaluated on their ability to effectively use their budget to mitigate hazard damage and injuries.
3	The student can assess **technologies** and **strategies** that can be used to mitigate the damage caused by natural hazard events.	The student will be given a variety of options in the game, including hiring staff, researching technologies, and building emergency management structures. The student will assess these options to effectively mitigate natural hazard events.
4	The student can describe how different **STEM professions** contribute to the prediction and mitigation of natural hazard events.	The student will be exposed to diverse characters in the game who hold STEM roles. The student will also hire staff from various STEM professions who contribute to different aspects of emergency management.

About the Game

Standards

While *AWARE* was designed with Oklahoma students in mind, game content is applicable to extreme weather events that occur across the United States. To maximize *AWARE's* educational impact, the game's instructional objectives come from the Next Generation Science Standards (NGSS). The selected standards are identical in content to the equivalent Oklahoma Academic Standards for Science, differing only in visual formatting and numbering conventions. *AWARE* aligns most closely with the following Next Generation Science Standards:

MS-ESS3-2: Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.

Like Oklahoma, the California Assessment of Student Performance and Progress (CAASPP) provides guidelines for writing assessments of the target standards.

Sample assessment integration from CAASPP:

- Task provides two (or more) data sets from the same natural disaster:
  - Compares the information provided in each and describes a pattern between the location and/or frequency and/or severity of a natural disaster and the geologic features of the impacted region (4.2.1, ESS3.B.4, and CCC1)
- Task provides a map showing the location and severity of a class of natural disasters:
  - Identifies a pattern that a geographic feature of a region makes it more susceptible to that class of disaster than regions that do not have that geographic feature (4.2.2, ESS3.B.4, and CCC1)
- Task provides data on the frequency and severity of a certain class of natural disasters:
  - Applies concepts in probability and averages to demonstrate that a "one-in-a-hundred year" event means that the probability that an event of that magnitude will occur in a given year is 1%, but not that the event will occur exactly once per hundred years (4.2.3, ESS3.B.4, and CCC1)
  - Uses probability to determine if a proposed structure (rated to some level of severity event) is well suited to a region (4.2.3, ESS3.B.4, and CCC1)
- Task provides information from many natural disasters about the severity of the event and the time difference between when an alert about an impending disaster event was made to the citizens of a region and the time when the event occurred (if at all):
  - Identifies the limitations of using the relationship between severity and lead time to predict the event in advance (4.2.4, ESS3.B.4, and CCC1)

About the Game

Standards

HS-ESS3-1: Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.

Sample assessment integration from CAASPP:

- Task provides data on geologic factors particularly related to climate and the impact of climate change and data of human populations:
    - Uses the data as evidence to support an explanation of the impact of changes to climate on human migration (6.1.2, ESS3.A.4, and CCC2)
- Task provides a claim about the effect of a natural hazard or geologic event on human populations in conjunction with a data table:
    - Identifies (with reasoning) whether the provided data is sufficient to support the claim (6.2.1, ESS3.B.5, and CCC2)
- Task provides data on a given geologic factor that could affect human activity:
    - Uses data as evidence to support or refute an explanation for how that factor contributed to known changes in human activity (6.2.2, ESS3.B.5, and CCC2)

Playing the Game

Overview

AWARE consists of five eras that represent different historical time periods. Each era is divided into 10 turns and can be played in about **20 minutes.** The entire game can be completed in about **two hours**, or over the span of **two to three class periods**.

In *AWARE*, the student assumes the role of an emergency manager tasked with predicting and preparing for severe weather events. The student hires STEM professionals, researches new technologies, and builds structures throughout the region to mitigate natural hazard event damage.

AWARE includes instructional messages explaining the use of 13 different weather maps. The student is given opportunities to review these messages to reinforce their understanding of severe weather prediction and mitigation.

Winning the game is contingent on the student's Public Trust score, which measures citizens' belief in the student's ability to manage emergencies. The Public Trust score is directly tied to the learning objectives of the game: When the student takes correct actions, their Public Trust score increases. If the student makes poor decisions, their Public Trust score decreases.

> If the student's Public Trust score drops too low, the student will need to repeat the current era.

The student **wins the game** when they have successfully protected the region through the fifth era. Then, they have the option to quit or begin a new game from scratch.

Playing the Game

Tutorial

AWARE begins with a tutorial led by Wilma Hennings, one of the main characters. During the tutorial, large red arrows point to different elements. Buttons and panels glow with a bright yellow outline.

The student must click the glowing buttons to progress in the tutorial.

The governor introduces the student to the game and walks them through the main interface. She points out the budget, map, and overlays. She also explains the Research, Staff, and Build menus, and she demonstrates the process of hiring staff and researching technologies to build structures.

The student is then given the opportunity to hire staff, research technologies, and build structures before ending their first turn.

The tutorial continues in the second turn, where the governor explains the State of AWAREness screen and map modes. She also walks the student through a sample instructional message.

Playing the Game

Characters

AWARE includes a diverse cast of characters with different roles. Some characters present game rules and menus. Others explain maps, tools, and instructional dialog. Characters also provide feedback after natural hazard events and at the ends of eras.

The **governor** introduces the student to the game and walks them through the main interface.

Wilma Hennings presides over the region, ensuring its citizens are safe and that everything is running smoothly. When a slew of severe weather strikes the area, she decides to hire an emergency manager. She pops up occasionally to exchange witty banter with Madison, the meteorologist. The two are great friends!

The **treasurer** keeps track of the student's finances throughout the game. He appears on the End of Era screen, where he details the cost of hazard damages and provides advice for the next era.

Mr. Jenkins is somewhat stuck in his ways. A realist, he prefers playing it safe rather than embracing new technologies. When the governor decides to hire an emergency manager, he begrudgingly accepts his new role in this adventure.

The **meteorologist** guides students through maps, simulations, and instructional content.

Madison Monzón loves a challenge! Her lifelong enthusiasm for natural hazards landed her a job as a weather scientist. Madison is aware of the severe weather occurring throughout the region and convinced the governor to hire an emergency manager. Madison's knowledge and resourcefulness make her an indispensable companion!

The **EMS administrator** appears during questions above the State of AWAREness screen, as well as during instructional dialog. He sometimes asks students where to issue alerts.

Earl Eagleton manages a team of firefighters and other safety personnel who are trained in fighting wildfires and administering medical support. Earl's friendly nature, sense of humor, and passion for what he does make other people feel at ease.

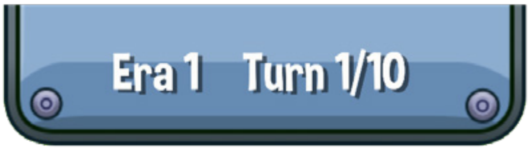
The **structural engineer** guides the student through a variety of emergency situations dealing mainly with floods and city infrastructure.

Sofía Stillwater is a no-nonsense problem solver with a knack for finding solutions. She hopes that she will be able to defer some of her team's responsibilities to the student. From redirecting water to sandbagging flood-prone areas, Sofía shows the student the ropes of emergency management.

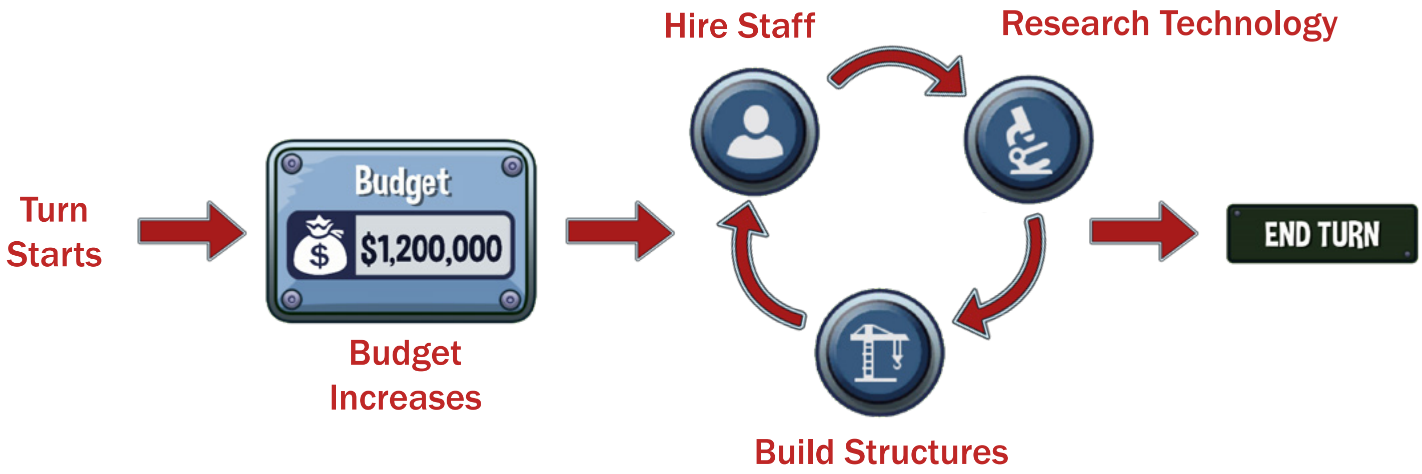
Playing the Game

Eras and Turns

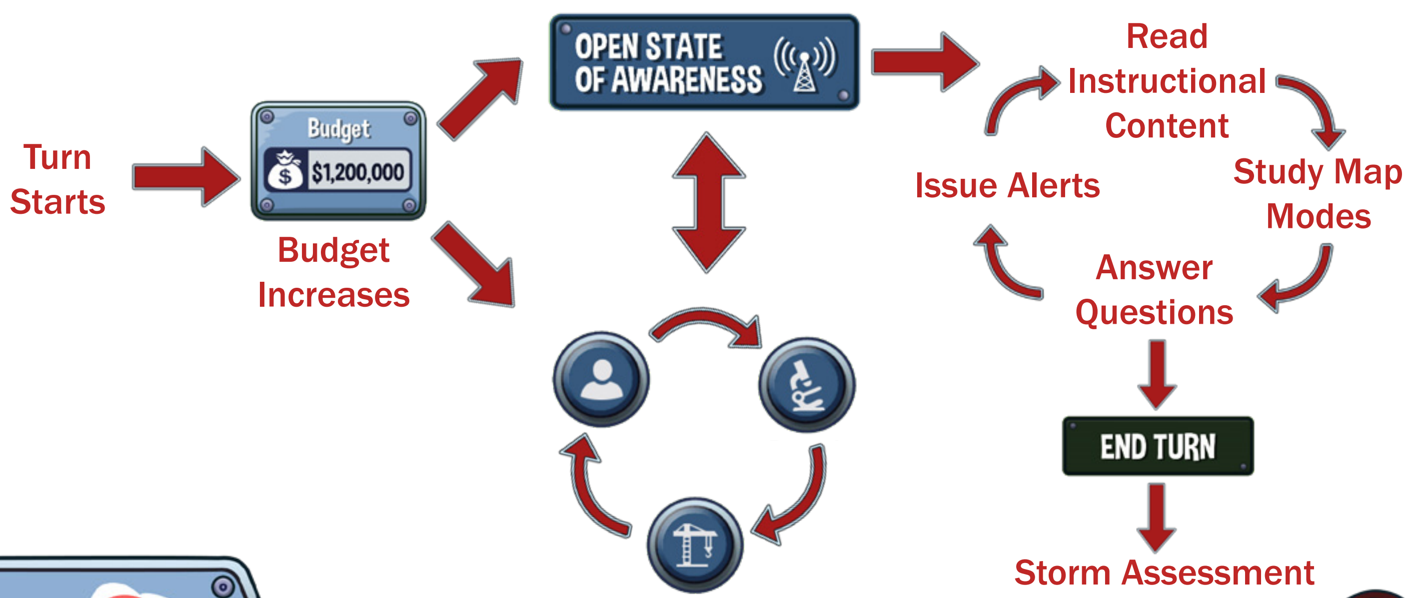
AWARE is divided into **five eras**, each with **10 turns**.



The student receives a certain amount of money at the start of each turn, which they use to hire staff, build structures, and research technologies. The student receives more money with each successive era.



On turns before natural hazard events, the student can access the State of AWAREness screen, where they view instructional content, answer questions, and issue alerts.



Playing the Game

Natural Hazard Events

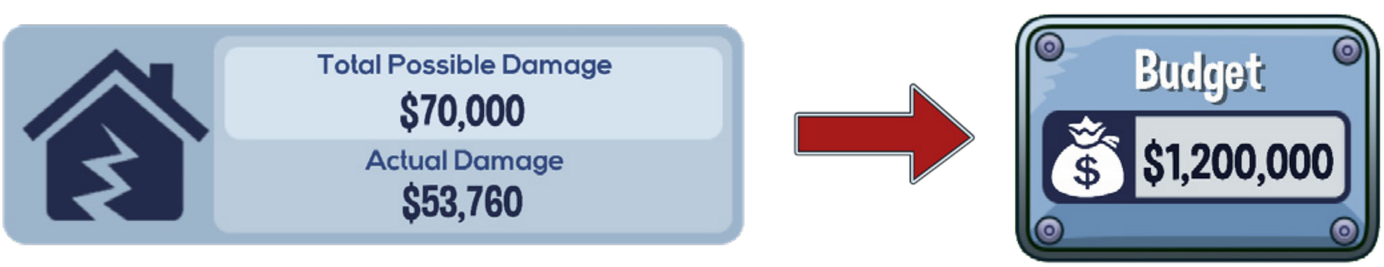
Natural hazard events occur between some of the turns. The student encounters four different hazard types in *AWARE:*

HAIL   TORNADO   WILDFIRE   FLOOD

Each hazard occurs in a specific city or area on the map. Some hazards are small and produce few injuries, while some are more destructive and cover a much wider range. Sometimes, a hazard may not be a hazard at all, but rather a false alert intended to test the student's comprehension.

> **TIP:** Warn students that hazards become more dangerous and unpredictable in later eras. Balancing the budget and managing resources will become even more important as time goes on.

The student will need to set aside money to pay for **damage** after natural hazard events. After each hazard, a summary screen displays the total cost of damage incurred. The cost is then deducted from the student's budget.



> **TIP:** Damage is expensive! Failing to save for hazard aftermath can cause the student's budget to go negative, which decreases their Public Trust score. The student may be tempted to spend all their money on structures and research, but it is important to save for relief efforts. On the other hand, hoarding unused funds can also have a negative effect on the Public Trust score.

Playing the Game

Assessment

A **summary** screen appears immediately after each natural hazard event.

This screen summarizes the cost of damages and the number of injuries incurred. It also depicts the student's updated Public Trust score. On the left side of the screen is a zoomed-in image of where the hazard occurred on the map.

The student uses this information to evaluate their current strategies and make adjustments for future hazards.

Sofía, the structural engineer, summarizes the cost of hazard damage.

Earl, the EMS administrator, describes the number of injuries.

Mr. Jenkins, the treasurer, discusses the student's budget.

The **End of Era** screen appears at the end of each era, providing the student with feedback on their overall performance.

This screen displays detailed information on hazard damage, injuries, and the Public Trust score.

The student uses this information to evaluate their current strategies and make adjustments for future eras.

Earl provides detailed information on injuries and advice for how the student can improve.

Sofía explains hazard damage and provides tips on research and structures.

Since starting an era with negative funds can be a serious detriment to the student, negative budget balances do not carry over.

If the student happened to end the era with a negative budget, their budget will reset to zero at the start of the following era.

User Interface

Map and Overlays

1 **Map**: This is the region the student oversees.

City names, buildings, and map overlays change each era.

2 **Map Overlays**: These buttons relay different information through various colors, shapes, and symbols. The overlays are designed for color blindness accessibility. The student can toggle between them.

3 **Era and Turn**: The current era and turn of the game.

4 **Options**: The student can adjust music volume or return to the main menu at any time.

5 **Budget**: The student's current funds. The student gets a certain amount of money each turn, depending on the era.

TIP: Remind students that the map overlays change each era. Students should regularly review these tabs to ensure they are building structures in areas that need them most.

User Interface

Map and Overlays

6 **Public Trust**: A measure of citizens' belief in the student's ability to manage emergencies. It is depicted graphically on a scale. If the pointer drops all the way to the left, the student will need to repeat the current era.

The student's Public Trust score resets to the middle at the beginning of each era.

Selecting correct answers to questions, building appropriate structures, and issuing alerts in the proper places will all positively impact the student's Public Trust score. Conversely, incorrect answers, poor budget management, and failed mitigation techniques will negatively impact this score.

7 **Skills**: This panel summarizes the current skill levels for the staff in each category. Each category has an associated symbol. The student can increase their skills by hiring staff and researching technologies.

User Interface

Map and Overlays

Flood: Displays flood-prone areas. Red areas signify heavy flooding. The student should build storm drains near bodies of water to reduce damage and injuries from floods.

Population: Displays population density. The more people icons, the higher the density. These zones change each era as populations grow and shift. The student should build structures in densely populated areas to reduce damage and injuries from hazards.

Economic: Displays economic diversity. The number of dollar signs indicates how wealthy an area is. These zones change each era. Areas with high economic activity incur more damage. Building structures in these areas is an effective strategy.

User Interface

Map and Overlays


Staff Menu Button: Opens the Staff Menu.


Research Menu Button: Opens the Research Menu.


Build Menu Button: Opens the Build Menu.

State of AWAREness Button: Opens the State of AWAREness screen. On turns *without* natural hazard events, it is the **End Turn** button.

End Turn Button: Ends the current turn.

User Interface

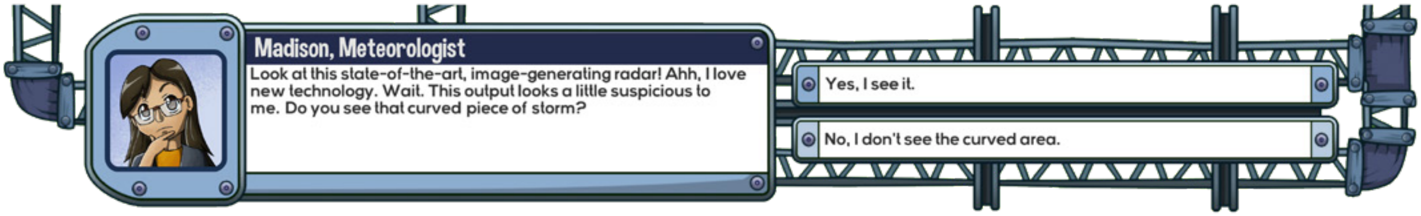
State of AWAREness

The **State of AWAREness** screen is accessible during turns before natural hazard events.

Questions within the character dialog serve as an **assessment** of the student's understanding. Answers result in either positive or negative feedback within the game. The types of questions depend on the hazard type and which technologies the student has unlocked through research.

The student must answer all the questions above the State of AWAREness screen before they can move on to the next turn.

Character dialog also presents the student with opportunities to review previous explanations and instructional content. In addition, characters mention new technologies as they become available.



User Interface

State of AWAREness

Alerts: The student can click these buttons to issue alerts throughout the region. Different alerts are helpful for different hazard types. Each alert has a specific cost. The student can confirm an alert before it is issued.

TIP: Characters may occasionally prompt the student to issue alerts. However, the student should initiate alerts whenever possible. Failing to do so can have devastating consequences for the student's Public Trust score.

Map Modes: The student can toggle between different map modes to view animations, videos, and other content that help them read and interpret weather data. Characters' instructional dialog often explains or references specific maps. Researching technologies unlocks additional map modes.

User Interface

Map Modes

Spotters

While spotters are not a "map," they appear in this area because they are a common source of firsthand information for the student.

Spotter

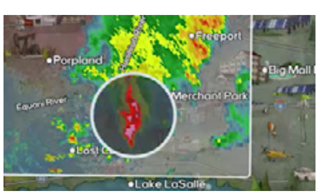
The student has access to this map mode at the start of the game.
Spotters are trained volunteers who relay weather-related information they observe. Spotter reports normally contain detailed information including the time, damage, and location of the hazard.

Advanced Spotters
Required Research: ASOS (Automated Surface Observing Systems)
This upgrade allows spotters to transmit a wide variety of data back to weather stations, greatly improving scientists' understanding of the region.

Radar

Base Reflectivity
Required Research: Weather Stations
Radars gather data by sending out microwaves. The radar "listens" for how long it takes the waves to bounce back, which tells the radar where and how far away the rain, sleet, or hail is. Dark areas indicate heavy precipitation.

Enhanced Reflectivity
Required Research: DOPPLER Radar
This updated radar provides a higher resolution and more accurate information. The map has a color spectrum, with each color representing a different reflectivity value. Reds and purples have the highest reflectivity, indicating dense precipitation.

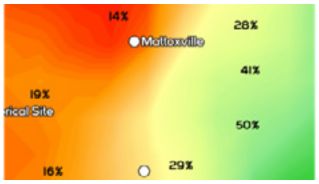


Phased Array
Required Research: Phased Array Radar
This radar uses an "array" of small antennas to emit signals, allowing it to collect more accurate information. The radar also picks up on less "noise" or useless data, making its images clearer.

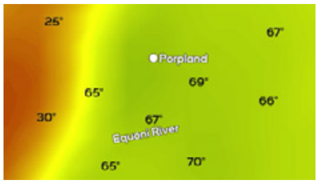
User Interface

Map Modes

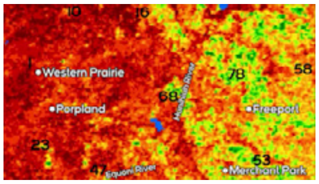
Atmospheric



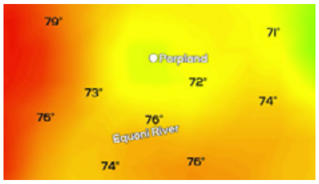
Air Temperature
Required Research: Station Models
Air temperature is a measure of how hot or cold the air is.



Dew Point Temperature
Required Research: Station Models
Dew point is the temperature at which water vapor condenses into a liquid. This results in precipitation such as dew, fog, or rain. A high dew point means the weather is hot and humid.



Relative Greenness
Required Research: Satellites
This map depicts how green (or lush) an area is relative to its historical data. It allows scientists to assess the likelihood of a wildfire. Things like dry underbrush, dead plants, and fallen branches catch fire more easily than green plants do.



Relative Humidity
Required Research: Station Models
Relative humidity describes how humid the air is compared with how humid it could be. It is a percentage that is calculated using air and dew point temperatures. Areas of low relative humidity foretell dry weather.

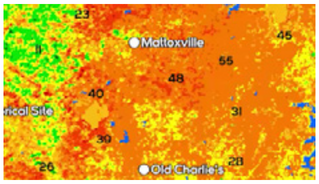
Wind

Base Velocity
Required Research: DOPPLER Radar
The Base Velocity map shows wind movement toward or away from the radar. Green areas represent wind that is moving toward the radar. Red areas represent wind that is moving away. This map detects wind patterns such as rotation or straight-line winds, which aids in the prediction of tornadoes.

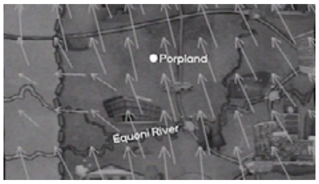
User Interface

Map Modes

Wind

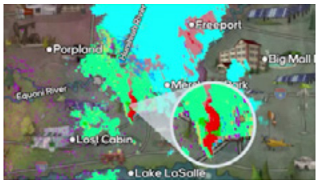


Burning Index
Required Research: **National Fire Danger Rating System**
A Burning Index is used to describe the potential amount of effort needed to put out a fire. In other words, it tells scientists how likely a small fire could turn into a wildfire. This number depends on a variety of factors, such as the amount of fuel, moisture, and wind.

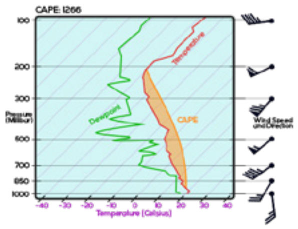


Surface Wind
Required Research: **Station Models**
This map displays wind speed and direction. Long arrows signify strong winds. Arrows also indicate which direction the wind is blowing. When two arrows point toward each other, it means there is a front (a boundary between two air masses).

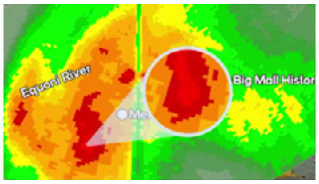
Special



Hydrometeor Classification
Required Research: **Dual-Polarization Radar**
This map looks like a regular radar. The difference lies in the colors and what they mean. In a Hydrometeor map, light green represents rain, dark green represents heavy rain, and red represents mixed hail and rain. This is different from what red and green mean in the Base Velocity map.



Skew-T
Required Research: **Mesonet Stations**
A Skew-T diagram displays information collected by weather balloons at different altitudes. The two solid lines represent dew point and air temperature. If these lines are close together, that means a natural hazard is brewing. The x-axis shows temperature, and the y-axis shows pressure. The wind barbs on the right indicate the speed and direction of the wind.



Storm Total Rainfall
Required Research: **DOPPLER Radar**
This map estimates the total rainfall from a natural hazard event. Areas of high rainfall are likely to produce floods.

User Interface

Staff Menu

Staff Menu: The student can hire staff members from five different categories:

- Data Sciences
- Earth Sciences
- Engineering
- Medical
- Public Safety

Each staff member has a unique job title, description, salary, and skill level. The student can hire one staff member from each category per turn.

White **dollar signs** on a staff member icon indicate the student does not have enough money to hire that staff member. The number in the bottom-right corner indicates how many **skill points** the student will acquire upon hiring that staff member.

TIP: New STEM professionals appear each turn. Encourage students to read the staff descriptions. This will expose students to different STEM careers and help them learn how each contributes to severe weather mitigation.

User Interface

Research Menu

Research Menu: The student can purchase technologies from three different categories: Construction, Earth Sciences, and Public Safety. Each technology has a specific cost and skill requirement. Some technologies provide damage or injury reduction, while others unlock new alerts and structures. More advanced technologies become available as eras progress.

For each type of research or technology, the panel on the right includes its name and **description**.

The cost is indicated below the description. If this number is **red**, it means the student does not have enough money to purchase the research or technology.

The numbers below the cost indicate the skill points required to purchase the research or technology. If a number is **orange**, it means the student does not have enough skill points in that category to make the purchase.

TIP: Prompt students to read the descriptions. They often include important information such as whether a technology reduces damage or injuries, unlocks a new type of structure, or improves the effectiveness of an existing structure.

TIP: Encourage students to consider their options before making purchases. For instance, they may want to read the descriptions of the technologies they have yet to unlock. This will help them determine which staff members they need to hire.

User Interface

Research Menu

A **red** exclamation point means new research or technology is available. The student can click on that icon to read its description.

A **dark** icon means that research or technology is available, but the student does not have the required skill points or money to purchase it.

A **light** icon means the student has the required skill points and money to purchase that research or technology.

A **green** check mark means the student has purchased that research or technology.

User Interface

Build Menu

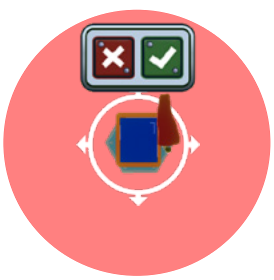
Build Menu: This menu displays the different structures that the student has unlocked. The student clicks on these buttons to build structures throughout the region. Once purchased, the student clicks and drags to place them on the map.

The student can use the mouse to hover over each building for its description and cost information.

TIP: Students should build a variety of structures rather than relying on one or two types to get by. For example, fire stations reduce both damage and injuries from hazards, but storm sirens warn citizens of impending danger. Each structure has its own benefits. Students should leverage them to get the most out of the game.

User Interface

Build Menu



Radii: Each structure has two radii. The large red radius indicates the structure's range of effectiveness. The small white radius indicates how close structures can be placed.

Structures cannot be moved or deleted once they have been placed on the map.

Build Cancel: Cancels the current action.

Build Confirm: Places the structure on the map. The structure's cost is deducted from the budget.

TIP: Overlapping radii of the same structure do *not* increase the effectiveness of those structures. However, overlapping radii of two different structures provide the benefits of both.

Back Button: Closes the Build Menu and returns to the main map.

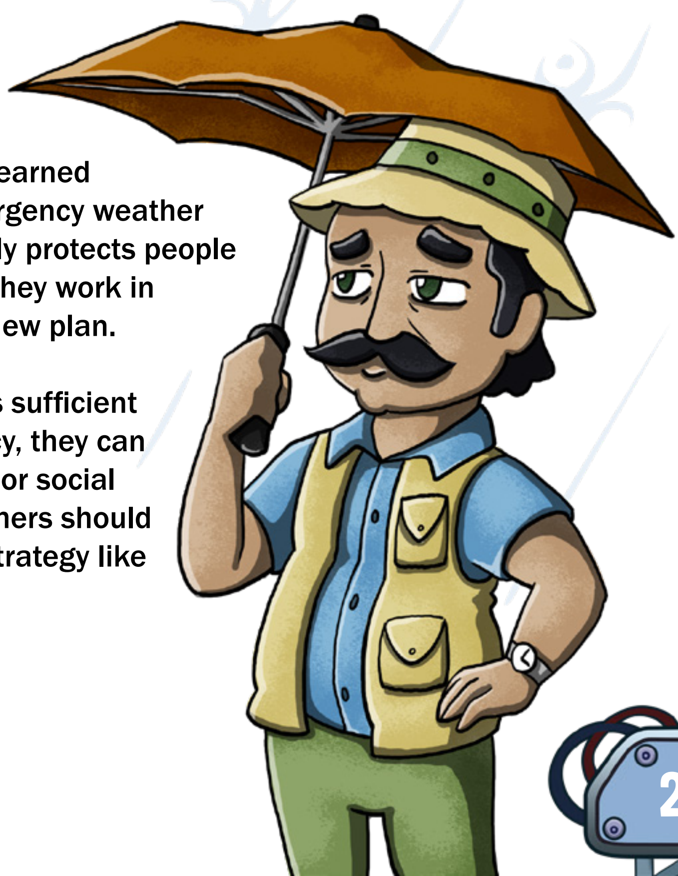
Learning Extension Activities

Long-Term Impacts of Wildfires

Students work in small groups to research the impacts of wildfires on either (1) water quality or (2) ecosystems, creatively displaying their findings. For (1), research should focus on how, why, and for how long water quality is affected following a wildfire. For (2), students should choose either forest or grassland ecosystems and focus their research on what happens to the environment immediately following a wildfire, in the first few years after the wildfire, and many years after the wildfire; "succession" is a relevant concept for students to research. Groups should display their results in the form of a Cognitive Comic, Concept Map, or another visual format.

Severe Weather Preparedness Activity

Students evaluate a school- or district-level severe weather preparedness plan using the National Weather Center's Severe Weather Preparedness Guide for Schools as a reference. Based on what they learned during gameplay and their understanding of local emergency weather situations, students decide whether the plan adequately protects people and property. If students find weaknesses in the plan, they work in small groups or as a class to strengthen it or create a new plan.



If students determine the existing preparedness plan is sufficient to protect students in the event of a weather emergency, they can instead develop a PSA (Public Service Announcement) or social media post that describes the steps students and teachers should take during an emergency and why. Consider using a strategy like Tweet Up or Elevator Speech to structure the activity.

Learning Extension Activities

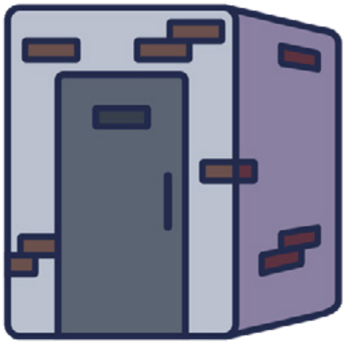
Structural Engineering Activity

Students use a variety of supplies (paper, popsicle sticks, tape, etc.) to build a model home that can withstand high winds. Students may also be given a budget with which to purchase materials. Once all students have completed their homes, the models are held in front of a leaf blower, which is slowly moved closer to the homes. The model that stands the longest wins the contest. In most cases, cone-shaped (teepee-like) structures are the most effective. This activity illustrates how design principles and budget constraints can affect the safety of a structure in the face of a natural hazard event.

Weather Phenomena Activity: *Feelin' the Phenomena*

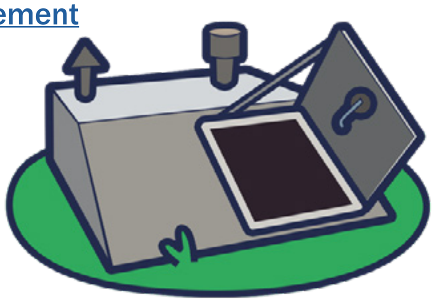
Students are given the path of a historic tornado in coordinates. They then use an online simulation to identify and record data such as wind speeds and moisture, graphing these in Desmos. Students use the data to make claims about the tornado's activity and which variables are most relevant. See the full lesson on K20's LEARN website at https://learn.k20center.ou.edu/lesson/415.

Weather Safety Structures



Students assess the pros, cons, and trade-offs of different types of severe weather safety structures. Students select two to three structures (e.g., above- and below-ground storm shelters, levees, diversion canals) and research their functions, costs, benefits, and drawbacks. FEMA's Risk Management resources, specifically Building Science and Safe Rooms, are useful sources for this exercise.

Students then select and justify what they think is the best structure. Ask them to explain their choice in a residential setting based on the safety structures in the area. Strategies such as Four Corners or Lines of Agreement are effective ways to structure these activities.



Appendices

STEM Professions

Data Sciences

Network Administrator | +1 | $30,000
Complex network systems require constant maintenance to work properly. Network administrators manage computer networks and cybersecurity to determine how systems can be improved.

Cartographer | +2 | $50,000 | National Fire Danger Rating System
Traditionally, cartographers drew maps. Now, they use advanced computer systems and satellite imaging to create as accurate a picture of our world as possible.

Operations Research Analyst | +2 | $50,000 | Modern Firetruck
Operations research analysts work to make processes more efficient. They help companies and agencies solve complex problems so they can make more beneficial decisions.

Programmer | +2 | $50,000 | Storm Sirens
Programmers write computer code to create software for a wide variety of purposes. In emergency management, computer programs are needed to operate advanced machinery, model natural hazard events, coordinate relief efforts, and more.

Data Scientist | +3 | $75,000 | Fujita Scale
Data scientists collect, organize, and analyze extremely large sets of data. They work to interpret weather data to better predict and mitigate hazard events.

Information Security Analyst | +3 | $75,000 | Supercomputer
Information security analysts are the anti-hackers. They protect important computer networks, such as those used by the government, from outside threats.

Statistician | +3 | $75,000 | Satellites
Predicting natural hazard events requires a deep understanding of statistics, probability, and mathematical models. Statisticians use math to create new ways to predict the likelihood of future natural hazard events.

Software Architect | +4 | $100,000 | Computer Aided Dispatch
Programmers build software from code, but software architects design how that software functions. They use programming to think through all aspects of the application.

Network Architect | +5 | $110,000 | Social Media Reporting
Network architects design data communication networks. These include the networks both meteorologists and emergency managers use to coordinate with first responders.

Appendices

STEM Professions

Earth Sciences

Meteorological Technician | +1 | $30,000
Meteorological technicians operate weather equipment and gather valuable data that is used to predict the weather.

Radar Scientist | +1 | $30,000
Radar scientists, also known as acoustic imaging specialists, interpret radar signals and develop advanced radar techniques.

Meteorologist | +2 | $50,000 | Tornado Forecasting
Meteorologists use their extensive knowledge of weather science to predict weather patterns, severe weather, climate change, and other atmospheric phenomena.

Meteorologist – Reporter | +2 | $50,000 | Station Models
Meteorologist reporters interpret weather data and convey that information to the public in a way that is easy to understand.

Chief Meteorologist | +3 | $75,000 | Mesonet Stations
A chief meteorologist is responsible for the accuracy of all forecasts and information coming from the weather center, especially in critical situations.

Geologist | +3 | $75,000 | ASOS (Automated Surface Observing Systems)
Geologists study the composition and structure of the Earth and the history of weather patterns over long periods of time. This helps them understand how flooding and weather affect the land.

Astronomer | +4 | $100,000 | NWSChat
Astronomers measure and track things like solar intensity, sun angle, and the position of the moon. All of these can affect the weather.

Weather Analytics Data Scientist | +5 | $110,000 | Enhanced Fujita Scale
Weather analytics data scientists look at historical weather data and use computer models to predict future weather patterns.

Appendices

STEM Professions

Engineering

Electronics Technician | +1 | $30,000
Electronics technicians build, maintain, and repair complex equipment used in meteorology, public safety, and countless other fields.

Electrical Engineer | +2 | $50,000 | Mobile Rescue Apparatus
Electrical engineers design and develop all sorts of electronics, including communication devices, power generators, and weather safety equipment.

Mechanical Engineer | +2 | $50,000 | Storm Drain Systems
Mechanical engineers design machines that produce or use power. Emergency management equipment is a great example of this.

Signal Processing Engineer | +2 | $50,000 | Siren Control Unit
Signal processing engineers find ways to make digital and analog signals more accurate and reliable. These engineers are responsible for improving our communication systems, GPS, and radar.

Civil Engineer | +3 | $75,000 | Flood Control
Civil engineers design our roads, bridges, sewers, and other public systems. Their designs ensure that our cities are clean, safe, and efficient.

Control Systems Engineer | +3 | $75,000 | Siren Control Unit
Ever wonder who designs the control panels that operate huge machines, command centers, and coffee makers? That's the job of a control systems engineer.

Radar Engineer | +4 | $100,000 | Dual-Polarization Radar
Radar engineers are trained to build, maintain, and operate radar systems. They ensure that our early warning systems work properly.

Structural Engineer | +4 | $100,000 | Below Ground Storm Shelters
Structural engineers use their advanced knowledge of physics to evaluate the safety of buildings and develop new construction techniques to make buildings safer.

Appendices

STEM Professions

Medical

Lab Technician | +1 | $30,000
Developing new medical devices and procedures requires lots of testing. Lab technicians perform tests and record results. Their work is essential to the progress of medical technology.

EMT (Emergency Medical Technician) | +2 | $50,000 | Ambulance
EMTs provide first aid and transportation for injured patients in emergency situations.

Nurse | +2 | $50,000 | PASS (Personal Alert Safety System)
Nurses are the frontline medical workers in emergency situations.

Doctor | +3 | $75,000 | Disaster Response Plans
Doctors are the core practitioners of medical science. Doctors can either specialize or practice general medicine. When someone is sick or injured, doctors diagnose and treat the problem.

Image Scientist | +3 | $75,000 | Next Generation 911
Image scientists look for better ways to display visual information such as weather maps and charts. They make it easier for people to see and understand complex data.

Medical Researcher | +3 | $75,000 | Firefighter Breathing Equipment
Medical researchers develop new medicines, devices, and techniques to treat sick or injured people.

Medical and Health Services Manager | +4 | $100,000 | EAS (Emergency Alert System)
These medical professionals manage the programs and services at hospitals and clinics. They also manage databases of patient information, ensuring records are accurate and secure.

Surgeon | +5 | $110,000 | FirstNet
Surgeons are trained to operate on sick or injured patients. In emergency situations, they can prioritize care for those who need it most.

Appendices

STEM Professions

Public Safety

Dispatcher | +1 | $30,000
Dispatchers operate communication systems, helping to direct first responders to where they are needed most.

Firefighter | +1 | $30,000
Firefighters not only control fires but also clear debris and search for survivors. They are essential in emergency situations.

Police Officer | +1 | $30,000
Police officers serve as first responders during natural hazard events. They conduct search and rescue and manage public safety during recovery.

Emergency Disaster Manager | +2 | $50,000 | Modern Firefighting
Emergency disaster managers prepare response plans for natural hazard events. It is their job to know how to mobilize first responders, when to evacuate cities, and how to coordinate public safety.

Communications Specialist | +3 | $75,000 | 911
Communications specialists develop and implement techniques for effectively getting important messages out to the world. This includes warning the public of potentially hazardous events.

Fire Chief | +3 | $75,000 | Lookout Stations
A fire chief is the head of a fire department. Fire chiefs develop plans, procedures, and training for firefighters, ensuring that their department is as effective as possible.

Fire Inspector | +4 | $100,000 | High Occupancy Safe Rooms
Fire inspectors have a deep understanding of how buildings and people react to fire and other emergencies. They improve the safety of buildings by enforcing fire codes and limiting occupancy.

Emergency Services Administrator | +5 | $110,000 | Incident Command System
Emergency service administrators manage and coordinate multiple agencies to ensure that everyone is prepared for and knows their role in future emergencies.

Appendices

Technologies

Construction

Above Ground Shelters

$440,000 | 8 10

These shelters are designed to withstand high winds and gusts. This technology allows the student to build above ground storm shelters, which reduce damage from wildfires, tornadoes, and hail.

Advanced Material Construction

$1,800,000 | 47 50 49

Improved construction materials increase building safety. Some examples are 3D-printed buildings, carbon fiber, and transparent aluminum. This technology reduces damage and injuries from all hazard types.

AI Construction

$800,000 | 36 33

Artificial intelligence is used to create safer structures while remaining within budget. Computer modeling allows architects to test how buildings will respond to potential threats. This technology reduces damage and injuries from all hazard types.

Below Ground Storm Shelters

$660,000 | 17 18

Although people have always had cellars and basements, new building methods for below ground storm shelters greatly reduce injuries in homes and workplaces. This technology increases the effectiveness of above ground storm shelters.

Construction Drones

$800,000 | 46 40

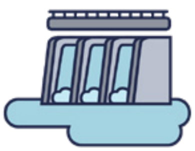
Drones survey construction sites and inspect structures. This makes construction faster, cheaper, and safer. This technology reduces damage from all hazard types.

Appendices

Technologies

Construction

Flood Control



$160,000 | **5** **5**

Flood control is any attempt to prevent the damaging effects of floods. This includes controlling vegetation, slopes, and runoff. It also includes building levees, dikes, dams, and reservoirs to redirect flood waters. This technology reduces damage and injuries from floods.

High Occupancy Safe Rooms

$560,000 | **27** **24**

These rooms allow large groups of people to fit in secure areas of public buildings. Although not quite as effective as storm shelters, these structures reduce injuries from tornadoes.

Impact-Resistant Windows

$360,000 | **16** **15**

This improved window technology reduces damage and injuries from hail and tornadoes.

Lookout Stations

$440,000 | **12** **11**

Fire lookout stations are positioned in areas that are prone to wildfires. These structures help firefighters identify and respond to wildfires more quickly. This technology improves the effectiveness of the student's fire stations.

Self-Repairing Concrete

$640,000 | **27** **30**

This amazing material began development in 2006. Additives in the concrete contain special bacteria whose byproducts seal cracks in damaged concrete. This prolongs the life of concrete structures and lowers repair costs. This technology reduces damage from all hazard types.

Appendices

Technologies

Construction

Siren Control Unit

$440,000 | 12 9 9

Siren control units allow the student to trigger alerts in specific areas. This technology improves the effectiveness of the student's storm sirens. Moreover, when a student triggers a siren alert, they will be asked to specify which region should receive the warning. This gives the student an opportunity to increase their Public Trust score.

Storm Drain Systems

$220,000 | 1 3 4

Storm drain systems are designed to carry rainfall and other drainage away from flood-prone areas. Water is carried in underground pipes to local bodies of water. This technology provides the student with the ability to build storm drains, which mitigate flood damage.

Storm Sirens

$220,000 | 1 1

During World War II, the military installed warning sirens to alert people about air raids. Now, this technology is used to warn people about severe weather. This technology lets the student build storm sirens, which reduce damage and injuries from tornadoes.

Supercomputer

$660,000 | 14 18

Improved computing allows staff to analyze data faster, build more accurate weather models, and improve safety. This technology allows the student to hire information security analysts. It also increases the effectiveness of weather stations.

Wind-Resistant Garage Doors

$480,000 | 24 21

Garage doors used to break easily during natural hazard events. Pressure changes caused damage to homes in high-wind situations. This technology reduces damage and injuries from hail and tornadoes.

Appendices

Technologies

Earth Sciences

AI Forecasting

$900,000 | 50 45 50

This program uses global data and artificial intelligence (machine learning and pattern recognition) to predict weather patterns. This technology provides a major upgrade to the student's weather stations.

ASOS (Automated Surface Observing Systems)

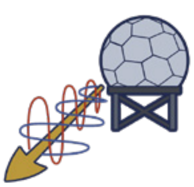
$880,000 | 30 26 24 19

Like mesonets, ASOS are automated weather observation systems. This technology reduces damage and injuries from all hazard types. It also allows the student to hire geologists, which improves spotter feedback.

DOPPLER Radar

$720,000 | 12 14 14

This radar measures the velocity of precipitation as it moves toward or away from weather stations. This technology provides the student with a variety of new weather prediction tools. It also improves the effectiveness of weather stations.



Dual-Polarization Radar

$1,200,000 | 26 19 23

"Dual-pol" radar measures both horizontal and vertical wind speeds. This helps scientists differentiate between high-altitude winds and those close to the surface. This technology also unlocks the Hydrometeor Classification map.

Enhanced Fujita Scale

$480,000 | 16 14

The Fujita Scale was updated to the Enhanced Fujita Scale in 2007, allowing for more accurate measurements of tornado damage. This technology allows the student to hire weather analytics data scientists.

Appendices

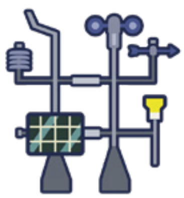
Technologies

Earth Sciences

Fujita Scale

$440,000 | **10** **9**

The Fujita, or “F,” Scale, is a measurement of the damage caused by tornadoes. It measures destructiveness from 0–5. This technology reduces damage from tornadoes and allows the student to issue broadcast alerts.



Mesonet Stations

$600,000 | **17** **13** **17**

Mesoscale networks, or “mesonets,” are automated weather stations that observe phenomena such as dry and squall lines and sea breezes. This technology unlocks Skew-T graphs and allows the student to hire chief meteorologists.

National Fire Danger Rating System

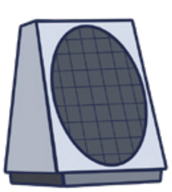
$360,000 | **10** **9**

The NFDRS helps scientists estimate the danger of wildfires using factors such as fuel, weather, and topography. This technology unlocks the Burning Index map.

NWSChat

$800,000 | **19** **20** **25**

This system allows meteorologists, weather spotters, and emergency managers to easily connect with one another and share information. This technology reduces damage and injuries from all hazard types.



Phased Array Radar

$800,000 | **36** **38** **40**

This radar is composed of multiple small radar antennas. It provides an accurate, high-resolution image of its target.

Appendices

Technologies

Earth Sciences

Satellites

$400,000 | 8 12 12

Satellites provide a wide range of data about large geographic areas. This technology unlocks the Relative Greenness Map, which helps scientists identify potential wildfires.

Social Media Reporting

$900,000 | 33 37

Social media is the default news source for many people. This technology unlocks the internet alert type, a more efficient means of communication.

Station Models

$180,000 | 3 2

Station models use numbers and symbols to communicate current weather conditions. These structures show information such as wind speed and direction, as well as air and dew point temperature. Station models unlock additional weather maps.

Tornado Forecasting

$200,000 | 1 1

The first tornado forecast was made in Oklahoma City and successfully predicted two tornadoes that hit Tinker Air Force Base in 1948. This technology unlocks radio alerts, which can be triggered to tell people to take cover from natural hazard events.

Weather Stations

$100,000 | 1

Weather stations contain meteorological instruments such as thermometers, barometers, and anemometers. This technology unlocks radar reflectivity, weather station structures, and the ability to hire meteorologists.

Appendices

Technologies

Public Safety

911

$480,000 | 8 6

The first 911 call in the United States was placed in 1968. Before that, people needed to call the fire station directly. This technology allows the student to build PSA (Police Service Aide) points, which route 911 calls to specific areas. PSA points reduce damage and injuries from all hazards.

Ambulance

$220,000 | 2 3

Modern ambulances are built to be "mobile hospitals." They are outfitted with the latest medical equipment to diagnose and stabilize patients. This technology allows the student to build hospitals, which reduce injuries from all hazards.

Computer Aided Dispatch

$900,000 | 13 16 13

Computer aided dispatch systems help first responders coordinate relief efforts. This technology allows the student to build PSA points and provides them with the ETN (Enhanced Telephone Notification) alert type.

Disaster Response Plans

$480,000 | 15 13

Training, planning, and preparation are essential when dealing with major hazard events. Disaster response plans include four phases: mitigation, preparedness, response, and recovery. This technology reduces damage and injuries from all hazards.

EAS (Emergency Alert System)

$880,000 | 26 24 29

The EAS replaces the emergency broadcast system. The EAS sends out alerts via broadcast TV, cable, wireless networks, satellites, and telephone. This technology allows the student to issue EAS alerts.

Appendices

Technologies

Public Safety

Fire and Rescue Drones

$1,000,000 | 50 43 40

Rescue operations are dangerous for first responders. Flying drones move rubble, search for trapped survivors, and put out fires. They can also access places that firefighters cannot. This technology allows the student to build drone hangars.

Firefighter Breathing Equipment

$420,000 | 13 13 14

Smoke inhalation is a major concern for firefighters. This technology reduces injuries from wildfires.

FirstNet

$1,200,000 | 34 34

The First Responder Network Authority allows police officers, firefighters, and paramedics to communicate through a secure private network. It helps first responders transmit important information between departments, enhancing their ability to serve and protect citizens. This technology increases the effectiveness of hospitals.

Incident Command System

$640,000 | 21 25

This system allows for better cooperation between agencies inside and outside the government. This means quicker response times, fewer injuries, and faster recovery. This technology reduces damage and injuries from all hazard types.

IPAWS (Integrated Public Alert and Warning System)

$900,000 | 37 38

The IPAWS integrates alerts through internet, TV, text messages, and radio. This technology combines all alert types into a single, more effective one.

Appendices

Technologies

Public Safety

Mobile Rescue Apparatus

C: $280,000 | 12 6 10

A mobile rescue apparatus is an advanced firetruck. It has ladders, high-powered pumps, and other advanced features. MRAs also include tankers and off-road vehicles. This technology reduces damage and injuries from wildfires.

Modern Firefighting

$220,000 | 1 1

Though firefighters have been around since ancient Rome, new technology in the early 20th century changed how fires were managed. Fire engines became gas-powered. Gas masks and other protective gear were developed. This technology allows the student to build fire stations.

Modern Firetruck

$200,000 | 3 3

Modern firetrucks have lights and sirens, pumps, ladders, and “cherry pickers.” They also have seating for the crew, so they don’t have to hang off the side of the truck. This technology increases the effectiveness of fire stations.

Next Generation 911

$1,200,000 | 30 30

An update from the classic 911 system, Next Generation 911 is better suited for mobile phones and digital technology. This technology increases the effectiveness of the student’s PSA points and provides them with the CMAS alert type.

PASS (Personal Alert Safety System)

$280,000 | 9 9

Firefighters wear these devices, which send out rescue alerts when firefighters are in danger. This technology reduces damage and injuries from wildfires.

Appendices

Structures

Above Ground Shelter
$20,000 | [Above Ground Shelters]
Above ground shelters reduce injuries from wildfires, tornadoes, and hail. They also reduce damage from tornadoes.

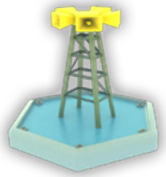
Drone Hangar
$400,000 | [Fire and Rescue Drones]
Drones extinguish fires, clear debris, and search for survivors. Drone hangars reduce damage and injuries from wildfires, tornadoes, and hail.

Fire Station
$100,000 | [Modern Firefighting]
Hazard events of all types can cause fires, damage, and injuries. Fire stations reduce damage and injuries from all hazard types in the surrounding area.

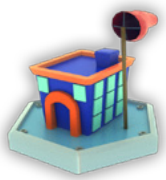
Hospital
$200,000 | [Ambulance]
Access to emergency health care is essential after natural hazard events. Hospitals reduce injuries caused by all hazard types in the surrounding area.

PSA Point
$50,000 | [911]
PSA (Police Service Aide) points help first responders communicate with people in need. This structure reduces damage and injuries from all hazard types.

Storm Drain
$20,000 | [Storm Drain Systems]
Flooding occurs when rainfall accumulates faster than it drains away. A well-constructed storm drain system reduces both damage and injuries from floods.



Storm Siren
$25,000 | [Storm Sirens]
Storm sirens emit a noise that can be heard for several miles. This structure reduces injuries from tornadoes in the surrounding area.



Weather Station
$70,000 | [Weather Stations]
Weather stations reduce damage and injuries from all hazard types in the surrounding area.

Appendices

Alerts

Warning
$15,000 | Weather Stations
In the past, weather warnings were issued through direct phone calls, manual alarms, or yelling. This alert reduces injuries from all hazards.

Radio
$11,774 | Tornado Forecasting
Radios send out public announcements to warn people about significant weather events. This alert reduces injuries from all hazards.

Sirens
$13,717 | Storm Sirens
Sirens emit a loud noise to alert people of incoming weather hazards. This alert reduces injuries from tornadoes.

ETN (Enhanced Telephone Notification)
$18,713 | Computer Aided Dispatch
An ETN alert is distributed via telephone. This alert reduces both damage and injuries from all hazards.

CMAS (Commercial Mobile Alert System)
$23,231 | Next Generation 911
A CMAS sends audio and text message alerts to mobile phones in the area. This alert reduces damage and injuries from all hazards.

Broadcast
$15,073 | Fujita Scale
Television stations send out broadcast alerts. This alert reduces damage and injuries from all hazards.

Internet
$23,231 | Social Media Reporting
This alert is sent via the internet to computers, smartphones, and other devices. It reduces damage and injuries from all hazards.

EAS (Emergency Alert System)
$21,478 | EAS
An EAS sends out electronic alerts via radio, television, and other media. This alert reduces damage and injuries from all hazards.

IPAWS (Integrated Public Alert and Warning System)
$97,714 | IPAWS
The IPAWS sends out an electronic "smart" alert to specific areas. This alert reduces damage and injuries from all hazards.

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