The Environment: Saving Ourselves from Ourselves

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- Setting the stage
  - A brief walk through time
- Globalization: (+/-)s
  - Energy
- Clearing the air
- Climate change
  - An industrial evolution
- Preserving the future?

*There are known knowns; there are things we know that we know.*

*There are known unknowns; that is to say, there are things that we now know we don’t know.*

*But there are also unknown unknowns – there are things we do not know we don’t know.*

-Donald Rumsfeld
But man is a part of nature, and his war against nature is inevitably a war against himself.
Globalization – Humankind’s Manifest Destiny

*Genesis 1:28 - King James Bible*

*On the 6th Day…*

…God blessed them, and God said unto them, Be fruitful, and multiply, and replenish the earth, and subdue it: and have dominion over the fish of the sea, and over the fowl of the air, and over every living thing that moveth upon the earth.
Early Migrations of Anatomically Modern Humans

Wiki user:Dbachmann [CC BY-SA (https://creativecommons.org/licenses/by-sa/4.0)]
In 100 BC the Silk Road kicked-off a 1350 year legacy of taking silk and spices from China to the _well-to-do_ in Europe.

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<tbody>
<tr>
<td>Leading Exports</td>
<td>Raw Material / Basic Goods</td>
<td>Textiles / Industrial Goods</td>
<td>Factories</td>
<td>Global Supply Chain</td>
<td>Digital Goods / Services</td>
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<td>Leading Nations</td>
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<tr>
<td>Exports as % World GDP</td>
<td>&lt;5%</td>
<td>6→14%</td>
<td>5→15%</td>
<td>15→&gt;20%</td>
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<td>Enabling Innovations</td>
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<td>Characterizing GDP Trend</td>
<td>Europe</td>
<td>Britain</td>
<td>World</td>
<td>United States</td>
<td>China</td>
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</table>
Per Capita Growth Seen by Most Nations

GDP per capita in 2016

GDP per capita in 1950

$70K

$10K

$1K

$1K

$10K

$70K
The human benefits of globalization.
Digital and IT sciences has given rise to never-before seen growth

The downside is growing disparity across socioeconomic groups due to shifts in manufacturing, energy production / use profiles

Emergence of push-back – growth of nationalism: Brexit; MAGA
So What Has Allowed the US and World Economies to Grow as They Have?

Cheap and Available Energy!!
Global primary energy consumption

Global primary energy consumption, measured in terawatt-hours (TWh) per year. Here 'other renewables' are renewable technologies not including solar, wind, hydropower and traditional biofuels.

Fossil Fuels

Source: Vaclav Smil (2017) and BP Statistical Review of World Energy

CC BY
Col. Edwin L. Drake struck oil on Aug. 27, 1859

An 1856 engraving from Harper's Monthly showing small whaling boats similar to those launched by crews off the Outer Banks in the nineteenth century. UNC-Chapel Hill Library.
• US consumes about 20M barrels of oil per day
• 69% transportation and 26% industry
• Electric vehicles will surpass fossil fuel vehicles in ~2038 (~40 M vehicles each sector)

Sad to say fossil fuels in the US will be here for a while

1861 Vanity Fair cartoon where the whales are celebrating the discovery of oil in PA
Global Energy Consumption

World energy consumption by energy source (1990-2040)
quadrillion British thermal units

- Petroleum and other liquids
- Natural gas
- Coal
- Renewables
- Nuclear

History vs. Projection (1990-2040)
Oh - There is the Matter of Climate Change…

Degrees cooler or warmer in 2019 compared to the middle of the 20th century

-2°C  -1°C  0°C  +1°C  +2°C  +3°C  No data

NYT Jan 15, 2020
What Lessons from the American Experience can we Apply to These Issues?
1940s - 1950s

Post-War Industrialization and Growth

Smoke was a symbol of prosperity!
Donora PA 1948
Los Angeles 1950s
Newark 1953
Ugly Scenes Crept into the 1960’s

- Chattanooga Munitions Plant
- Steubenville Steel Mill
- Burn on the Cuyahoga River, Cleveland
- DC – Open Burning of dumps
Social Change on the Rise in the 1960s

• The WWII Generation and Baby-Boomers emerge
  – New young and vibrant president with a bold vision
  – Challenges to the status quo and public outcry for change
  – Self-empowerment of the young boomers

• Issues of the day
  – Civil rights
  – Antiwar and military intervention
  – Anti-establishment (govt, corps, religion…anyone >30!)
  – Environmental awareness and fear of impacts
    • Silent Spring – Rachel Carson
Earth Day – April 22, 1970

20 million people participated in a national teach-in
Believe it or Not…

- The birth of EPA in 1970 consolidated many disparate federal environmental efforts.

- The Clean Air Act 1970 established regulations for 6 “criteria” air pollutants within the first 5 months of EPA’s existence.
Back to Air, There is a Good News Story…

Comparison of Growth Areas and Emissions, 1970-2015

- Gross Domestic Product: 246%
- Vehicle Miles Traveled: 184%
- Population: 57%
- Energy Consumption: 44%
- CO₂ Emissions (Six Common Pollutants): 28%
- Aggregate Emissions: -71%
Public Distress with Health Consequences

...and Economic Growth Drove Efforts to Clear the Air
There a Model to Visualize this Process...

Simon Kuznets, 1950s
A Special Lesson from Sulfur in Fossil Fuel

Grand Canyon

Acid Rain

National Parks
How Creativity, Cooperation and Courage Helped Clear the Air

C Boyden Gray
WH Counsel

Fred Krupp
Envir Def Fund
How Creativity, Cooperation and Courage Helped Clear the Air

The Clean Air Act Amendments of 1990

- Targeted smoke reduction & lower sulfur coal and oil
- CAP & TRADE on sulfur had a dramatic effect

1989

2005
Given what we know, how might we meet the multiple environmental challenges ahead?

“The interest in air pollution is proportional to what they can see.”

Sir Patrick Lawther (~1981)
Today’s Reality

• COVID-19 provides a lesson
• Everything environmental is “systems”
• Disproportionate impacts – $f(\text{wealth}^{-n})$
• Climate change – finding an equilibrium
• Regulation alone is not likely to succeed
• Economic health = $f(\text{access to cheap energy})$
• We likely have the tools – do we have the courage?
Pandemics – A By-Product of Globalization

1855 Third Plague Pandemic
1875 Fiji Measles Pandemic

Columbian Exchange, 1492

Preparedness versus Adaptation

50M deaths worldwide

1957 Asian Flu - 1.1M global deaths and 116K in US
1981 HIV – 75M infected and 32M deaths worldwide
This image released by NASA shows the average concentration of atmospheric nitrogen dioxide in March of 2015-19. (left), compared to March of 2020. (NASA/NASA's Scientific Visualization Studio)
Nominal Public Health Impacts of Climate Change

**DIRECT**
- Temp. rise
- Sea level rise
- Changes in Precipitation
- Storms

**INDIRECT**

- Heat stress, cardiovascular failure, outdoor work stress
- Injuries, fatalities
- Asthma, cardiovascular disease
- Resp allergies, invasives
- Malaria, dengue, hantavirus, encephalitis,
- Cholera, cryptosporidiosis, campylobacter, leptospirosis
- Malnutrition, diarrhea, harmful algal blooms
- Anxiety, post-traumatic stress, depression, despair
- Forced migration, civil conflict
- Agricultural collapse

International Security Issues

Temperature
Sea level rise
Precipitation
Climate Change and Global Health Inequity

Emissions of greenhouse gases:

Estimated mortality attributable to climate change:

EXAMPLE: Climate-Associated Coastal Storms Can Impact The Poor More, with Underappreciated Consequences

Florence and Michael Help Break State Records

Mt. Mitchell 139.9"

Annual State Precipitation Record

Florence + Michael Mt. Mitchell: 22.8"

Rural, Vulnerable Communities Heavily Impacted

Old Fort, NC

Boone, NC Saluda, NC

Precipitation (in.)

50-60
60-70
70-80
80-90
90-100
100+

Courtesy of Montana Eck, UNC
Climate Change is Different

Simon Kuznets, 1950s
The Interface of Globalization and Climate Change – Ground-Zero has to be the Amazon **Rainforest**
The Ongoing Problem: Global Air Pollution

- 7.4 Billion people on earth
- 9 out of 10 people breathe polluted air
- 7 million people/year die from air pollution
- Average global PM$_{10}$ level is 71 µg/M$^3$

World’s top 5 most polluted megacities

Based on the number of particles of pollution per cubic meter. Megacities are those with at least 14 million people.

<table>
<thead>
<tr>
<th>City</th>
<th>PM$_{10}$ Level</th>
</tr>
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<tbody>
<tr>
<td>Delhi</td>
<td>292</td>
</tr>
<tr>
<td>Cairo</td>
<td>284</td>
</tr>
<tr>
<td>Dhaka</td>
<td>147</td>
</tr>
<tr>
<td>Mumbai</td>
<td>104</td>
</tr>
<tr>
<td>Beijing</td>
<td>92</td>
</tr>
</tbody>
</table>

May 2, 2018 WHO news release on air pollution

Delhi

Buenos Aires

Beijing

Cairo

3B breath smoke from cook stoves

4.3M deaths
Electrification is Still the **Goal**.

*Transition to Renewables*
The Wickedness in the Problem Brings Out the Best of Us

Millennials will be the last generation to act on climate and the first to fully experience the full tipping of change.
Cities Take Action

NCA, 2018

Total State-Level Mitigation-Related Activities by Type

- GHG Target / Cap / Pricing
- Renewable / CCS / Nuclear
- Transportation
- Energy Efficiency
- Non-CO2 Greenhouse Gases
- Forestry and Land Use

Public Action
Cap & Trade / Soc Cost of Carbon?

Bold Free-Market Action

Using the SCC to Calculate Costs and Benefits of Changing Emissions

Policy A Scenario

Baseline Scenario

Policy B Scenario

- **Policy A**
  - Increases emissions by 500,000 tons
  - $50 per ton CO₂ (SCC)
  - $25,000,000 (Cost of Policy A due to added emissions)

- **Baseline Scenario**
  - No change in emissions

- **Policy B**
  - Decreases emissions by 500,000 tons
  - $50 per ton CO₂ (SCC)
  - $25,000,000 (Benefit of Policy B due to decrease in emissions)

In this example, the social cost of carbon has been calculated to be $50 per ton of CO₂.

Some form of this approach has been proposed by most economists.
Where is the US Leadership?

CBS 60 Minutes (Oct 14) - Comments on climate change:

“most of the threats from climate change are 50 to 75 years out.”

– [Andrew Wheeler, April, 2019]

"EPA has been working hard to fulfill President Trump’s promise to cut burdensome and ineffective regulations for our domestic energy industry.“ [Methane Decision 8/14/2020]

- Andrew Wheeler
# Administration Efforts to Deregulate

<table>
<thead>
<tr>
<th>Category</th>
<th>Rollbacks Completed</th>
<th>Rollbacks in Process</th>
<th>Total Rollbacks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air pollution and emissions</td>
<td>16</td>
<td>9</td>
<td>25</td>
</tr>
<tr>
<td>Drilling and extraction</td>
<td>10</td>
<td>9</td>
<td>19</td>
</tr>
<tr>
<td>Infrastructure and planning</td>
<td>11</td>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td>Animals</td>
<td>7</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>Toxic substances and safety</td>
<td>5</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>Water pollution</td>
<td>4</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>Other</td>
<td>5</td>
<td>6</td>
<td>11</td>
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“Shall we surrender to our surroundings or shall we make our peace with nature and begin to make reparations for the damage we have done to our air, to our land and to our water?
- Richard Nixon
State of the Union Message, 22 Jan 1970

Too many Americans continue to breathe dirty air. And political paralysis has plagued further progress against air pollution…”
- George H. W. Bush
…upon signing the CAAA Nov 15, 1990
You cannot affirm the power plant and condemn the smokestack, or affirm the smoke and condemn the cough.


<table>
<thead>
<tr>
<th>Country</th>
<th>Electricity Consumption (KW/capita/yr)</th>
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<tbody>
<tr>
<td>USA</td>
<td>12,071</td>
</tr>
<tr>
<td>China</td>
<td>4,475</td>
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<tr>
<td>Russia</td>
<td>7,481</td>
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<tr>
<td>India</td>
<td>1,181</td>
</tr>
<tr>
<td>Egypt</td>
<td>1,510</td>
</tr>
<tr>
<td>Liberia</td>
<td>69</td>
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</table>

World avg electricity consumption

**But What About Us?**
And when our children’s children look us in the eye and ask if we did all we could to leave them a safer, more stable world, with new sources of energy, I want us to be able to say yes, we did.

-  Barack Obama
State of the Union Message
Jan 28, 2014
Thank You

Good environmental policy is a fabric woven with the threads of science