Download huge wall maps to help students of all ages to

- explore aspects of Europe and mapping technologies without computers
- see Europe hands-on, from new and exciting perspectives
- think like geographers in analyzing cultural and environmental data and patterns across this amazing continent

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Teachers are encouraged to copy materials in this toolkit for use in the classroom.

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Toolkit Overview
Why Mapping?

ACTIVITIES

Grades K-1: Language of Location
How do we talk about places?

Grades 2-3: Europe’s Symbols, Lines, and Direction
What does it mean to read a map?

Grades 4-5:
Mapping Mammals and Protected Areas
What are the patterns of mammals and protected areas across Europe?

Grades 6-8: Tourism Across Europe
How are tourism and World Heritage Sites related in Europe?

Grades 9-12: Powerful Causes and Effects
How are energy and environments connected across Europe?

Glossary
Websites for Mapping and Data Sets
Bibliography
Photo Credits
Download the GA! Europe tile map and support materials:
www.nationalgeographic.com/geography-action

Use GA! Europe activities:
• As collaborative projects in social studies class
• As events celebrating world cultures or Geography Awareness Week
• As a hands-on, low-tech GIS Day activity
• In after-school clubs, scouting, and other extracurricular activities

National Geographic Education Programs is excited to present Geography Action! Europe.

With this GA! Europe toolkit, for use with the Europe tile map or projection map, we are providing educators a set of tools to engage K-12 students in
• Unique, large-scale activities that help students see the world in new ways, while exploring its dynamic environmental and cultural aspects.
• Opportunities to manipulate and analyze a variety of information sets geographically, building skills in critical thinking, representation of data, and mental mapping.
• Insight into and experience working with key mapping concepts, preparing students for use of geotechnologies in future academic and career pursuits.

How does Geography Action! work?

Using the GA! Europe toolkit, students create maps in two ways: either tracing poster-sized maps using an overhead projector or assembling a very large wall or floor map by putting together printable pieces of the continent of Europe. Teachers can prepare either of these maps ahead of time to tailor the resources to class time and students’ needs.

Once the maps are drawn or assembled, students in younger grades attach symbols and a legend, use cardinal directions, or practice language of place and location. Fourth graders and older can map layers of Europe’s cultures and environments using charts and symbols provided in the resources, working with different mapping styles, charts containing data, and using latitude and longitude.

Creating these new learning tools in small or large groups lets students build on their curiosity about the world. Displaying and analyzing geographic information on such a large scale helps students to develop new views of the world, enhancing their mental mapping and analytical thinking abilities.
In what settings can students use Geography Action! Mapping Europe?

Geography Action! activities are rich and flexible enough to use in world geography, global studies, mapping skills, environmental studies, and other courses that offer students an opportunity to explore their world. Educators can also select activities to build into Geography Awareness Week celebrations and GIS Day events, family international nights, and after-school club activities.

Creating the Base Map

Build your Geography Action! Europe Map using the projector map or tile map found in the Geography Action! Europe support materials.

The Projector Map includes outlines of the continents, major islands, and country and state borders. Print or copy the page as an overhead transparency, then project it onto a large sheet of poster-sized paper. Use a document camera or a projector connected to a computer to create the same type of image. Trace the image using markers or pencil. Once the map is drawn, students can use an atlas to add geographic details depending on the activity planned: names of countries, compass rose, latitude, and longitude.

The Tile Map (7.5’ tall x 10’ wide) includes outlines of Europe’s continents, major islands, and country and state borders, plus major cities, bodies of water, and rivers. Pale lines labeled on the four sides in degrees indicate longitude and latitude. The finished product can cover the wall of a classroom, cafeteria, or gymnasium.

To build the map, print the 112 pages [from four grouped 28-page pdfs] to a regular black and white printer on 8.5”x11” paper. Use a paper cutter to trim the borders for clean lines, and if possible, laminate the tiles for sturdiness and repeated use.

On the floor or on tables have students, depending on their ages and class time available, assemble groups of contiguous tiles to form small sections of the map. To save time, teachers can also assemble in advance sections for students to work with, then students can help to fit the entire map of Europe together in class.

Assign groups to work on different areas of the map. Start with the first layer from the activity you have chosen, and have each group apply that layer to their part of the map. After each layer is placed on the map, have students discuss patterns they see and the effects on these patterns when a new layer is added to the map.

When each group has finished, a “map construction crew” with ladders and transparent tape can assemble the map on the wall or the floor.
Maps are important tools that help us explore and expand our understanding of the world.

The mapping activities in this handbook are designed to stimulate student exploration of Europe’s cultural and environmental characteristics while they learn critical thinking skills in a geographic context. Students apply different kinds of data to maps, analyze layers individually and combined, then form conclusions. Geography Action! Europe activities simulate what professionals using geotechnologies do every day.

What do maps tell us?

Every map tells a different story. Maps are representations in miniature of much larger places. They shrink large areas such as continents onto a sheet of paper. Symbols represent features such as rivers, famous places, and cities, or topics such as population and precipitation. Maps are made for a variety of purposes, and the features on each map support particular purposes. No single map can show everything.

Because mapping Earth projects a spherical body onto a flat surface, some distortion is inevitable. Mapmakers have created various projections to reduce distortion of area, direction, or shape. Equal area projections maintain accurate relative sizes of land areas throughout the map, but distort shape. The commonly used Mercator projection is not an equal area projection. It shows the polar regions much larger than they actually are. It excels, however, at showing direction.

What are the different kinds of maps?

Some maps show physical features that are clearly visible on the landscape—for example, rivers and mountains. Some highlight other kinds of information not so visible, such as SO₂ emissions or the number of tourists visiting a country in a year. Most maps fall into two general categories:

Reference maps use symbols to represent features of physical and human-made environments—for example, rivers, lakes, mountains, roads, and cities. Road maps and maps that show political boundaries are examples of reference maps.

Thematic maps feature a particular topic and show its spatial distributions or patterns. Common thematic maps are rainfall, temperature, or population maps. Thematic maps use shading, color, dots, and different-sized symbols to represent differences in quantity, such as number of people. They use shapes or colors to represent differences such as climate types. One thematic map type commonly used is a choropleth map, where layers of light and dark shading or colors show geographic patterns. Population density maps are choropleth maps, where each color or shade represents a range of values for the information mapped.
Mapping “Layers” of Geographic Information

Geographic tools and technologies enable placement of thematic and reference maps together for viewing at different scales. Through analysis of two or more map “layers” together, it’s possible to identify patterns and relationships that might not be apparent when analyzing layers in isolation. For example, mapping locations of major cities, industries, pollution levels, and energy use can help in understanding how one factor might influence—or be influenced by—the other factors. Layering data can help in analyzing direct and indirect relations visually at different scales all over Earth.

Map layers combined with graphing features enable geographic analysis of complex visual information. For example, the maps below and on the next page show three different layers of data related to energy and the environment. Each layer can be analyzed on its own for patterns across regions. Then as several layers are combined, students can look for relationships between data sets in different regions of Europe and across the continent. See pages 17-19 for the full activity using these layered data sets.

Layer 1

In this activity, the first layer applied is using data for SO₂ emissions by country across Europe. Each color on choropleth maps like this one represents a different range of values, usually with light colors as low values and darker colors as high values. Students can apply this layer by coloring or by using patterns such as lines of different colors.

Layer 2

For this layer, students apply the pie charts provided, representing the ratio of renewable to non-renewable energy sources for each country. Students can discuss regional patterns they see for each layer separately, as well as correlations they see.
The third layer, shown with dots, features areas most sensitive to acid rain. Students may ask why some of the areas with the lowest emissions and the most renewable energy sources are highly sensitive to acid rain. These questions are part of the analysis process, helping students to recognize that across Europe, countries’ environmental issues are highly interconnected.

Students who map this complex data—through toolkit lessons for grades four and above—will gain familiarity with patterns across regions of Europe. In addition, they will build understanding of how the layering of data is used in a geographic information system, or GIS. Governments, businesses, and the nonprofit sector around the globe use GIS for display and analysis of characteristics and patterns at local to global scales.

Challenge students with more mapping of data layers either on paper or using GIS software or online tools.

One source for GIS education content for K-12 students and teachers is ESRI, Inc. Go to http://edcommunity.esri.com/ for resources.
The following five sets of activities are designed for hands-on, collaborative projects for students using either a poster-sized or wall-sized map of Europe. Activities for young students begin with mapping basics and the language of location, then progress with fourth grade and up to using data sets to create thematic maps exploring cultural and environmental characteristics of Europe’s countries and regions. Activities can be adapted for higher- and lower-grade levels based on students’ interests and abilities.

Activities are designed for students to think geographically, asking and answering questions such as “Where?” and “Why there?” By looking closely at information about tourism, energy use, wildlife, and other concepts that relate to places all over the planet, students can gain a sense that the patterns they are exploring to better understand Europe can help them see the whole world in new ways.
**Objective**

Students use the language of key geographic concepts of place and location in relation to classroom objects and themselves, then apply language to learn the relationship between continents, countries, and cities.

**Guiding Question**

- How do we talk about maps?

**Preparing the Map**

These activities are designed for use with the Tile Map of Europe, but can be adapted for use on the projector or smaller map.

For young students assembling the tile map may be challenging, so consider (1) putting together sections for the students, and then, together as a class, you can help them more quickly assemble the map using these larger, puzzle-like pieces; or (2) consider having them work in small groups with 4-6 pieces of the map, assembling them into a rectangle using the numbers on the pages and the lines on each piece. Students can work with the concepts below on their section of the larger map. Then the teacher can assemble the pieces to display the larger map.

**Directions**

**Activity 1: What is a Map?**

1. Help students understand the concept of a model of something real by showing miniature items representing things from their daily lives, such as a doll house or toy car. Then show students a map of their town or neighborhood, explaining that maps are miniature versions of places on the Earth. Some students might be able to explain that globes are miniature models of planet Earth. Have they seen their parents or grandparents use maps? Tell about it.

**Activity 2: Practicing Geographic Language in the Classroom**

2. Practice geographic language by having students stand in a circle, arm’s length apart. Ask students to look to the students on either side of them. Have them describe their location as “next to” their neighbor. Then help them practice concepts of near and far, by describing their neighbor as “near,” and the children across the circle as “far.” Next, pick two children who are not standing next to one another, and ask who is “between” them. Continue practicing this language using objects in the room, too. Tell students they are talking about the “location” of people and things in their classroom.
3. Explain to students that they are “inside” of the classroom. Ask: What else is inside of the classroom? (Desks, chairs, teacher, books, etc.) Sketch a simple map of the classroom on the board and some of the things that are in it. The classroom is inside of what? (The school) What else is inside of the school? (The cafeteria, the bathroom, the principal’s office, etc.) If possible, add to the map of the classroom by sketching the school and some of the places students list as inside it. Trace the boundaries—the walls—of the classroom, asking students, “How do we know we are inside the classroom?” Then ask questions using “next to,” “between,” “near,” and “far” with the sketched map.

**Activity 3: Europe the Continent**

4. Using a globe or world map, help students repeat after you where they live starting with town/city, then country, then continent. Together, name and point to the seven continents. Point out the oceans. Help students to see the relationship between the globe or world map and the map of Europe they will be using.

5. Tell them they will be taking a very large look at one continent: Europe. Ask: Where is Europe? What lies between the Europe and their own continent? (Possible answer: Atlantic Ocean.)

6. On the tile map, point to parts of two other continents that are near Europe: Asia and Africa. Point out that Asia is next to, near, or east of Europe. Point to Africa, which is next to, near, or south of Europe. Ask: Which continent is between Asia and Africa? (Europe) Have students repeat after you to practice geographic language:

   - Next to — Africa is next to Europe. Asia is next to Europe.
   - Near — Africa is near Europe. Asia is near Europe.
   - Between — Europe is in between Asia and Africa.
   - Far From — The Atlantic Ocean is far from Asia.

**Activity 4: Countries are Inside Continents**

7. Prepare cut-outs of countries by printing out specific tiles and pasting them together. Consider colored paper for the cut-outs so that the country shapes stand out on the map. Suggested countries with their corresponding tiles are below, but feel free to choose any country as an example.

8. Explain that countries are inside of the continent of Europe. Show students the prepared country cut-outs, and help them place them on the map, as if they are pieces of a puzzle. Trace the border of one of the countries with a finger, then have students go to the map one at a time and outline a country with their finger. To reinforce that countries are inside of continents, have students repeat after you “_____ is inside of Europe.” If students ask questions about the island countries that are “inside” Europe, remind them that the continents stretch around the island countries, too.

9. You can also teach “larger than” and “smaller than,” but remember that country size is measured in population as well as land size. To be clear, have students state that a country has more land or less land than another country.

**Country suggestions** — Italy (tiles 75-76, 89-91, 104-105); France (tiles 59- 61, 73-75); Spain (tiles 71-74, 85-88); Lithuania (tile 50)
Objective

Students will label parts of a map with symbols and build a map legend. Extensions give students opportunities to use cardinal directions, a compass rose, and latitude and longitude.

Guiding Question

• How do people use maps to learn about places such as the continent of Europe?

Preparing the Map

These activities are designed for use with the Tile Map of Europe, but can be adapted for use on the projector or a smaller map. For complete instructions for each map, see pages 2-3.

With this activity designed for young students, assembling the tile map may be challenging or time-consuming, so consider putting together smaller sections for the students in advance. Then, together as a class, you can help them assemble the map from the larger pieces. A second option is giving small groups of students four to six contiguous pieces of the map to assemble. Groups can then do the activities below on only their section of the larger map. Then the class can assemble the pieces to form the complete Europe map.

Directions

Activity 1: What Can We Do With Maps?

1. Show students a globe, and describe it as a model of Earth. Compare it to other models they might be familiar with, such as a doll or toy truck. Help students find their home country or state on the globe, then show them a map of their town or neighborhood to help them see that maps are miniature representations of places on Earth. Have them name places on the map, such as streets, buildings, or parks. Talk about how maps are not the real place, but they help us to know about real places. Ask:

   • Have you seen your family members use maps? Tell about it.

2. Draw a map of the playground or classroom on the board or large paper. Ask:

   • What things are in the playground or classroom that you might show on the map?

   Attach small rectangles to the map as students’ desks on the map, or alternatively shapes of swing sets or other playground features. Talk about how these are symbols.
Point to a symbol on the map and have a student go to that place in the room or playground. Ask students to point to symbols for the places on the map where they like to play or learn. Talk about how maps help us to show our ideas about places.

3. Look at a world map or globe and identify the town/city, country, and continent where the students live. Review how a town or city is inside of a country, and in some countries inside of a state; then review how countries are inside of continents. You might have students review the seven continents on maps or globes, then have students name a country inside of each continent. Find Europe, then tell students they will learn more about using maps with a very large map of the continent of Europe. Ask:

- What do you know about Europe? What would you like to know about Europe?
- Where is Europe in relation to where we live?

**Activity 2: Symbols and Legend**

4. Explain to students how a symbol can represent places such as cities, mountains, or rivers, and that we can use a map legend to show these symbols. The map legend helps in reading the map. Create a large map legend on a piece of paper, with “Legend” written at the top. Glue a piece of blue string below the legend name at top left, labeling “rivers” to the right. You will attach this legend to the tile or projector map later. Find one of Europe’s rivers on a map section, then glue blue string to it. Have students continue to glue the blue string to rivers on their assigned sections.

5. Show students another symbol, a gold star, and ask:

- How could this be used on the map? *Stars are usually map symbols for capital cities.*

Place one in the legend and write capital city next to it, then have students place gold stars on the capital cities of each country. Ask:

- How could we use small black circles as symbols on the map? *They could be cities.*

Draw and label in the legend a black circle to represent cities, or have students create their own symbol to place in the legend and on the non-capital major cities. Ask:

- What does the map show you about cities and capital cities in Europe? *Possible answers: Each country has one capital city. The map helps us to know where cities are inside of their countries. Some cities are by rivers.*

6. Choose other features on the map to have students label. Students can again design their own symbols. For example, students can cut out triangles for mountains.

**Activity 3: Using Latitude and Longitude or Grid Systems to Identify Locations**

7. Have students trace over the latitude (horizontal) and longitude (vertical, but curved) lines with colored markers, circling each of the numbers for degrees on the sides of the map. Choose several cities or other symbols on the map and have students tell which lines of latitude and longitude are closest. Students can complete the Longitude and Latitude Worksheet using the tile map as a reference. Ask:

- How can lines of longitude and latitude help us to “read” and use maps?

*Note:* Using degrees of longitude and latitude may be too advanced for some students. As an alternative, cover the lat/long numbers along the map’s margins horizontally with letters starting with A, and vertically with numbers starting with 1. Then have students use this grid to identify locations on the map.
Objective

Students will use a variety of mapping techniques to explore the distribution of land and marine mammals across Europe and the relationships with protected marine and land areas.

Guiding Question

• What connections are there between protected marine/land areas and the ranges in which Europe’s mammal species live?

Preparing the Map

These activities are designed for use with the tile map of Europe, but can be adapted for use on the projector map.

For students, assembling the tile map may be challenging or time-consuming, so consider putting together sections in advance. Then, together as a class, they quickly assemble the pieces to make the base map.

Directions

Activity 1/Map Layers 1 and 2: Protected Marine and Land Area

1. Once their tile or projector map is ready, show students the Protected Land Area Key and Protected Marine Area Key documents. Choose colored markers to represent the different ranges on the key. For the protected land area, draw diagonal lines of different colors in each of the rectangles on the key. For the marine areas, color each line next to the ranges a different color.

2. Divide students into two groups and assign one the data chart for Protected Land Area and the other group the data chart for the Protected Marine Areas. Students can then follow the keys and take turns drawing the lines on the countries for the Protected Land Areas, and coloring the coastlines to represent the Protected Marine Areas.
3. Once the data is applied, have students examine it. Ask:
   - Which countries have the largest number of protected marine areas?
     Which countries have the smallest number?
   - Which countries have the largest number of protected land areas?
     Which have the fewest?

**Activity 2/ Map Layer 3: Mammals**

4. Using the Europe map, review with students the four cardinal directions, labeling or attaching cards saying north, south, east, and west in large letters in the map’s margins if needed.

5. Tell students that they are going to map the areas where different mammals live in and around Europe. Assign each student or pairs of students one of the land or marine animals to learn more about. Give students colored paper to create ten shapes for their animal to be used as map symbols. Some students may need to cut more later. Make map keys on paper to attach to the left side of the map, labeling them “Land Mammals of Europe” and “Marine Mammals of Europe.” Have students attach one animal symbol to the appropriate key and label it.

6. Give students a two-sided copy of the Land Mammals/Marine Mammals of Europe data charts. Have students find the column for their mammal. Discuss the meaning of endangered and threatened species with students. Looking at their charts, is their mammal labeled endangered or threatened? Have students mark symbols for endangered mammals with an “E” and threatened mammals with a “T.” Also, mark the symbols that have been placed on the keys with these letters where applicable.

7. Have students look down the column for their mammal to find the groups of countries or bodies of water where it may be found. Students can mark the chart with the information that they need. Then have students go the map and locate each area, attaching a symbol to the countries or groups of countries where the mammals may be found.

8. Once all students have attached their mammal symbols, ask questions and see what observations students have about the patterns of the different mammals.
   - Which marine and land mammals have the most symbols on the map? Which have the least?
   - How many of the mammals are endangered or threatened?
   - Which marine mammals’ ranges are to the north? To the south? To the west of Europe? Have students name the bodies of water where their mammal lives.
   - Which land mammals’ ranges live in the northern parts of Europe? In the southern part? Are there some that only live in the east or west?
   - Is there a pattern or relation between the countries that have a lot of protected areas and the number of mammals—including endangered and threatened—that can be found there?
   - Why do you think these countries are protecting these land and marine areas?

**EXTENDING THE LESSON**

Have students research the mammals that they are mapping to learn more about them and also to find images for each that they can use to show the class. Student teams can be assigned their mammal to research as a homework assignment. Before placing the symbols on the map, each group can describe their mammal’s characteristics and habits.
Objective

Students will practice different techniques to map information about tourism in Europe, then will use the map to explore characteristics of countries and regions that relate to tourism.

Guiding Question

• What are the patterns of tourism and World Heritage Sites across Europe’s countries and regions?

Preparing the Map

These activities are designed for use with the Tile Map of Europe, but can be adapted for use on the smaller projector map.

In using the tile map for this lesson, consider having groups of students first assemble four to six contiguous pieces of the map, then have them combine the pieces to create the large map. If preferred, students can map data for small sections, looking at geographic patterns in smaller regions of Europe. Once the entire map is assembled, the whole class can analyze patterns across the continent.
Directions

Activity 1/Map Layer 1: Total Number of Tourists

1. Once the tile or projector map is ready to use, tell students they are going to build a choropleth map—where colors or symbols represent statistical information—of Europe’s tourist visitors. (See pages 4-6 for more on choropleth mapping.) Students will then map additional layers of information and analyze patterns related to Europe’s tourism. Ask:

- Where have you been a tourist? Would you like to visit any countries in Europe? What would you like to see or do?
- Why do tourists matter to Europe? (Tourists are good for the economy, helping to support jobs; people come to Europe to see famous sites, explore their roots.)
- What countries/places do you think people might want to visit in Europe? (Possible answers: famous sites such as the Eiffel Tower in Paris, art museums, cathedrals, Rome, London.)

2. Add colors or patterns of lines to the boxes on the Total Number of Tourists Key, so that students will know which colors to use for the different values in their data chart. Attach the legend to the map below the title, or give out copies of the key if working in groups.

3. Using the key and copies of the data chart, have students apply the appropriate pattern for different countries, creating the choropleth map. Ask students about the patterns they see.

- Which countries have the highest number of tourists? Which have the lowest?
- Are there groups of countries that have similar patterns of tourism? (Countries in the western part of Europe, including Germany, Austria, and Italy, have similar numbers of tourists. Countries to the east, such as Poland, Czech Republic, and Croatia—often called Eastern Europe—have fewer tourists. The countries to the north, including Sweden, Norway, Finland—called Scandinavia—also have similar numbers of tourists.) Tell students that groups of countries close together with similar characteristics are often called regions.
- Are there any countries that do not seem to fit the patterns of their region? Why might this be? (Greece and Russia have higher numbers of tourists than other countries in the eastern region of Europe. List students’ ideas for why this might be.)
- Why do you think tourism seems more popular in some areas than others? (Help students draw conclusions on their own throughout the activities. Possible ideas might be that tourists often want to vacation in warm places with beaches, so countries along the Mediterranean Sea have high numbers of tourists. Countries without coastlines seem to have fewer tourists. Countries such as France, Italy, Spain, and the U.K. have famous landmarks and many visitors.)

Activity 2/Map Layer 2: Money Received From Tourism

4. Have students predict how the money received through tourism might compare with patterns for numbers of tourists.

- What might tourism income include? (Income from hotels, restaurants, transportation)
In which countries would you expect high income from tourism? In which countries would you expect money received from tourism to be low?

5. Add the Tourism Income Key to the map. Have students look at the ranges for the symbols on the Key and use the data sheet to determine which of the graduated euro symbols should be attached to each country. Graduated symbols provide another way of looking at data, where the size of the symbols represents different ranges of value.

• What relationship do students see between the number of tourists and the money received from tourism in different countries? In different regions? [The most tourism money received is in the countries of western Europe and southern Europe. Russia has a high number of tourists, but not the highest level of money received from tourism.]

• Looking at the two layers, are there any countries that stand out as different than their surrounding countries?

Activity 3/Map layer 3: Total Number of World Heritage Sites

6. Explain that there are nearly 900 sites of cultural or natural significance around the world named by the United Nations as “World Heritage Sites,” and nearly 400 of them are in Europe. Examples include:

• Palaces, castles, cathedrals built centuries ago
• Ruins from the Roman and Greek empires, thousands of years old
• Entire cities, including Italy’s Venice and Vatican City
• Cave systems, mountains, national parks

7. Have students make predictions about the third layer, thinking about what they have learned from the previous two layers.

• Which countries do you think have the most World Heritage Sites? Which regions?
• Which do you expect will have the fewest?

8. Attach the Number of World Heritage Sites Key to the map. Using the data sheet and the ranges on the key, have students apply the World Heritage Sites graduated symbols for each country.

9. Have students examine any patterns they see within the Number of World Heritage Sites layer. Ask:

• Which countries and regions have the most World Heritage Sites? (The western region of Europe has more World Heritage Sites, as well as Russia, Greece, and Hungary; this may explain why Greece and Russia have many tourists).

• Which countries or regions have the fewest number of World Heritage Sites? (The eastern and northern regions of Europe have fewer World Heritage Sites than western Europe.)

• Are there countries in Europe that have a high number of World Heritage Sites and a low amount of tourism income? Which countries have a low number of World Heritage Sites and a high amount of tourism income? Ireland, Switzerland, Austria. Why might this be? (These countries may be popular destinations because of reasons beyond the World Heritage Sites: their landforms and natural beauty, intriguing culture and lifestyle.)
Objective

Students will map and analyze layers of energy use statistics, sulfur dioxide (SO₂) emissions, and acid rain patterns to explore environmental issues across Europe.

Guiding Question

• What are the patterns of relationships between energy sources and energy consumption in Europe?

Preparing the Map

These activities are designed for use with the Tile Map of Europe, but can be adapted for use on the smaller projector map.

For the Tile Map, divide the tiles into regions so that each group of three students works with roughly four to six tiles of land. Some groups can assemble the extra tiles to complete the surrounding ocean and continents, or you can arrange those non-Europe tiles in advance to speed the map assembly.

Give each group the tiles for their sections, providing the map key if needed, and transparent tape. Students begin by carefully taping their pieces together to form part of the larger map. In the activities below, students work with the data on their map tiles first, then the class can further discuss the patterns across the continent after assembling the whole map.

Directions

Activity 1/Map layer 1: Total SO₂ Emissions Per Capita

1. Explain to students that chemical reactions in the atmosphere cause sulfur dioxide emissions to contribute to acid rain. Acid rain, which falls in rain or snow, is harmful to plants and animals. One cause of SO₂ emissions is the burning of non-renewable resources. Review with students as needed the difference between renewable and non-renewable resources, especially as it relates to energy resources.
2. Discuss why data is often presented per capita. Ask:
   - How does this help in comparing and contrasting data for different countries? *(Per capita data helps in comparing and contrasting data for different countries because it puts each country in a standard of units per person. For example, a country may have more total SO2 emissions because it has a larger population, but when comparing the SO2 emissions per person, it could have far less than a smaller country.)*
   - Ask students to list the countries they think will have the lowest and highest SO2 emissions per capita.

3. Have students apply data layer 1 from the data sheet as a choropleth map to their section (see pages 4-6 for more on choropleth mapping). Where countries are split between groups, have the group that has the name of the country on their section, or the first part of the name on their section, apply the data. Discuss:
   - Which of their countries mapped have high SO2 emissions per capita compared to neighboring countries?

**Activity 2/Map layer 2: Energy Consumption by Source**

4. Next, have students place the pre-constructed pie charts that show resource consumption on their countries. Discuss:
   - Which of their countries have a high percentage of non-renewable energy sources?
   - Which have a high percentage of renewable energy sources?

5. Discuss the possible relationships between the data layers.
   - Does there seem to be a relationship between SO2 emissions and energy consumption by source? Are there any surprises?

6. At the end of the first class period or beginning of second—time permitting—have the class assemble the whole map using tape. Add the sample pie chart with labels to the map key.

**Activity 3: Analyzing Data for All of Europe**

7. Once assembled, have students analyze the data for all of Europe. Ask:
   - Which countries of Europe have the highest SO2 emissions per capita? The lowest? *(Czech Republic, Estonia, Lithuania, and Bulgaria have higher SO2 emissions; and Spain, Italy, France, Croatia, and others have lower SO2 emissions.)*
   - What patterns do they see in different regions of Europe? *(Countries along the Mediterranean Sea generally have lower SO2 emissions, and countries in the eastern part of Europe generally have higher SO2 emissions.)*

8. Next, discuss renewable and non-renewable energy sources, and their impact on SO2 emissions. Discuss the pros and cons of visualizing data in this way. Ask:
   - In what ways does placing the pie charts on a map help in analyzing this data? Why do you think the pie charts were used in this exercise? *(Pie charts enable layering over the choropleth data on the base layer.)*
   - Which countries and/or regions use the highest levels of renewable energy? The least? *(Scandinavian countries use the highest percentage of renewable energy compared with non-renewables; the U.K., Ireland, Czech Republic, and the Ukraine use the lowest levels of renewable energy.)*
9. Have students examine the relationship between the “SO₂ Emissions per Capita” layer and the “Energy Consumption by Source” layer. Ask:

- What correlations do you see between energy consumption and SO₂ emissions? *(In general, countries with lower SO₂ emissions are those that use higher levels of renewable resources.)*

- Are there any surprises/exceptions to this pattern? *(Norway, Finland, Estonia, and Latvia have high SO₂ emissions and high renewable resource use. Note: Burning renewable resources such as wood can contribute to SO₂ emissions, so may be a factor in high SO₂ levels for these countries.)*

10. Review how chemical reactions in the atmosphere cause sulfur dioxide emissions to contribute to acid rain problems. Ask:

- Which areas of Europe do you think are most sensitive to acid rain? *(Students may predict that countries that produce the most SO₂ emissions are most likely to be sensitive to acid rain. In the next activity they will see that this is not always the case.)*

**Activity 4/Map Layer 3: Areas Most Sensitive to Acid Rain**

11. There are multiple ways of placing this layer on the map. Use tinted cellophane or a string to outline the areas; be sure to use a material that will allow the choropleth layer to be seen underneath the acid rain layer. Discuss:

- What areas of acid rain sensitivity are most surprising? Why might this be? *(In some countries there is high acid rain sensitivity even though SO₂ emissions are low. One reason for high acid rain sensitivity where SO₂ emissions are low is that wind patterns in the atmosphere carry the SO₂ from other areas before the acid rain precipitation. Another factor was discussed in Activity 2, that burning renewable resources such as wood can contribute to SO₂ emissions, so may affect high SO₂ levels for some countries.)*

- How might this affect energy policy discussions among European countries?
acid rain – precipitation containing acid droplets resulting from the mixture of moisture in the air with carbon dioxide, nitrogen oxide, sulfur dioxide, and hydrocarbons released by factories and motor vehicles.

choropleth map – a map that shows differences between areas using colors or shading to represent distinct categories of qualities (such as vegetation type) or quantities (such as population density or income).

city – a large concentration of people and buildings.

compass rose – a symbol on a map that indicates the map’s orientation in relationship to the four cardinal directions.

continent – one of the seven main land masses on Earth’s surface.

country – a territory whose government is the highest legal authority over the land and people within its borders.

endangered – an animal species in immediate risk of becoming extinct.

geographic information system (GIS) – computerized system for storing, analyzing, and displaying data about places. It allows the user to control the look of the map using different layers of data represented in different ways, and use the power of the computer to answer questions.

graduated symbol – images of different sizes on a map that illustrate ranges of quantities (such as population size or income).

landmark – a geographic feature, natural or man made, that is easily recognized and can be used to help navigate in an area.

latitude – distance in degrees north and south of the Equator, which is 0° latitude.

legend/map key – a key to symbols used on a map.

longitude – distance in degrees east and west of the Prime Meridian, which is 0° longitude.

mammal – a warm-blooded animal that is relatively covered in hair and gives birth to live young.

map – a geographic representation of Earth, or a portion of it, that is usually drawn to scale on a flat surface.

non-renewable energy source – energy from resources that form in extremely slow geological processes (e.g., petroleum and minerals).

ocean – the large body of salt water that surrounds the continents and covers more than two-thirds of Earth’s surface.

per capita – an average amount of a commodity per person in a specific population.

protected land area – any area of land that has been reserved by government regulations to provide lasting protection to the region.

protected marine area – any area of marine environment that has been reserved by governmental regulations to provide lasting protection to the region.

range – the area within which an animal species lives and moves.

region – an area of Earth that is grouped together because of similarities in physical or human characteristics that set it apart from other areas.

renewable energy source – energy resources that are replenished naturally, but the supply of which can be endangered by overuse or subject to weather (e.g., timber, solar, wind).

SO₂ emissions – the release of sulfur dioxide into the air from various sources, including but not limited to car and factory exhaust.

symbol – a shape or small image on a map that represents a geographic feature such as a mountain, city, habitat.

thematic map – a map representing a specific spatial distribution, theme, or topic (e.g., population density, cattle production, or climates of the world).

threatened – an animal species at risk of becoming endangered and extinct.

tourism – the activity of travel for pleasure and the industry based on such travel.

World Heritage Site – a natural or cultural area or structure designated by United Nations Educational, Scientific, and Cultural Organization (UNESCO) as being of global significance. Each site is under strict protection by its respective government.
**Websites for Mapping and Data Sets**

www.nationalgeographic.com/earthpulse

http://earthtrends.wri.org/

http://prb.org/DataFinder.aspx

http://www.worldmapper.org/

http://www.loc.gov/rr/geogmap/

**Bibliography**


www.nationalgeographic.com/geography-action


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