Activity #3: Environment

Earth, Energy, & Environment STEM Kit

Leader Guide

Summary

In this activity students will use a device with various sensors to measure the environment around them. The lesson will go deeper into how to measure air, water, soil quality and noise pollution. Students will collect data, review results, and discuss the relation to and potential benefits of environmental protection. The lesson will dive deeply into environmental pollutants, examples of pollutants and where they come from. Students will also gain a conceptual understanding of how these pollutants can impact our environment.

Real World Significance

The objective of this activity is to solidify student's understanding on how our environment can be monitored for pollution and what effects they can have. Students will attain a conceptual understanding of the following:

- Understanding the health of your environment
- Promotes environmental awareness
- STEM education and technological literacy
- Community engagement and improvement
- Air, water, soil quality and noise pollution

By measuring air, water, soil quality, and noise pollution, students gain practical knowledge about the environment around them. This hands-on experience helps them understand how different factors contribute to the overall health of their surroundings.

Through this activity, students learn about various pollutants and their sources. This awareness can foster a sense of responsibility and encourage proactive behavior towards environmental protection.

Students analyze data and discuss findings, allowing them to practice critical thinking and problem solving skills. They learn how to measure and understand the health of their environment, identifying any issues and considering practical solutions. This prepares students to address similar challenges in their future careers.

Using sensors and other technology introduces students to STEM (Science, Technology, Engineering, and Mathematics) concepts in an engaging way. This can spark interest in these fields and demonstrate how technology can be used to solve real-world problems.

This activity can inspire students to take action within their communities. By understanding the importance of environmental health, they can initiate projects that aim to improve their local environment, such as community clean-ups, or tree planting.

Air: Utilizing an air sensor to detect CO2, alcohol, smoke, etc. Students learn about the effects of air pollution on the environment and public health. Poor air quality can lead to respiratory diseases, cardiovascular problems, exacerbated asthma and contribute to climate change.

Water: Understanding water contaminants, importance of protecting water sources for drinking, agriculture, recreation, and sustaining aquatic ecosystems. Water pollution can lead to health risks, loss of biodiversity, and challenges sectors like fishing and tourism.

Soil: Healthy soil is essential for growing food, supporting plant life, and maintaining ecosystems. Soil degradation can result from contamination, erosion, and nutrient depletion, impacting food security and biodiversity.

Noise: Noise pollution is an often-overlooked environmental issue that can affect mental health, disrupt wildlife, and reduce quality of life. High noise levels can cause stress, hearing loss, and sleep disturbances in humans and animals.

Foundations of Environmental Science

The purpose of this section is to equip instructors with fundamental knowledge about environmental pollutants and the impacts they can have. It establishes a comprehensive understanding of key concepts, relevant terminology, and scientific principles that will be delved into during the activity.

1. What are air/water pollutants and their effects on health/environment?

Air and water pollutants have profound effects on both the environment and human health. Air pollutants, such as particulate matter and toxic gasses, can cause respiratory diseases, cardiovascular problems, and contribute to climate change, while also harming plants and animals by damaging ecosystems and reducing biodiversity. Water pollutants, like chemicals, heavy metals, and pathogens, contaminate drinking water sources, leading to illnesses such as gastrointestinal diseases and developmental issues in humans. They also degrade aquatic ecosystems, killing fish, disrupting food chains, and reducing water quality. Together, these pollutants undermine the health of our planet and its inhabitants, highlighting the critical need for pollution control and environmental protection.

- **Particulate Matter (PM2.5 and PM10)**: Tiny particles from car exhaust, industrial emissions, and wildfires can penetrate deep into the lungs, causing respiratory issues. PM2.5 meaning particles are 2.5 micrometers or less in diameter and PM10 meaning 10 micrometers.
- **Carbon Dioxide (CO2)**: A greenhouse gas that contributes to global warming. Elevated CO2 levels can also indicate areas with high vehicle traffic or industrial activity.
- **Nitrogen Dioxide (NO2)**: Emitted from vehicles and power plants, NO2 can cause lung irritation and decrease resistance to respiratory infections.
- **Ozone (O3)**: A secondary pollutant formed by the reaction of sunlight with pollutants like NO2. It can cause breathing difficulties and harm plants.

Potential WATER pollutants

- **Nitrates**: Often from agricultural runoff, nitrates can contaminate drinking water, leading to conditions like "blue baby syndrome" in infants.
- **Phosphates**: These come from fertilizers, detergents, and wastewater. Excessive phosphates can lead to algal blooms in water bodies, depleting oxygen and harming aquatic life.
- **Lead**: A toxic metal that can leach into water from old pipes, leading to serious health issues, particularly in children.
- **Turbidity**: High turbidity can indicate the presence of pollutants like silt, clay, or organic matter, which can harbor harmful bacteria and viruses.
- **Total Dissolved Solids (TDS)**: TDS refers to the total concentration of dissolved substances in water, including minerals, salts, and organic matter. While not all dissolved solids are harmful to humans, high TDS levels can affect the taste of water, lead to scaling in pipes, and indicate potential contamination from industrial or agricultural activities.

2. What is healthy soil and how does drought impact the environment?

Healthy soil provides the foundation for plant growth, supports biodiversity, and contributes to agricultural and natural processes. Healthy soil has the following characteristics:

- **Balanced Nutrient Content**: Healthy soil contains a high level of organic matter, such as decomposed plants and animals, which provides essential nutrients for plants. Soil should have a balanced mix of nutrients, including nitrogen, phosphorus, potassium, calcium, and magnesium, which are necessary for plant growth.
- **Good Structure and Porosity**: Healthy soil has a crumbly texture, allowing air and water to move freely through it. This structure supports root growth and helps retain moisture.

- **Diverse Microbial Life**: Healthy soil is teeming with microorganisms like bacteria, fungi, and earthworms, which help break down organic matter, recycle nutrients, and improve soil structure.
- **pH Balance**: Healthy soil has a pH level that is suitable for the types of plants it supports, usually slightly acidic to neutral (pH 6-7) for most crops.
- **Water Retention and Drainage**: Healthy soil can retain sufficient moisture for plants while also allowing excess water to drain, preventing waterlogging and root rot.
- **Soil Moisture**: Healthy soil maintains the right balance of moisture, not too wet or too dry, to support plant growth. Proper moisture levels ensure that plants can absorb nutrients effectively and that microorganisms can thrive, contributing to overall soil health.

Potential SOIL pollutants

- **Pesticides**: Chemicals used in agriculture to control pests can remain in the soil, affecting non-target organisms and entering the food chain.
- **Heavy Metals (e.g., lead, cadmium, mercury)**: These can accumulate in soil from industrial activities, posing risks to plant, animal, and human health.
- **Excessive Fertilizers**: Overuse of fertilizers can lead to soil acidification, nutrient imbalances, and contamination of nearby water sources.
- **Plastic Residues**: Microplastics and plastic residues can contaminate soil, affecting its structure and potentially entering the food chain.

Drought is a prolonged period of abnormally low rainfall, leading to a shortage of water. Drought has significant impacts on both the environment and human populations. It can affect soil health, causing it to be dry and leading to the following impacts:

- **Soil Degradation**: Drought can lead to the loss of soil moisture, making the soil dry and hard. Without adequate moisture, soil structure deteriorates, leading to erosion, loss of nutrients, and a decline in soil health.
- **Reduced Plant Growth**: Lack of water limits plant growth, leading to reduced agricultural yields and the loss of vegetation in natural ecosystems. This can result in the loss of habitat and food sources for wildlife.
- **Increased Wildfire Risk**: Dry conditions during a drought can increase the risk of wildfires, as vegetation becomes more flammable. Wildfires can cause widespread environmental damage, destroying habitats and releasing carbon into the atmosphere.
- **Food and Water Shortages**: Drought can severely impact agriculture, leading to crop failures, reduced food production, and higher food prices. It also affects water supply, leading to water shortages for drinking, irrigation, and sanitation.

2. Where does noise pollution originate and how does it affect human/wildlife health?

Noise pollution affects both human and wildlife health by causing stress, disrupting communication, and interfering with natural behaviors. In humans, prolonged exposure to high noise levels can lead to hearing loss, sleep disturbances, increased stress levels, and even cardiovascular issues. Wildlife is similarly impacted; noise pollution can disrupt mating calls, navigation, and hunting, leading to reduced reproductive success and altered ecosystems. Noise pollution represents one significant, often overlooked threat to environmental and human well-being.

Potential NOISE pollutants

- **Traffic Noise**: From cars, trucks, and trains, which can be particularly problematic in urban areas.
- **Industrial Noise**: Machinery and operations in factories can produce loud, continuous noise that impacts nearby communities.
- **Construction Noise**: Heavy equipment and construction activities can create significant noise pollution, particularly in growing cities.
- **Recreational Noise**: Loud music, events, and activities can contribute to noise pollution, affecting local residents and wildlife.

3. What are some other examples of pollution?

Light pollution, similar to noise pollution, can interfere with natural rhythms by obscuring the night sky and disrupting sleep patterns, as noise pollution disrupts the natural soundscape, leading to adverse effects on health and behavior for both people and animals. E-waste, microplastics

4. How could it be beneficial to monitor the health of our environment?

Monitoring the environment can be beneficial because it helps us detect and understand changes in natural systems, identify sources of pollution, and assess the health of ecosystems. By regularly tracking air and water quality, soil health, and biodiversity, we can quickly respond to environmental threats, prevent long-term damage, and protect human health. Environmental monitoring also provides valuable data that informs policies and actions aimed at sustainability, ensuring that we preserve natural resources for future generations and maintain a balanced, healthy ecosystem.