ENVIRONMENTAL IMPACTS OF FOSSIL FUELS

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INTRODUCTION

- Many environmental problems which the world faces today have arisen from using fossil fuel
- The ones that have received the most publicity in recent years have been the
 - "greenhouse effect," which is changing the Earth's climate.
 - > acid rain, which is destroying forests and killing fish.
 - > air pollution, which is killing tens of thousands of American citizens every year.

BURNING FOSSIL FUELS

- Fossil fuels such as coal, oil, and gas consist largely of carbon and hydrogen. The process that we call "burning" actually is chemical reactions with oxygen in the air.
- The carbon dioxide that is released is the cause of the greenhouse effect as it traps heat in the earth's atmosphere thereby increasing the temperature of the Earth.



- Prior to the industrial age, the concentration of carbon dioxide in the atmosphere was less than 280 ppm (parts per million).
- By 1958 the carbon dioxide concentration had risen to 315 ppm, and by 1986 it was 350 ppm. The average temperature of the Earth has been about 1 degree warmer in the 20th century than in the 19th century.
- As the rate of burning coal, oil, and gas escalates, so too does the rate of increase of carbon dioxide in the atmosphere.
- If current trends continue the concentration of CO₂ will be 700 ppm by 2030 and the result would be to raise the earth's temperature by 7 °F.



GLOBAL CO₂ EMISSION BY COUNTRY





Fossil Fuel CO₂ Emissions – 2009 Fossil Fuel Data Assimilation System (FFDAS)

kg of CO₂ / m^2 / year

____0.01

___ 0.001 ___ 0

100



U.S. Greenhouse Gas Emissions in 2014

Other (Non-Fossil Fluorinated **Fuel Combustion) Nitrous** Gases 6% Oxide_ 3% **Residential &** 6% **Commercial** Methane 10% 11% Electricity Industry 37% Carbon 15% Dioxide 81% **Transportation** 31% U.S. Carbon Dioxide Emissions, 1990-2014 7,000 Carbon Dioxide Emissions (Million Metric Tons CO₂ Equivalent) 6,000 5,000 4,000 3,000 2,000 1,000 0 2000 - 2001 -2004 2008 -1992 1993 1995 1996 1998 1999 2003 2006 2010 2011 1990 1991 1994 1997 2002 2007 2012 2013 2014

U.S. Carbon Dioxide Emissions, By Source



METHANE EMISSIONS

- CH₄ is the second most prevalent greenhouse gas emitted in the United States from human activities
- Methane's lifetime in the atmosphere is much shorter than CO_2 , but CH_4 is more efficient at trapping radiation than CO_2



NITROUS OXIDE EMISSIONS

- > N₂O accounted for about 6 percent of all U.S. greenhouse gas emissions from human activities
- > N₂O stay in the atmosphere for an average of 114 years before being removed by a sink or destroyed through chemical reactions
- The impact of 1 pound of N₂O on warming the atmosphere is almost 300 times that of 1 pound of CO₂



EMISSIONS OF FLUORINATED GASES

- fluorinated gases(HFCs, PFCs, NF₃, SF₆) have no natural sources and only come from human-related activities.
- fluorinated gases are the most potent and longest lasting type of greenhouse gases emitted by human activities
- Many fluorinated gases, small atmospheric concentrations can have large effects on global temperatures
- Fluorinated gases are removed from the atmosphere only when they are destroyed by sunlight in the far upper atmosphere



PREDICTED CONSEQUENCES OF THE GREENHOUSE EFFECT IN USA

According to EPA,

- Crop yields in Minnesota will be increased 50-100%.
- Corn growing will become difficult in Illinois, but it can be replaced by sorghum
- The Great Lakes region will be helped by the longer growing season. Crop yields in Minnesota will be increased 50-100%.
- If present trends continue, there will be a 1.5-2.0 feet rise in the middle of the 21st century which would flood major areas in Boston, New York, Charleston, Miami, and New Orleans.



PREDICTED CONSEQUENCES OF THE GREENHOUSE EFFECT IN THE WORLD

Top 20 Most At-Risk Countries

By	/ Total		By Percent		
Country	Population Exposed (thousands)	Percent of National Population Exposed	Percent of Population National Country Exposed Population (thousands) Exposed		
1. China	50,465	4%	1. Netherlands 7,793 47%		
2. Vietnam	23,407	26%	2. Vietnam 23,407 26%		
3. Japan	12,751	10%	3. Thailand 8,176 12%		
4. India	12,643	1%	4. Japan 12,751 10%		
5. Bangladesh	10,230	7%	5. Myanmar 4,742 9%		
6. Indonesia	10,157	4%	6. Bangladesh 10,230 7%		
7. Thailand	8,176	12%	7. United Arab Emirates 570 7%		
8. Netherlands	7,793	47%	8. Philippines 6,205 7%		
9. Philippines	6,205	7%	9. Bahrain 80 6%		
10. Myanmar	4,742	9%	10. Belgium 619 6%		
11. United States	3,087	1%	11. Oman 148 5%		
12. United Kingdom	2,574	4%	12. Taiwan 1,302 4%		
13. Brazil	1,737	1%	13. Indonesia 10,157 4%		
14. Germany	1,665	2%	14. Denmark 232 4%		
15. France	1,256	2%	15. United Kingdom 2,574 4%		
16. Malaysia	1,171	4%	16. Malaysia 1,171 4%		
17. Taiwan	1,032	4%	17. China 50,465 4%		
18. Korea, Republic of	1,028	2%	18. Hong Kong 241 3%		
19. Nigeria	848	1%	19. Cambodia 449 3%		
20. Italy	842	1%	20. Ireland 133 3%		

People living on land that will be below sea level or chronic flood levels by the end of the century, assuming current emissions trends continue, and medium sensitivity of sea level to warming. Some countries, such as the Netherlands, have levees that may provide protection. For the list ranked by percent exposure, we considered only countries with total populations over 1 million.

Ozone Layer Depletion



• Each chlorine atom reacts with ozone, repeatedly combining with and breaking apart as many as 100,000 ozone molecules during its stratospheric life

ARCTIC OZONE HOLE



ACID RAIN

- Coal and oil contain small amounts of sulfur & nitrogen, typically 0.5% to 3% by weight.
- In the combustion process,



• Sulfur dioxide and nitrogen oxides undergo chemical reactions in the atmosphere to become sulfuric acid and nitric acid, respectively, dissolved in water droplets that eventually may fall to the ground as rain.







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US SO2 and NOx Emissions By Source

EFFECTS OF ACID RAIN

- The ecological effects of acid rain are most clearly seen in aquatic environments, such as streams, lakes, and marshes where it can be harmful to fish and other wildlife.
- Acidic rain water can leach aluminum from soil, the more acid that is introduced to the ecosystem, the more aluminum is released.
- Acid rain also removes minerals and nutrients from the soil that trees need to grow.
- At high elevations, acidic fog and clouds might strip nutrients from trees' foliage, leaving them with brown or dead leaves and needles.

AIR POLLUTION

- During the combustion of fossil fuels, sometimes carbon monoxide, a dangerous gas, is produced instead of carbon dioxide.
- During combustion, some of the carbon remains unburned, and some other materials in coal and oil are not combustible; these come off as very small solid particles, called particulates.
- Coal contains trace amounts of nearly every element, including toxic metals like beryllium, arsenic, cadmium, selenium, and lead, and these are released in various forms as the coal burns.

Primary Air Pollutants in U.S.





Figure 1. Percentage of emissions from fossil fuel use in the United States (1).

Air America Some parts of the United States experience much more particle pollution than others.



fine particles (in micrograms per cubic meter)

> Premature deaths attributable to pollution in 10 of the largest US metropolitan areas in 2005:

Metro Area	Deaths
New York City	2,040
Los Angeles	7,569
Chicago	4,802
Detroit	2,406
Philadelphia	2,207
Washington	2,094
Boston	2,070
Houston	1,506
Minneapolis-St. Paul	1,171
San Jose	979

Source: MIT

Source: University of Washington Department of Environmental and Occupational Health Science's Center for Clean Air Research and MESA Air project; map based on models

Mother Jones

MOST POLLUTED CITIES IN THE WORLD

Source: WHO

149

144

PM 2.5 (micrograms per cubic meter) in the most polluted cities in 2014



AIR POLLUTION DEATHS IN 2012

1	*)	China	1,032,833			
2		India	621,139			
3		Russia	140,851			
4		Indonesia	61,792			
5	Ċ	Paksitan	59,241	25 🗮 UK	16,355	
6	_	Ukraine	54,507			
7		Nigeria	46,750			
8	13	Egypt	43,531			
9		USA	38,043			
10		Bangladesh	37,449			

EFFECTS OF AIR POLLUTION

- High SO₂ levels causes increased death among people with heart and lung diseases.
- Nitrogen oxides (NO, NO₂ etc) can irritate the lungs, cause bronchitis and pneumonia, and lower resistance to respiratory infections such as influenza.
- CO bonds chemically to hemoglobin, and thus reduces the amount of O₂ available to the body tissues.
- Particulates, when inhaled, can scratch or otherwise damage the respiratory system, causing acute and/or chronic respiratory illnesses.
- Hydrocarbons cause smog and are important in the formation of ozone. Ozone irritates the eyes and the mucous membranes of the respiratory tract.

OTHER ENVIRONMENTAL EFFECTS BY FOSSIL FUELS

- Acid drainage from abandoned mines, which eventually seeps out and gets into streams, making them acidic.
- Land subsidence causing buildings on the surface to crack or even to be completely destroyed.
- Subsidence in rural areas can change drainage patterns and make land unfit for farming.
- Oil seepage into the sea from normal operations or large spills from accidents.
- Release of drilling muds containing heavy metals, such as barium, that may be toxic to marine life.







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