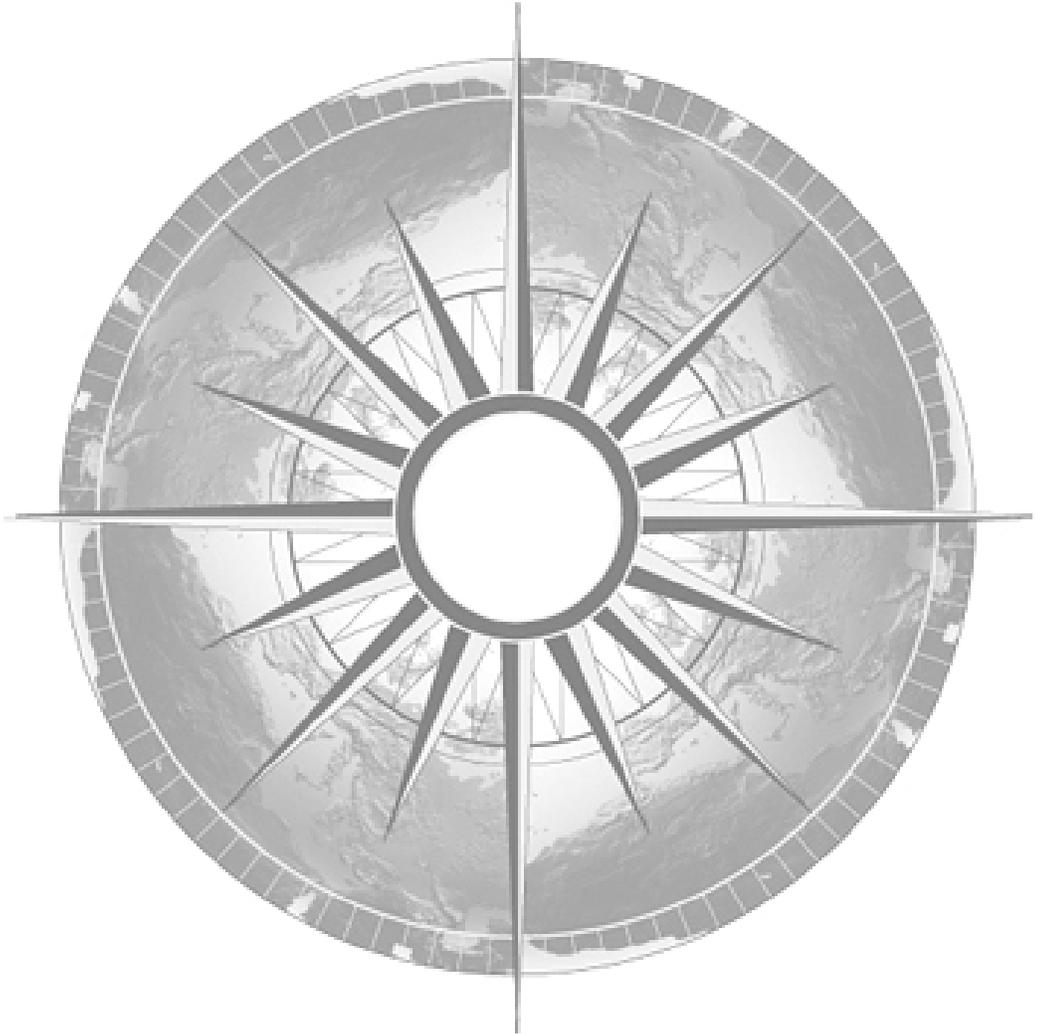


HEMISPHERES

People and Place Curriculum Resources on Human-Environmental Interactions

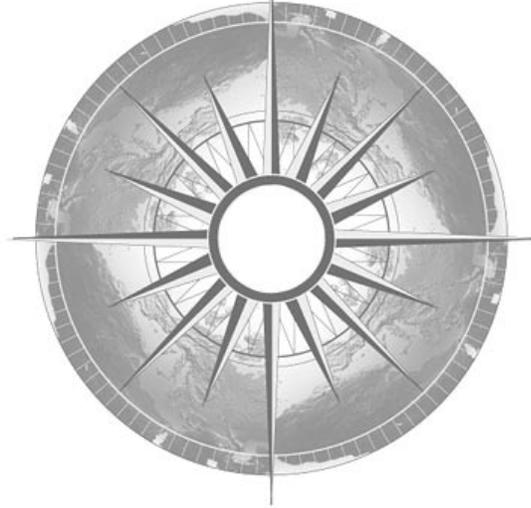


Hemispheres is a joint project of:
Teresa Lozano Long Institute of Latin American Studies
Center for Middle Eastern Studies
Center for Russian, East European & Eurasian Studies
South Asia Institute

in the College of Liberal Arts
at The University of Texas at Austin

People and Place

Curriculum Resources on
Human-Environmental Interactions



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People and Place
Curriculum Resources on
Human-Environmental Interactions

Final Version

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TEACHER NOTES**GOALS**

This case study was prepared to foster understanding of urban air pollution problems in the world. Students will understand that: (1) the factors involved in creating pollution are varied; (2) pollution has serious effects on health and well-being; and (3) solutions to environmental damage are complex and have their own repercussions. Students will work with readings, maps, charts, and graphs in order to develop geographic skills.

ASSESSMENT EVIDENCE

Propose a Pollution Prevention Plan for Mexico City: Students will support a proposal to lessen air pollution by drawing on evidence in the case study and presenting it in a written or visual presentation. All readings included in the case study can be given as handouts, which is recommended so that students have appropriate background information to complete the final activity.

LEARNING ACTIVITIES

- As an *Introduction*, and based on the level of preparedness of your class, you may want to write the term “air pollution” on the board and ask students what they already know about it or what they associate with the term.
- *Dramatic Moments in Mexico City* provides a “hook” that demonstrates the worst-case scenario regarding air pollution. Students are introduced to types and causes of air pollution.
- In *The Geography of Mexico City*, students find Mexico City on a map (included in this unit). The instructor should either present or have the students read the geography text. Class discussion questions are included for comprehension.
- *Pollutants/Geographical Challenges* is an introduction to types of air pollutants and reasons why they remain in Mexico City, accompanied by discussion questions for comprehension.
- *The World’s Megacities* provides data on the largest cities in the world, accompanied by a map placement exercise. This activity prepares students for an analysis of the most polluted cities in the world. This activity can be eliminated if time is limited.
- Using *Polluted Megacities of the World*, students complete and analyze a chart of air pollution in the world’s biggest cities. This activity can be eliminated if time is limited.
- In *Causes of Pollution*, students reflect on causes of pollution as presented in pie charts.
- After completing the *Pollution and Health Problems* reading, students journal about how high air pollution would affect their lives.
- After reading *Day Without a Car*, part of Mexico City’s plan to decrease air pollution, students answer comprehension questions in preparation for the final activity.

“Comparing the air of cities to the air of deserts and arid lands is like comparing waters that are befouled and turbid to waters that are fine and pure. In the city, because of the height of its buildings, the narrowness of its streets, and all that pours forth from its inhabitants and their superfluities...the air becomes stagnant, turbid, thick, misty, and foggy...If there is no choice in this matter, for we have grown up in the cities and have become accustomed to them, you should...select from the cities one of open horizons...endeavor at least to dwell at the outskirts of the city...”

MOSES MAIMONIDES (1135-1204)

Dramatic Moments in Mexico City

ARTICLE 1: Wednesday, May 27, 1998

No let-up for Mexico City pollution

The authorities in Mexico City have extended emergency measures for a second day after air pollution once again reached dangerously high levels.

The Mexican Environment Minister, Julia Carabias, says no significant rainfall is expected for at least another two weeks and warned that the worst pollution is still to come.

Since Tuesday, more than a third of cars have been ordered off the roads, factories have been forced to reduce output, and schoolchildren are not allowed to play outside.

The Mexican capital, one of the world's biggest and most polluted cities, is covered by a thick veil of smog, along with smoke from surrounding forest fires.

The BBC correspondent in Mexico City says one of the greatest concerns at the moment is the high ozone level. The elderly are being advised to stay indoors for fear that it could cause respiratory problems, or worsen heart complaints.

Ozone is a colourless, highly reactive pollutant created by sunlight reacting with car and factory fumes.

Alert also in Texas

Much of Mexico's smoky haze originates from forest fires in Oaxaca, and the southern state of Chiapas.

Fifty firefighters have been killed in the line of duty in the first five months of the year. The Mexican army has also been mobilised in the environmental emergency.

This week the US government sent Mexico firefighting advisers, some equipment, and at least \$2m for the hire of private blaze-extinguishing helicopters.

The fires, aided by southerly winds, have carried soot particles north causing hazy skies in Texas and other parts of the United States.

The Texas health officials have suggested that people with respiratory problems avoid exercise and outdoor activities.

Source: BBC News Online, <http://news.bbc.co.uk/1/hi/world/americas/101035.stm>

ARTICLE 2: Saturday, October 16, 1999

Mexico City pollution emergency

The authorities in Mexico City have taken emergency action to cut dangerously high air pollution levels by ordering hundreds of thousands of cars off the roads and telling factories to work at thirty percent of normal capacity.

The alert was declared after amounts of harmful ozone rose almost three times above the highest level considered acceptable by other countries.

The BBC Correspondent in the Mexican capital says that even by Mexico City's standards the unseasonally high pollution levels have been quite literally breath-taking. Meteorologists say an unusually clear dry spell has drawn huge amounts of ozone into the Mexico City basin. Environmentalists say drastic action is needed to reduce the four million tons of toxic emissions released into the city's air each year.

Source: BBC News Online, <http://news.bbc.co.uk/1/hi/world/americas/476540.stm>

The Geography of Mexico City

In 1325, the Aztecs founded their capital of Tenochtitlán on a beautiful site: two islands in Lake Texcoco, at the southern end of the plateau of Anáhuac. The site is high in the mountains, at an altitude of 7800 ft (2,380 m). Two major mountain chains come together there, creating a stunning view around the city. The climate is gentle and, most of the year, cool and dry. Although the Aztecs flourished there, the magnificent city of Tenochtitlán was mostly destroyed, in battle with the Spaniards, before it was rebuilt as Mexico City.

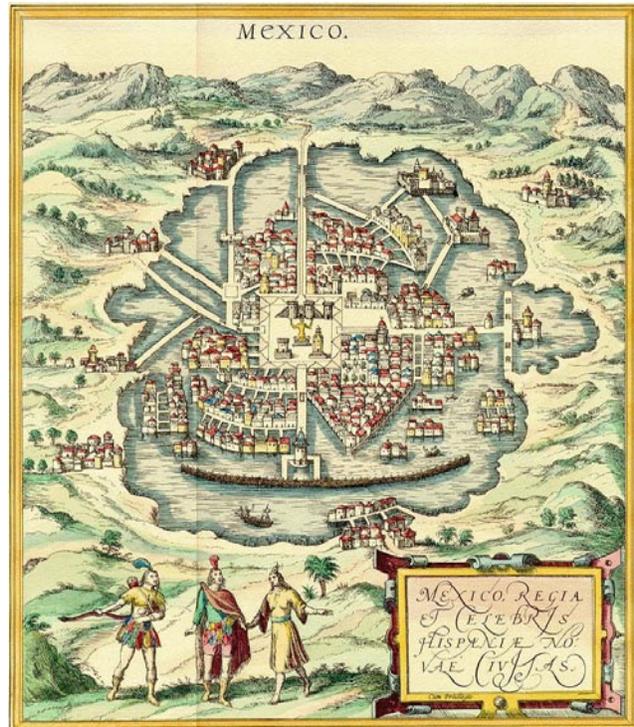
Over time, Lake Texcoco and other surrounding lakes were drained so that the city could grow. Because of the extensive draining, the city is now sitting on soft subsoil—the surface soil is no longer supported by water underneath it—and some of the city’s heavy buildings are sinking 4–12 inches a year. Some of the city’s oldest and most beautiful buildings have been damaged, including the old cathedral and the Palace of Fine Arts.

Earthquakes are also a risk in Mexico City. The 1985 earthquake, which lasted only a few seconds, caused more damage than any other natural disaster in Mexico’s recent history. Additionally, volcanoes—including nearby Popocatepetl and Iztaccihuatl—are common in the region.

Overcrowding in Mexico City has added to the city’s environmental problems. Heavy volumes of traffic and factory emissions, along with the surrounding mountains that do not allow pollutants to escape, combine to cause heavy air pollution. The government has worked on the problem by imposing car restrictions (based on license plate number, cars are required to stay off the roads for one day each week), upgrading buses, and working with industry to reduce pollutants. However, as one engineer has noted, trying to reduce air pollution is like trying to “fix an airplane while it’s in flight.”

Sources: *The Columbia Electronic Encyclopedia*, 6th ed. Copyright © 2004, <http://www.infoplease.com/ce6/world/A0859611.html>

R. Conrad Stein. 1998. *Mexico: Enchantment of the World*. NY: Children’s Press. 83.



A Renaissance-era map of Mexico City depicts the geography of the area. Source: Henry Davis Consulting, <http://www.henry-davis.com/MAPS/Ren/Ren1/337.3.html>.

Class Discussion Questions

- (1) Is Mexico a high city? What is it surrounded by?
- (2) What is good about the site that Mexico City is built on? What is bad?
- (3) In addition to problems caused by geography, what environmental problems are caused by people?

Map of Mexico



Source: Perry-Castañeda Map Collection, University of Texas at Austin, http://www.lib.utexas.edu/maps/americas/mexico_rel97.jpg

Pollutants and Geographical Challenges

Pollution in Mexico City is regularly above the air quality standards considered acceptable by most other countries and international organizations; this means that people who live in Mexico City breathe in gases and chemicals that are bad for their health. Fossil fuels (oil, coal, natural gas) are the main source of energy in Mexico's factories. But the use of fossil fuels can lead to pollution: their combustion releases chemicals and gases, or **primary pollutants**, into the air. These primary pollutants can cause any number of problems, from eye and throat irritation in people, to global warming. Primary pollutants include carbon monoxide, nitrogen oxides, sulfur oxides, and particle matter (dust, ash, etc.).

In addition to being dangerous on their own, when exposed to the sun, many primary pollutants go through a photochemical reaction that creates **secondary pollutants**. Secondary pollutants include sulfuric acid, nitrogen dioxide, and ozone. Primary and secondary pollutants, combined with aerosols (tiny particles like water droplets, dust, and soot that are suspended in the air), can form smog, the brown haze we see over large cities like Los Angeles and Mexico City.

Mexico City's most important air pollutants are ozone (O₃), sulfur dioxide (SO₂), nitrogen oxides (NO_x), hydrocarbons (HC), and carbon monoxide (CO). Much of this pollution comes from gas exhaust from private vehicles.

The unique geographical structure of Mexico City allows pollutants like carbon monoxide to stay in the air. Mexico City is surrounded by mountains, making it seem as if it is trapped by high walls of mountains. This makes the city look like a basin (imagine it as a kitchen sink, with Mexico City at the bottom, surrounded by mountains on all sides); hence the popular phrase, "Mexico City Air Basin." Because of the structure of the land, the winds are not able to push smog over the surrounding mountains, and as a result many pollutants like carbon monoxide build up over the city. The highest level of carbon monoxide in the air is usually on weekday mornings between 7:00 and 9:00 a.m. During this time period, low temperatures, low atmospheric stability, and heavy traffic all occur at the same time. In the evening the winds effectively circulate through the air, but the particles remain nearby to be blown into the city again the next morning.

Sources: Source: Universität Salzburg, <http://www.sbg.ac.at/ipk/avstudio/pierofun/mexico/air.htm#Pollution>
 University of Washington, <http://carbon.cfr.washington.edu/esc110/2003Fall/projects/043/Causes.html>

Class Discussion Questions

- (1) What is the primary energy source in Mexico's factories? Why is this bad?
- (2) What are primary pollutants? What dangers do they pose?
- (3) What are secondary pollutants?
- (4) What is one of the most important sources of air pollution? Do you think that Mexico City's population (22 million) contributes to this problem?
- (5) How do the mountains surrounding the city contribute to the pollution problem?
- (6) When is pollution at its worst? At night, does the pollution go away? Explain.

Name: _____

The World's Megacities

Look at the following chart of the world's biggest cities as of August 2004.

(1) Using maps in your geography book, label the cities and countries listed below on the blank world map.

(2) Underline the names of the following cities on the map: Beijing, Buenos Aires, Cairo, Jakarta, Karachi, Los Angeles, Mexico City, São Paulo, and Seoul. The underlined cities are the most polluted cities in the world.

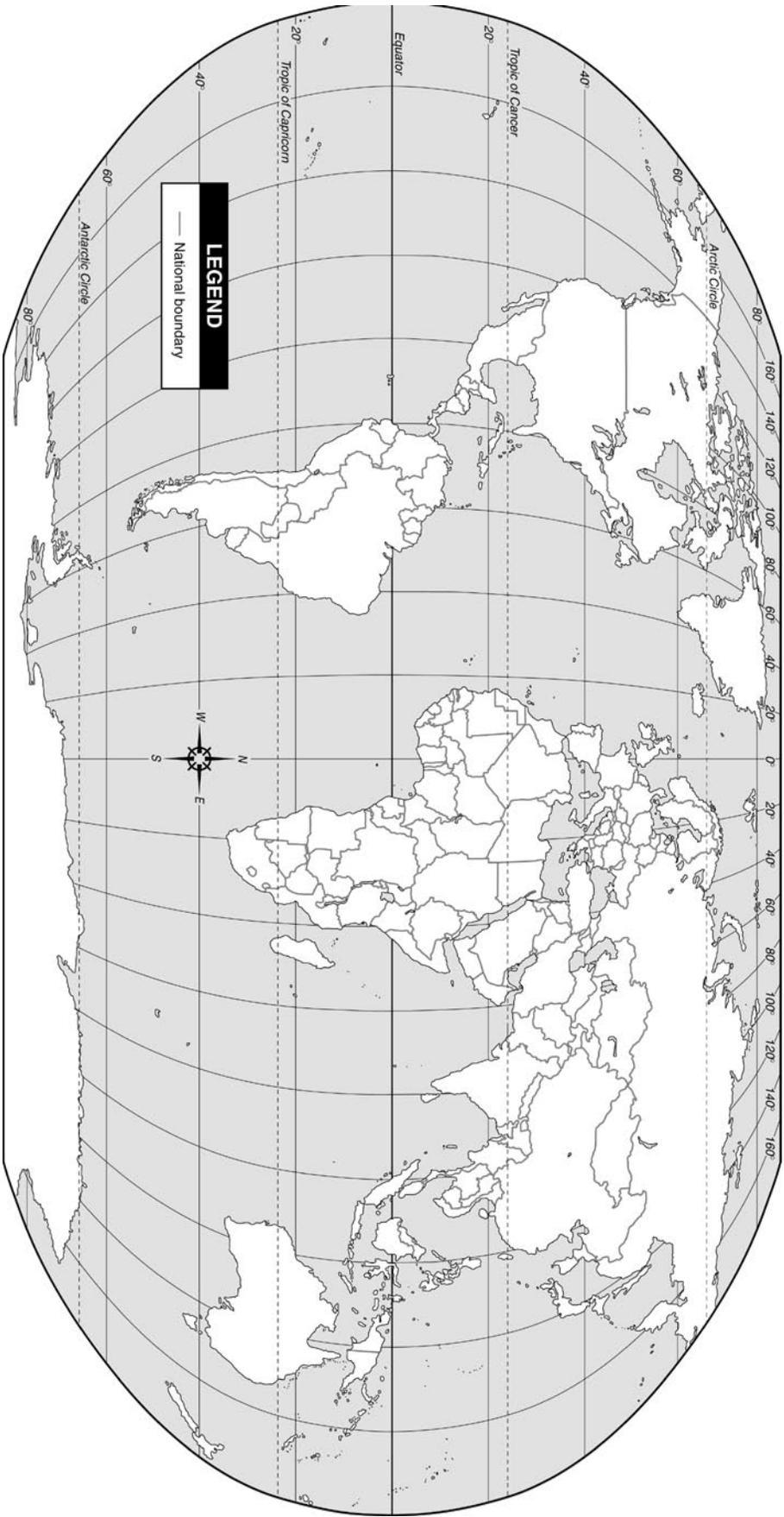
City	Country	Population
Tokyo	Japan	33,900,000
Mexico City	Mexico	22,150,000
Seoul	South Korea	21,950,000
New York	USA	21,750,000
São Paulo	Brazil	19,900,000
Bombay	India	19,200,000
Delhi	India	18,700,000
Los Angeles	USA	17,600,000
Osaka	Japan	16,750,000
Jakarta	Indonesia	16,650,000
Calcutta	India	15,200,000
Cairo	Egypt	15,100,000
Manila	Philippines	14,350,000
Karachi	Pakistan	13,550,000
Moscow	Russia	13,550,000
Shanghai	China	13,250,000
Buenos Aires	Argentina	12,600,000
Dacca	Bangladesh	12,500,000
London	Great Britain	11,950,000
Rio de Janeiro	Brazil	11,950,000
Tehran	Iran	11,550,000
Istanbul	Turkey	11,100,000
Lagos	Nigeria	10,650,000
Beijing	China	10,600,000

Source: Thomas Brinkhoff: City Population, <http://www.citypopulation.de/World.html>

(1) If air pollution were directly related to population, what would be the most polluted city in the world?

(2) List the U.S. cities with more than 10,000,000 people.

Name: _____



Education Place, <http://www.eduplace.com>
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Polluted Megacities of the World

The following table shows the levels of six of the most common air pollutants in 12 major world cities. Color in each square on the blank chart, choosing a different color for each level of air pollution (low, moderate, heavy, severe).

Beijing	Buenos Aires	Cairo	Jakarta
SO ₂ : severe	SO ₂ : low	SO ₂ : low	SO ₂ : moderate
PM: severe	PM: heavy	PM: severe	PM: severe
Pb: moderate	Pb: moderate	Pb: severe	Pb: heavy
CO: low	CO: severe	CO: heavy	CO: heavy
NO ₂ : moderate	NO ₂ : severe	NO ₂ : low	NO ₂ : moderate
O ₃ : heavy	O ₃ : severe	O ₃ : low	O ₃ : heavy
Karachi	Los Angeles	Mexico City	Moscow
SO ₂ : moderate	SO ₂ : moderate	SO ₂ : severe	SO ₂ : low
PM: severe	PM: heavy	PM: severe	PM: heavy
Pb: severe	Pb: moderate	Pb: heavy	Pb: moderate
CO: low	CO: heavy	CO: severe	CO: heavy
NO ₂ : low	NO ₂ : heavy	NO ₂ : heavy	NO ₂ : heavy
O ₃ : low	O ₃ : severe	O ₃ : severe	O ₃ : low
Mumbai	São Paulo	Seoul	Tokyo
SO ₂ : moderate	SO ₂ : moderate	SO ₂ : severe	SO ₂ : moderate
PM: severe	PM: heavy	PM: severe	PM: low
Pb: moderate	Pb: moderate	Pb: moderate	Pb: low
CO: moderate	CO: heavy	CO: moderate	CO: moderate
NO ₂ : moderate	NO ₂ : heavy	NO ₂ : moderate	NO ₂ : moderate
O ₃ : low	O ₃ : severe	O ₃ : moderate	O ₃ : severe

SO₂ = Sulfur Dioxide. From industry; causes respiratory problems, severe coughing attacks.

PM = Particle Matter. Suspended particles cause haze over cities, from aerosols, gaseous emissions; causes pulmonary illnesses.

Pb = Lead. From vehicles using leaded gasoline; causes anemia, kidney disease, hearing damage, and can cause death.

CO = Carbon Monoxide. From incomplete combustion and internal combustion engines burning fossil fuels; causes pulmonary and hearing problems, headache, fatigue, sleepiness, respiratory problems, can cause death.

NO₂ = Nitrous Dioxide, From vehicles; causes respiratory problems and bacterial infections.

O₃ = Ozone. From vehicles; causes irritated eyes, persistent headaches, may cause cancer.

Source: Universität Salzburg, <http://www.sbg.ac.at/ipk/avstudio/pierofun/mexico/cities.htm>

Name: _____

Polluted Megacities of the World

Comprehension Exercises

Fill in the code to the chart with the colors you have chosen:

severe heavy moderate low

Fill in the chart using the *Polluted Megacities of the World* table:

	SO ₂	PM	Pb	CO	NO ₂	O ₃
Mexico City						
Buenos Aires						
Beijing						
Cairo						
Seoul						
Karachi						
Jakarta						
Los Angeles						
São Paulo						
Moscow						
Mumbai						
Tokyo						

Answer the following questions on the back of this worksheet.

- (1) According to the chart, does Mexico City have a low or moderate level of any of these major pollutants?

- (2) Which cities have low levels of at least one pollutant?

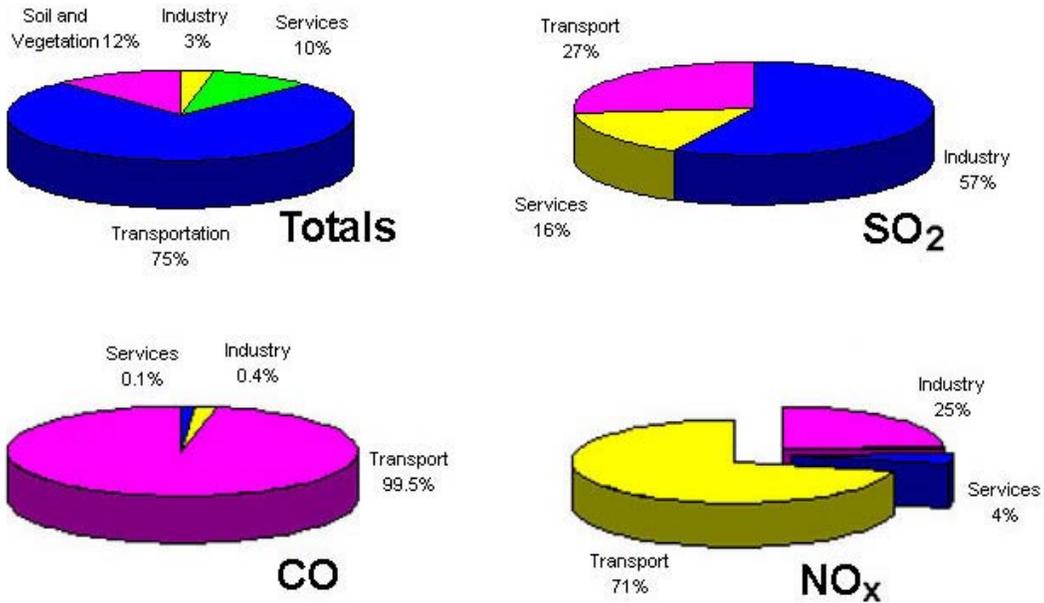
- (3) The cities on the chart are listed in order from most to least polluted. Why do you think Los Angeles, which has moderate to severe levels of all pollutants, is less polluted than Karachi, which has low levels of three pollutants?

- (4) Knowing that Tokyo is the most populated city on the list, are you surprised that it is the least polluted? Why or why not? And why do you think it might be less polluted than the others?

- (5) What kinds of health problems are caused by the following pollutants: CO, NO₂, O₃?

- (6) If the pollutants listed in question 5 come from cars on the road, what is one solution to reduce the level of those pollutants in the air?

Causes of Pollution



Source: Universität Salzburg, <http://www.sbg.ac.at/ipk/avstudio/pierofun/mexico/air.htm#Pollution>

TRANSPORTATION DATA ON MEXICO CITY	
Percentage of population that:	
Uses public transportation:	84%
Owens cars:	16%
Percentage of vehicles on road that are:	
Private vehicles:	79%
Public transportation:	7%
Freight:	5%

Source: University of Washington, <http://carbon.cfr.washington.edu/esc110/2003Fall/projects/043/Causeshtml>.

Class Discussion Questions

- (1) What is the leading source of almost all types of air pollutants in Mexico City? What pollutant is the exception?
- (2) If 16% of the population own cars, about how many people own cars (hint: 22 million x 16%)? Even though most people ride the bus every day, are there a lot of privately-owned cars on the road?
- (3) If the population is growing, what effect might that have on the number of cars on the road? Why?

Thinking about Pollution and Health Problems

Imagine you live in a city where a gray-brown noxious haze of smog permeates the streets in your district. Imagine that these streets are filled with jam-packed traffic, a slow moving assembly of automobiles which blow out unhealthy exhaust fumes of carbon monoxide and other harmful chemicals. You cover your nose and mouth with a handkerchief to avoid excess exposure to dust and chemical particles in the air. The air is not pleasant to inhale in deeply, and it gives you breathing trouble, making you cough and wheeze. In addition, your eyes water, your nose runs, and you have headaches and irritated eyes regularly when you are outdoors. As you walk on a street in this particular city on a weekday afternoon, a jogger passes by you wearing a face mask, and you observe children playing in a nearby school, inside a giant glass bubble to shield them from the city air.

Imagine this scene and you have in your mind the current state of affairs in Mexico City, a city whose air was recently ranked by the World Health Organization (WHO) as the most contaminated in the world. WHO studies indicate that it is unhealthy for human beings to breathe air with more than 100 to 120 parts per billion (ppb) of ozone contaminants for more than one day a year. Yet Mexico City residents breathe this level, or more, for over 300 days a year. Over a five-day emergency period last November [1996]—the longest continuous period in six years since the establishment of the emergency warning system—readings rose above 250 ppb, and city hospitals and clinics reported 400,000 pollution-related patients and 300 deaths.

Over one million Mexico City residents suffer permanent breathing difficulties, headaches, coughs, and eye irritations. New studies suggest that children living in neighborhoods with the worst air could suffer permanent alterations to cells in their nose and throat linings which could lead to cancer later in life.

Source: University of Pennsylvania, Penn Environmental Group, http://dolphin.upenn.edu/~pennenv/greentimes/spring97/air_asim.html

Student Self-Reflection

Journal about how the scene depicted above makes you feel. You should address the following questions:

- (1) How would your life change if you could only go outside when absolutely necessary (to get to and from school, to do important errands)?
- (2) How much energy do you think you would have if you had watery eyes, a cough, and a headache all the time? Would you want to ride your bike? Play outdoor sports? How would you concentrate on school? Homework?
- (3) How would you feel if your family was prohibited from using the car every Thursday, in order to try to stop the pollution? How would you, and your other family members, get where you need to go? Would it be worth it if it lessened the pollution?

Day Without a Car

The following is part of Mexico City's plan for reducing air pollution through restrictions on private cars. This plan is currently in effect.

Day Without a Car – Permanent Vehicular Restriction Program

Day	Plate Ending Digit
Monday	5 6
Tuesday	7 8
Wednesday	3 4
Thursday	1 2
Friday	9 0

In case of high levels of air pollution, as described below, Phase I of the Environmental Contingency Program will be declared with the **Double Day Without a Car**:

Suspended Particles PM-10: 175 IMECA points

Ozone: 241 IMECA points.

Double Day Without a Car

Day	Plate Ending Digit
“Odd” Day	1 3 5 7 9 – odd numbers
“Even” Day	2 4 6 8 0 – even numbers and provisional circulation permits

On days when Phase I of the Contingency Program is active, the vehicular restriction will apply to “Even and Odd” license plate ending numbers, which will switch on alternate contingency days.

Phase I, Environmental Contingency Program

The following actions will be carried out with Phase I of Environmental Contingency Program:

- Application of Double Day Without a Car vehicular restriction program from 5:00 a.m. to 10:00 p.m.
- 50% of vehicles from public offices will not be allowed to circulate.
- Reduction of the industrial activity by 30-40%.
- 20% of gas stations will be closed randomly.
- Stop public works, including gardening, road maintenance, and all other activities that may obstruct vehicular circulation in the Mexico City Metropolitan Area and State of Mexico.
- Stop all outdoor school activities in the Metropolitan Area.
- Conduct a special epidemiological and health observation campaign.

Source: Sistema de Información Ambiental, http://www.sima.com.mx/valle_de_mexico/vehicula.htm

Name: _____

Day Without a Car

Comprehension Exercises

(1) How do residents know what day they cannot drive their car during the permanent restriction program (Day Without a Car)?

(2) Why do you think there are no restrictions on weekends?

(3) If a family has more than one car, how much do you think “Day Without a Car” affects them? Why?

(4) “Double Day Without a Car” is much more complex. If this plan is put into effect, what percentage of cars will be off the road on that day? How do you think people find out when this program is in effect or if it’s an even or odd day?

(5) What two restrictions in Phase I of the Environmental Contingency Plan would affect your life the most? Why?

Propose a Pollution Prevention Plan for Mexico City

Break students into groups of 4 and ask them to create approaches to lessen air pollution and address health concerns. Students should prepare a written proposal or visual presentation (PowerPoint, poster board, etc.) to be delivered to the mayor of Mexico City. Students can pull information from handouts included in this case study or from independent research.

Assign each group one of the plans on the attached cards or brainstorm a variety of solutions as a class.

(1) Students should consider how these proposals would affect their lives, thereby making it easier to see the pros and cons of the proposal as it relates to Mexico City. Each group should create a T-chart of the pros and cons of the plan from their perspective.

(2) Students should include the following information with their proposals.

- Title
- Background information on current air pollution (What is it? Where does it come from? How bad is it?) and problems associated with air pollution (health, environmental, etc.)
- An explanation of why the plan focuses on transportation (rather than on other sources of pollution)
- A description of the plan
- A list of potential problems with the plan and how those will be solved (a defense of the plan)
- A description of how to enforce the plan (Will violators be fined? Who will make sure that the plan is being followed: police, government officials, honor system?)

Students have to walk or take public transportation to school and all school (sport, club) activities.

Keep in mind that there are no school buses in Mexico City, so kids who live far from their schools would have to take city buses.

Essential question:
Will young kids have to ride the bus alone? If schools are far away, how much longer will it take to get there?

Car owners have to stop driving their cars on the weekends, since weekend activities are not as important as work and school.

Essential question:
Are there enough buses, or other means of public transportation, to accommodate all the people who will use them on the weekends?

Cars can only be used for transportation to and from work or school, and not for errands or entertainment purposes.

Essential questions:
How will people get their groceries? Will people stop going to the movies, theatre, sporting events?

Car owners must carpool to work/school with at least 2 other people.

Essential questions:
What if people in the neighborhood don't work or go to school in the same place? Will it take more time to go out of their way to pick up coworkers/fellow students?

Regardless of the number of family members or the different places they need to go, families can only have one car.

Essential questions:
How hard will it be to coordinate the activities of parents and kids with only one car? Will people need to use more public transportation?

Cars cannot be driven from 6:00–9:00 a.m., since early morning sunlight and heavy traffic cause the greatest amount of pollution.

Essential questions:
How will people get to work and school? Will more buses be needed?

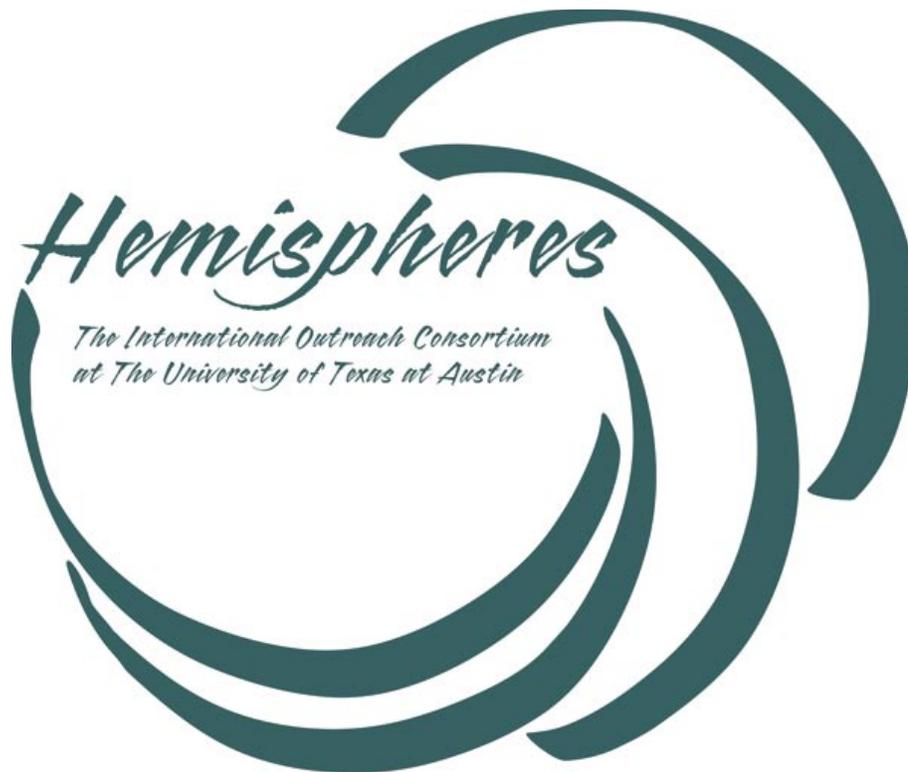
About Hemispheres

Created in 1996, Hemispheres is the international outreach consortium at the University of Texas at Austin. Hemispheres utilizes University resources to promote and assist with world studies education for K-12 and postsecondary schools, businesses, civic and non-profit organizations, the media, governmental agencies, and the general public.

Comprised of UT's four federally funded National Resource Centers (NRCs) dedicated to the study and teaching of Latin America; the Middle East; Russia, East Europe & Eurasia; and South Asia, Hemispheres offers a variety of free and low-cost services to these groups and more. Each center coordinates its own outreach programming, including management of its lending library, speakers bureau, public lectures, and conferences, all of which are reinforced by collaborative promotion of our resources to an ever-widening audience in the educational community and beyond.

Hemispheres fulfills its mission through: coordination of pre-service and in-service training and resource workshops for educators; promotion of outreach resources and activities via exhibits and presentations at appropriate state- and nation-wide educator conferences; participation in public outreach events as organized by the consortium as well as by other organizations; and consultation on appropriate methods for implementing world studies content in school, business, and community initiatives.

For more information, visit the Hemispheres Web site at:
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