ENVIRONMENTAL SCIENCE JOURNAL FOR TEENS

How do transportation choices affect air pollution?

LESSON

Introduction

During the first few months of the COVID-19 pandemic, many people switched to working and learning from home. The decrease in traffic and small business activity resulted in improved air quality cities around the world. In this lesson, students learn about the relationship between air pollution and transportation choices. They then spend time thinking about how to improve transit in their own communities.

Learning Objectives

After the lesson, the students should be able to:

- Describe how transportation and air pollution are connected.
- Share ideas about how their community could be made safer and cleaner.

Key Terms

- population density
- pollutant
- concentration

Time Requirement

Minimum 3 class periods (could be on separate days).
With extensions: up to 6 class periods.

Grade Level

Grades 6-10

Teaching standards

AP ENVIRONMENTAL SCIENCE:

- Analyze and interpret quantitative data represented in tables, charts and graphs
- Propose and justify solutions to environmental problems

NEXT GENERATION SCIENCE STANDARDS:

MS-ESS3-3
Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

HS-ESS3-4
Evaluate or refine a technological solution that reduces impacts of human activities on natural systems

HS-ESS3-6
Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.

Materials

- Teacher's computer and projector or a Smartboard
- (Optional) Printed copies of Handout 1: "Population Density and NO_2 concentration"
- Printed copies of the article **How did COVID lockdowns affect air pollution?** from *Science Journal for Kids*
- Printed map of your city with landmarks
- Colored markers
- 2 colors of stickers
- Paper and writing materials
- Printed copies of Handout 2: "COVID-19 Lockdowns & Air Pollution" (preferably in color)
- Computers or other devices with Internet for students to access the online activity (either alone or in groups)

Lesson Plan

1 GETTING STARTED

To start out, either give students copies of Handout 1: "Population Density and NO_2 concentration" or project for the class the maps in the Appendix: "Global Population Density in 2020" and "Annual Average NO_2 Concentration in 2019". Explain that population density is the number of people per unit of area and looking at population density on a map helps us understand where people are living in large numbers close together. The dark blue areas on the map represent areas with high population density. Explain that nitrogen dioxide (NO_2) is a pollutant that comes from burning fuels like gasoline, diesel, coal, and natural gas. It is an ingredient in smog. On the map, the light blue color represents areas with low amounts of NO_2, while the dark blue represents areas with high amounts of NO_2. Ask the students to compare and contrast the two maps. (This could be done in writing, individually or in pairs, or orally in pairs or small groups.)

- What places have the highest population density?
- What places have the highest NO_2 concentration?
- Does every place with high population density have high NO_2? Why or why not?

Show students the video **"The Science of Smog"** from TED-Ed. Then have them discuss with a partner or in small groups:

- What is smog made of?
- Do all cities get smog? If not, where is smog more likely to happen?
- Why do you think that scientists use NO_2 measurements for tracking air quality?
- What do nitrogen oxides like NO_2 have to do with smog?
- Do places with high concentrations of NO_2 always have smog?
- Did anything surprise you in the video? Why?

Duration 15-30 min, depending on level of engagement

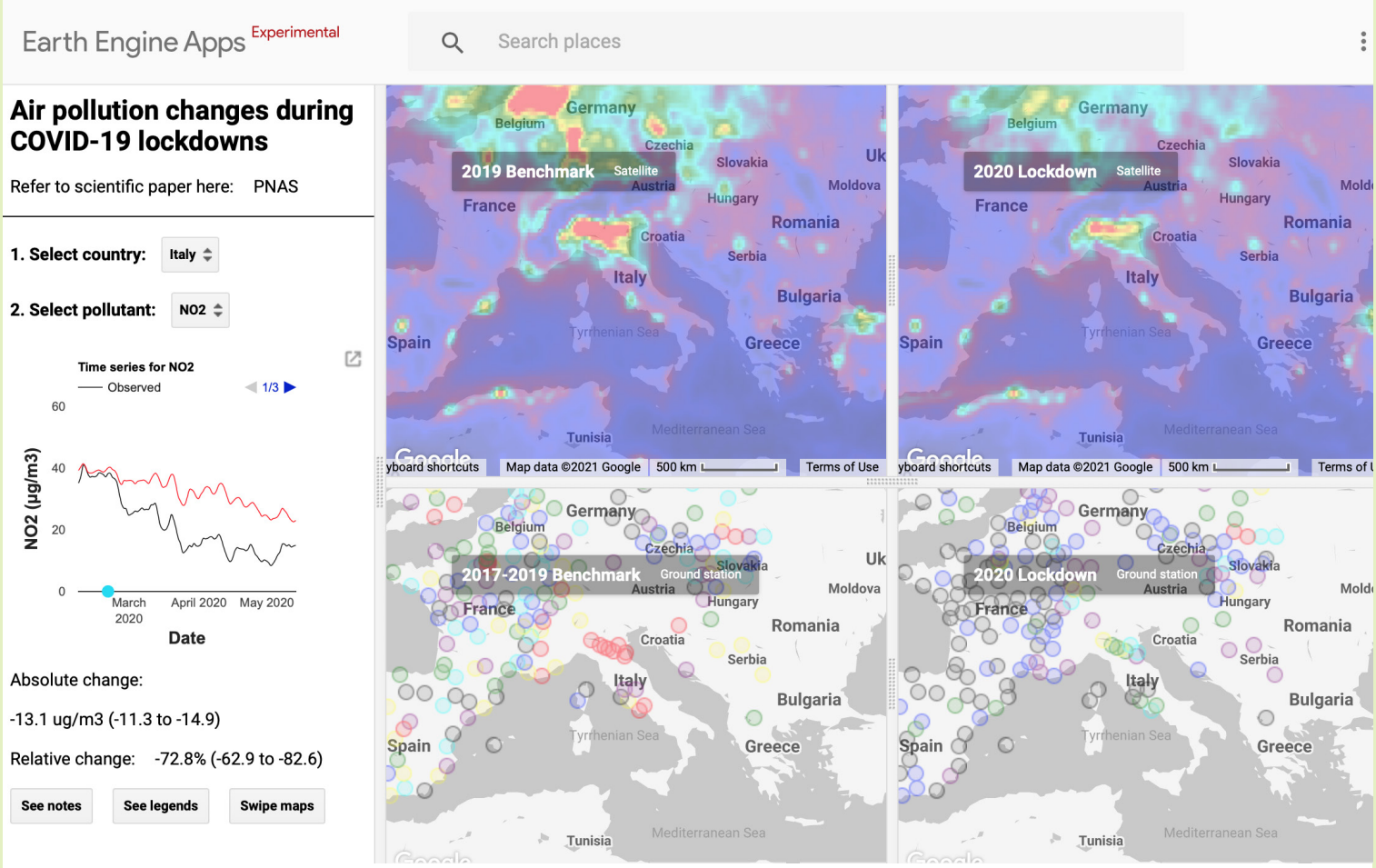
2 ONLINE ACTIVITY

Explain that during the beginning of the COVID pandemic, lockdowns made it so people stayed home instead of driving to work and school. Depending on what you feel is appropriate for the class, discuss how your community was impacted by COVID. Read the "Introduction" section of **How did COVID19 lockdowns affect air pollution?** from Science Journal for Kids out loud to students (and maybe also display it on the smartboard/projector).

Distribute copies of Handout 2: "COVID-19 Lockdowns & Air Pollution" and assign students a computer or other device with Internet access, whether individually or in small groups.

Students will visit the online tool **"Air pollution changes during COVID-19 lockdowns"** from Earth Engine Apps (**nina.earthengine.app/view/lockdown-pollution**). It may be helpful to show them this tool on the board or projector before they begin working on their own.

By default, the landing page should look like this:



At the top is a search bar where the user can type in the name of a city or country. Searching a country here will move the maps to center on that location.

On the left hand side, there are dropdown menus that allow the user to choose a country and a pollutant. After choosing a country/pollutant, a graph will appear showing the observed pollutant concentration as a black line, with a dot marking the beginning of the lockdowns, and a red line showing the expected amount of pollution. Only countries with publicly available weather station data are available in this section.

The remainder of the screen is divided into four panels. The top two panels show measurements of NO_2 from a satellite. The bottom two panels show where weather stations used by the researchers are located. Data from the three years before COVID are shown on the left-hand side, while data from the 2020 COVID lockdowns are shown on the right-hand side. The maps will move together if you click and drag.

Alternatively, at the bottom left of the page, there is a button that reads "Swipe maps". Clicking this button changes the map into a single map with three sliders, allowing the user to slide the lines back and forth to see before and after.

The color scale ranges from dark purple (low concentration) to red (high concentration). The colorbar may be difficult for some people to read, as the colors may appear differently for people with colorblindness. Since the legend is not always easy to see on the site, a copy of the color bar is included on Handout 2.

Allow the students to spend some time familiarizing themselves with the online tool. After they have had the chance to look around, ask them to choose NO_2 from the dropdown, and ask them to answer the questions on the handout.

Duration: 45 min

3 READING ASSIGNMENT

- Hand out copies of **How did COVID lockdowns affect air pollution?** from *Science Journal for Kids*.
- Individually or in groups, have the students read the remainder of the article.
- Discuss as a class and make sure they understand the graphs.
- Have students answer the assessment questions at the end of the article (teacher's key available on the same page).

Duration 30-45 min, depending on reading level

4 HANDS-ON ACTIVITY

The goal of this activity is for students to think about how transportation works in their home city, and to identify ways that it could be improved.

- Place a large map of your city at the front of the class (either on paper, or projected/on a smartboard). Give each student a printout of the same map.
- Ask the students to name their favorite places to go. Have them place a "destination" sticker at each destination on the map in front of class. Have them do the same on their own copy of the town map.
- Have the students place a "starting point" sticker on their neighborhood or block on the classroom map and on their copy of the map.
- Next, students should use a marker to trace out how they would get from the starting point to the destination. They should write out a brief description of their route on a piece of paper. For example: "My parent drives me there" or "I walk to the bus stop, get on the bus and ride most of the way, then walk the rest."
- On the board, write the words "Car", "Walk", "Bike", "Train", and "Bus". Ask each student to make a mark under the transportation they would use to travel their route. (Multiple answers are okay!)
- Next, the students should answer the question: "If you didn't have the option to go by car, would it be possible to get to your destination? If not, why not? If so, how would you do it?"
- Form small groups so students can compare their routes and answers. Discuss within the group "What would make it easier to travel this route without a car?" Answers could range from small changes, like adding a stoplight, to major changes like adding subways.

A basic version of this discussion could focus on differences in neighborhoods in town. Are there buses or trains available? Are there places where it's impossible to get around without a car? Is it safe to go through town on foot?

The project could be extended over multiple class periods by giving the students the task of researching different low-emission transit options. (A good resource to direct them to is the **Transportation Sector Summary** from Project Drawdown.) What works for one city is not necessarily going to work for another.

For example, Shenzhen, China replaced over 16,000 buses with electric buses and lowered the air pollution and noise in the city significantly. But Shenzen has a moderate climate and not many hills. The buses use batteries that aren't strong enough to handle very cold weather or large hills. (Students could read about this example in the article **How China Took Charge of the Electric Bus Revolution** from Bloomberg.)

Duration 45 min (for the basic activity)

Writing Extension

Individually or in small groups, assign students to answer the following in the form of a proposal to the city government:

1. Describe what low-emission transportation is available in your city.

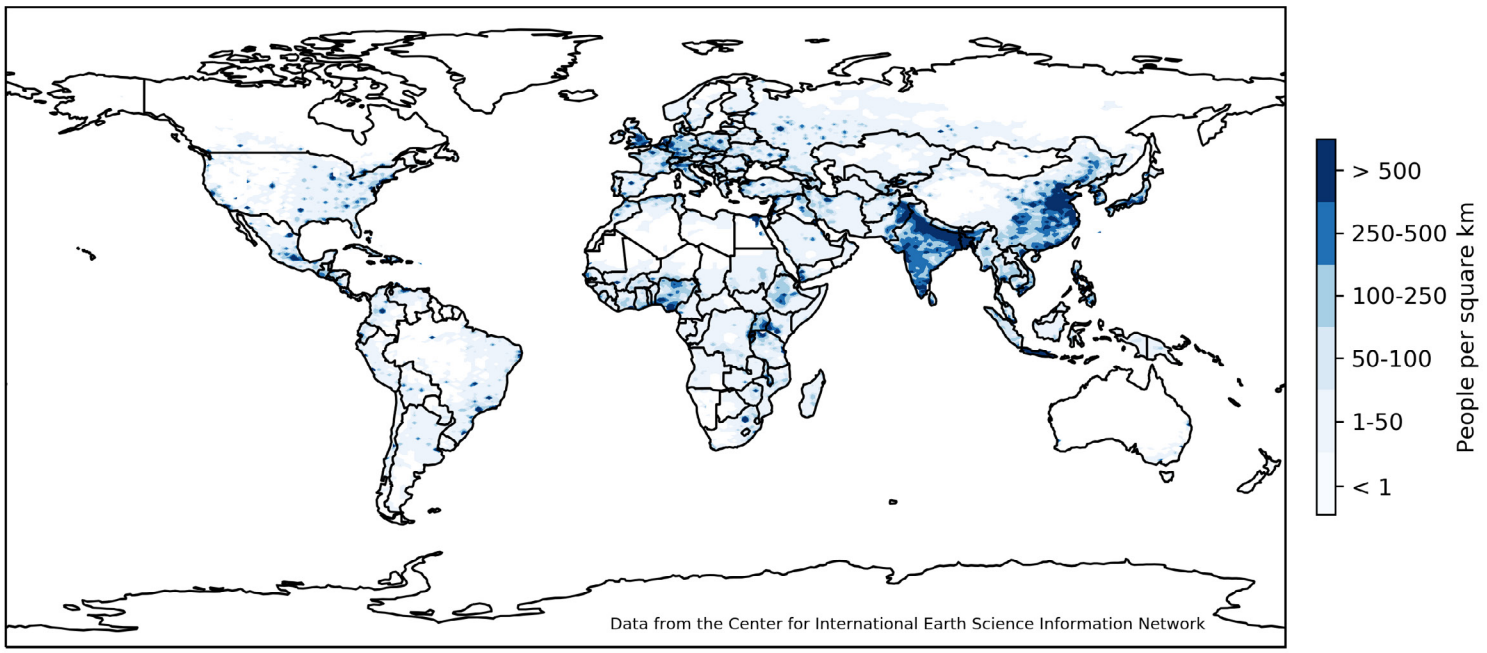
2. Describe obstacles that keep people from being able to walk or bike.

3. Write down three possibilities for making transportation easier in your city.

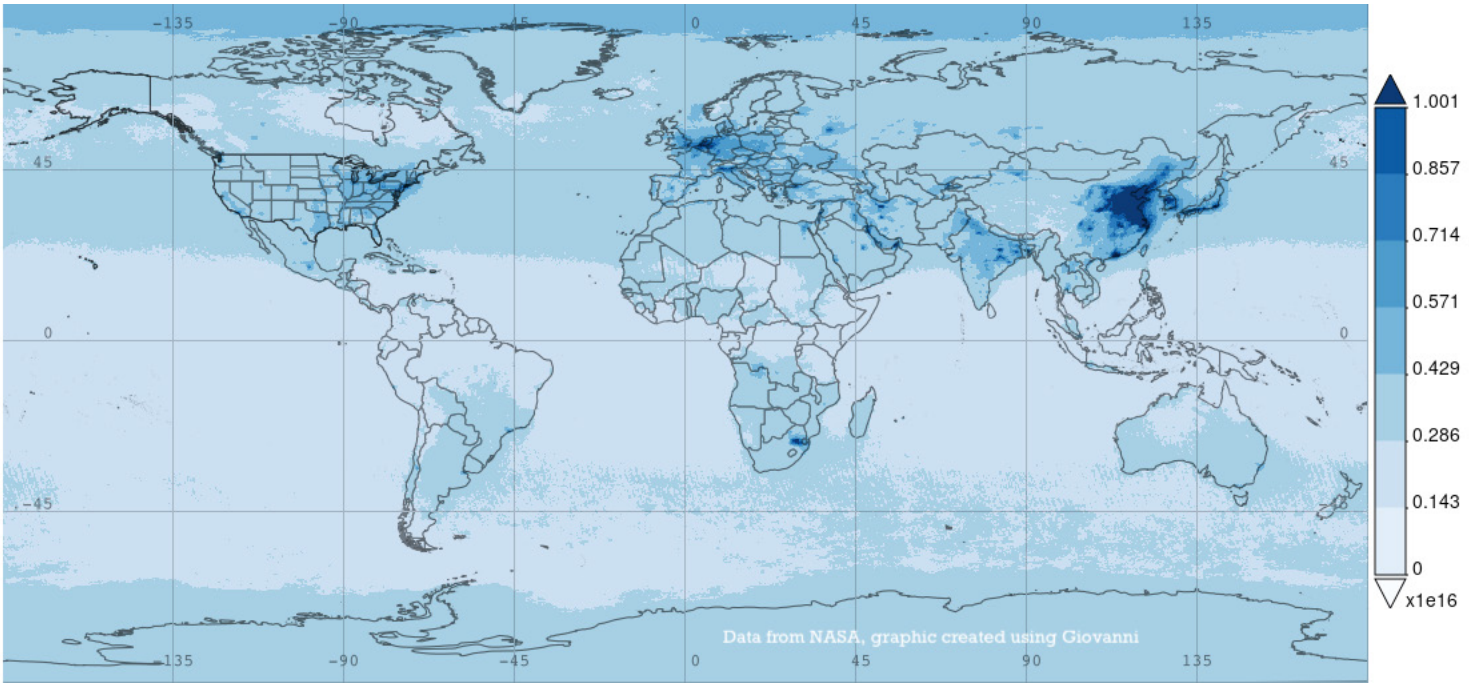
4. Choose one possibility and describe why you think it is the best option. What would need to be done to make this a reality?

APPENDIX

Global Population Density in 2020



Annual Average NO_2 Concentration in 2019

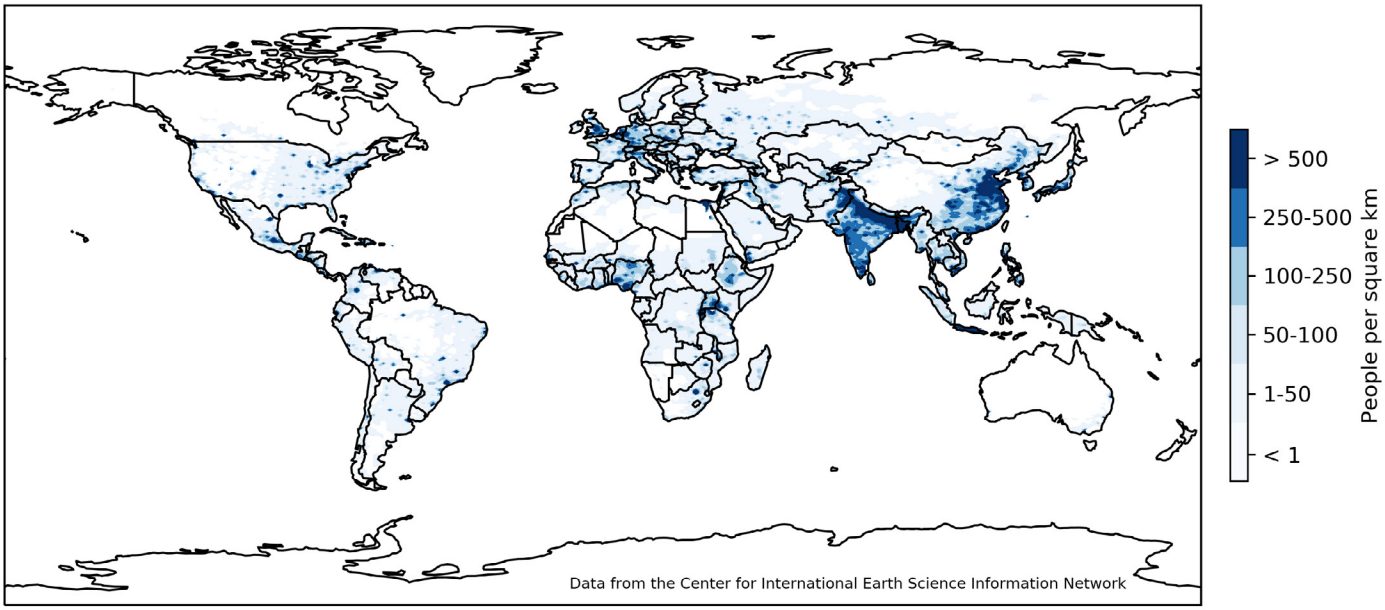


NAME:_____ **DATE:** _____

Population Density and NO_2 Concentration

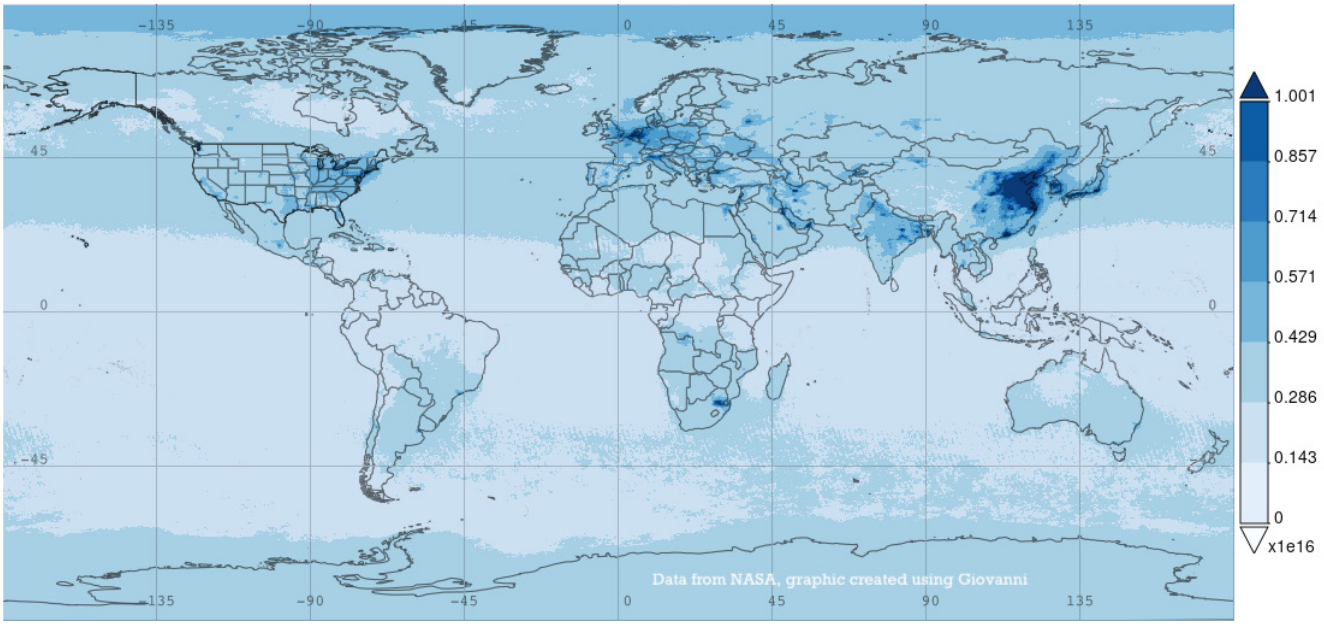
Global Population Density in 2020

Population density is the number of people per unit of area. Looking at population density on a map helps us understand where people are living in large numbers close together. The dark blue areas on the map represent areas with high population density.



Annual Average NO_2 Concentration in 2019

Nitrogen dioxide (NO_2) is a pollutant that comes from burning fuels like gasoline, diesel, coal, and natural gas. On the map, the light blue color represents areas with low amounts of NO_2, while the dark blue represents areas with high amounts of NO_2.



1. What places have the highest population density?

2. What places have the highest NO_2 concentration?

3. Does every place with high population density have high NO_2? Why or why not?

NAME:_____ **DATE:** _____

COVID-19 Lockdowns & Air Pollution

During the beginning of the COVID pandemic, lockdowns made it so people stayed home instead of driving to work and school. So how did that affect air pollution? We'll visit the online tool "Air pollution changes during COVID-19 lockdowns" from Earth Engine Apps to find out.

URL: https://nina.earthengine.app/view/lockdown-pollution

At the top is a search bar where you can type in the name of a city or country. Searching a country here will move the maps to center on that location.

On the left hand side, there are dropdown menus where you can choose a country and a pollutant. After choosing one of each, you will see a graph. The black line is the observed pollutant concentration. The dot marks the beginning of the lockdowns. The red line shows the expected amount of pollution.

The rest of the screen is divided into four panels. The top two panels show measurements of NO_2 from a satellite. The bottom two panels show where weather stations used by the researchers are located. Data from the three years before COVID are shown on the left-hand side, while data from the 2020 COVID lockdowns are shown on the right-hand side. The maps will move together if you click and drag.

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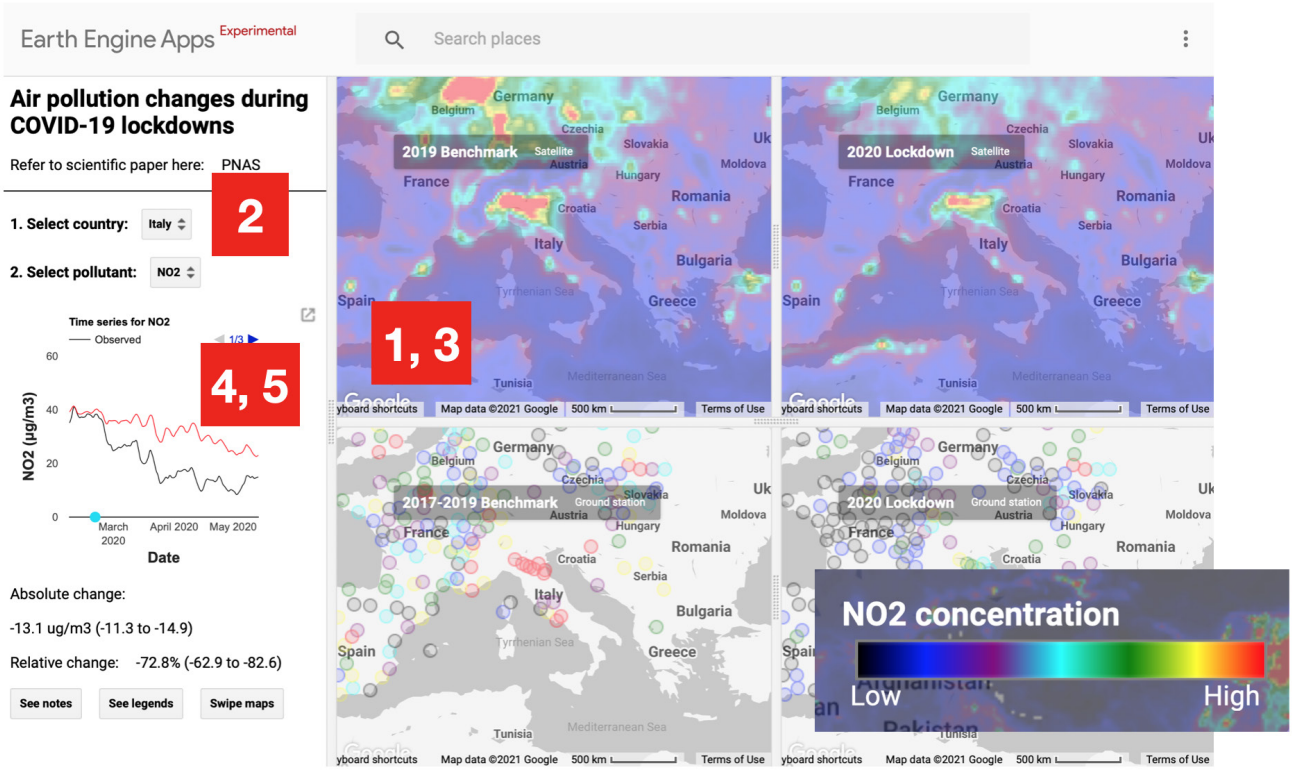

The color scale ranges from dark purple (low concentration) to red (high concentration). Since the legend is not always easy to see on the site, a copy of the color bar is included on the image above.

Answer the following questions.

1. Choose NO_2 from the dropdown menu. On the satellite map, where do you see differences between the pre-lockdown and lockdown maps? Describe the differences you noticed.

2. Choose a country from the dropdown menu. Some countries may not have enough available data, so if no chart appears, choose a different country.

I chose: _____

3. On the satellite map, where in your chosen country is most of the NO_2 pollution located?

4. How do the black and red lines behave after the beginning of lockdown?

5. From the chart, how long do you expect the lockdown lasted?

6. Repeat the activity with another country. Answer questions 2-5 again below.