

# CRITICAL DATA GAPS AND THE PROMISE OF NEW METHODS

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**Children's Environmental Health:**

**A Workshop on Future Priorities for Environmental Health Sciences**

National Academies of Sciences, Engineering, and Medicine

August 1, 2022



**BOSTON  
COLLEGE**

# THREE EXISTENTIAL THREATS TO CHILDREN'S ENVIRONMENTAL HEALTH IN THE USA

- Climate Change
- Air Pollution
- Chemical Pollution, including Pesticides and Plastics

**Key Question: For each of these threats, what are the key data gaps and the strategic opportunities for new research and science-based advocacy that have potential to make a difference for children's health and save lives?**



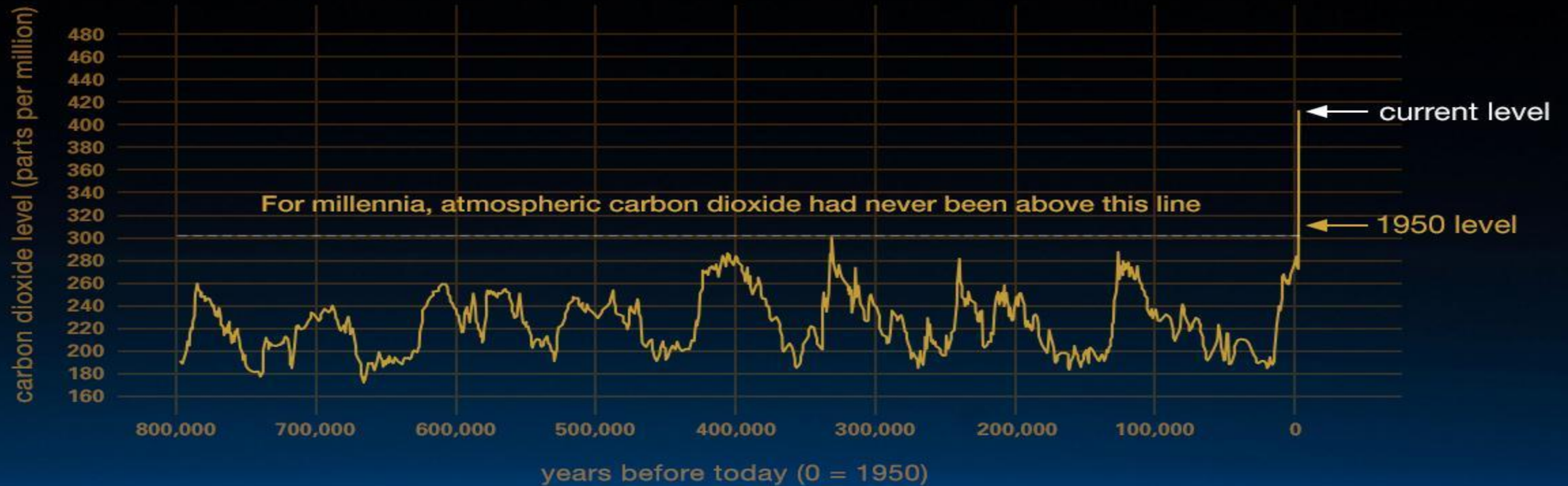
# CLIMATE CHANGE

## Key Facts

- The earth's mean surface air temperature has increased by about 1 °C (1.8 °F) since 1900
- The main driver is fossil fuel combustion, which results in increasing concentrations of CO<sub>2</sub> and other greenhouse gases in the earth's atmosphere
- Ecologic consequences : Wildfires, drought, increased frequency of violent storms, melting glaciers, sea surface rise, coastal flooding, expanded ranges and longer seasons for vector-borne diseases.
- Direct and indirect impacts on children's health: Adverse pregnancy outcomes, heat-related illness, allergic diseases, cardiovascular disease, water shortages, malnutrition and famine, forced migration, and war.
- Beautifully summarized by Frederica Perera and Kari Nadeau, *NEJM*, June 16, 2022

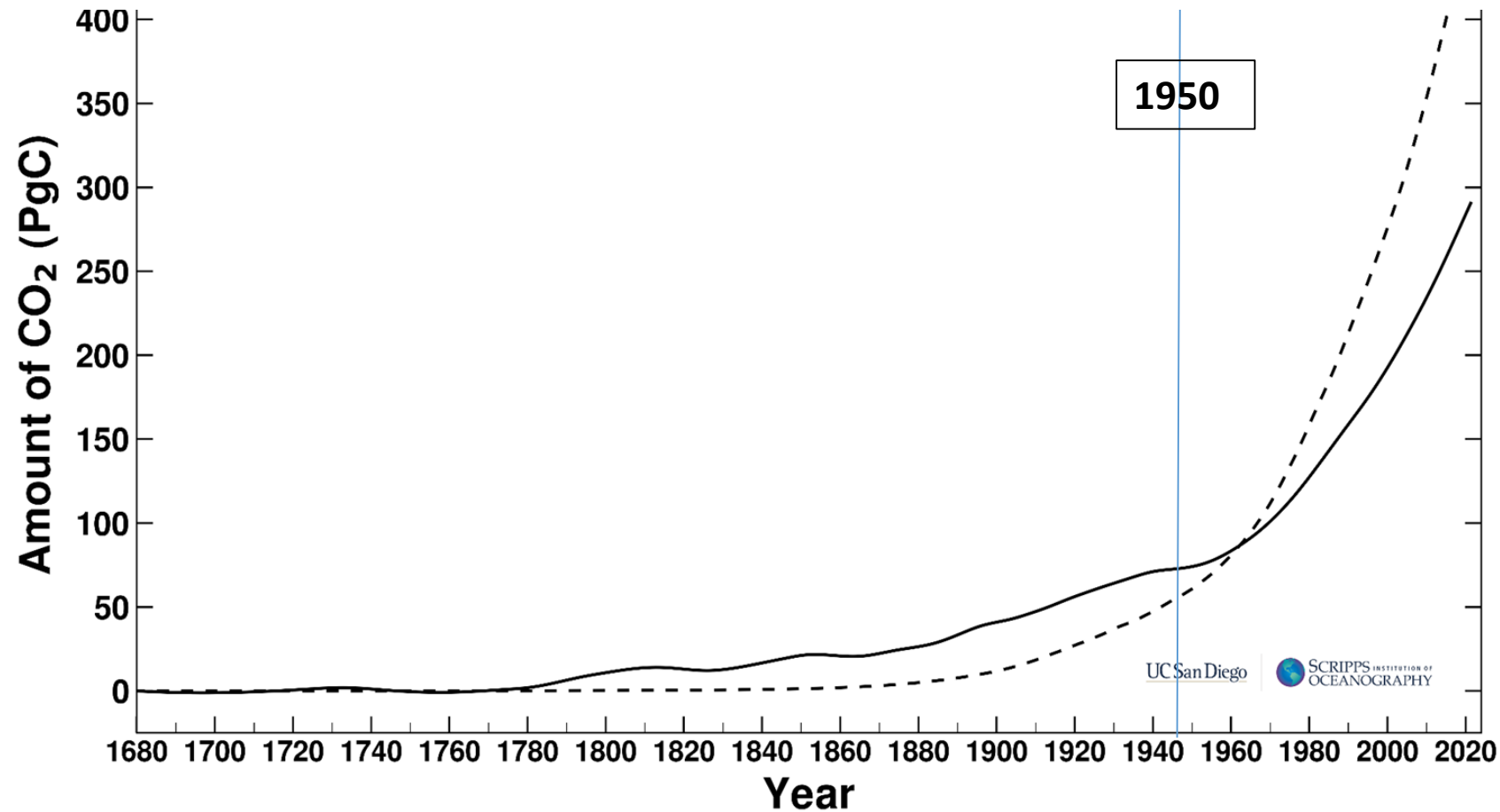


# ATMOSPHERIC CO<sub>2</sub> LEVELS - PAST 800,000 YEARS



The last time CO<sub>2</sub> levels were this high,  
dinosaurs walked the earth

# CUMULATIVE FOSSIL FUEL COMBUSTION AND ATMOSPHERIC CO<sub>2</sub>, 1680-2020



**More than 50% of all CO<sub>2</sub> emissions have been released since 1950**

Solid Curve: Observed increase in atmospheric CO<sub>2</sub>

Dashed Curve: Cumulative production of industrial CO<sub>2</sub> from fossil fuel and cement



# CLIMATE CHANGE

## Research Recommendations

- Continue to document and quantify the consequences of climate change for children's health
  - Clinical and epidemiological studies in the aftermath of climate disasters – opportunistic studies and shoe-leather epidemiology
  - The importance of having teams of investigators trained, equipped and ready to go when disasters happen
- Modelling studies in partnership with climate scientists, oceanographers and medical geographers
  - Work across disciplines to monitor long-term trends: food and water shortages, spread of vector-borne diseases, migration and conflict.
  - Define populations at risk on a highly localized, fine-grained scale
- Estimate the burden of disease due to climate change and its consequences – partnership with IHME
- Economic analyses



# CLIMATE CHANGE

## Advocacy Recommendations

- **Advocate nationally** through organizations such as PSR and AAP to:
  - Incentivize renewable energy and build out the power grid
  - End all federal subsidies and tax breaks for the fossil fuel industry
  - Resist the temptation to go to nuclear energy
- **Advocate at the state and local levels to:**
  - Shut down fossil-fuel-fired power plants
  - Block construction of gas and oil pipelines and forbid gas hook-ups in new construction
  - Provide tax breaks and subsidies for wind and solar at both the individual and the system level
  - Require operators of electric power grids to favor renewable energy over electricity produced by fossil fuel combustion
  - Convert state and city vehicle fleets to hybrid or all-electric
  - Mandate that by 2030 75% of all new cars and trucks sold in the state be hybrid or all-electric
  - Expand and enhance rapid transit
  - Build out regional high-speed, electric-powered rail systems
- **Build partnerships with diverse groups** - faith-based organizations, environmental justice community, green business community, local foundations, journalists, and grass-roots advocates



# AIR POLLUTION

- **Key Facts**

- Fossil fuel combustion is the predominant anthropogenic source
- Responsible for 6.7 million (CI, 5.9–7.5 million) deaths globally in 2019, with the overwhelming majority in low- and middle-income countries.
- Responsible for an estimated 197,000 deaths annually (95% CI, 183,000 – 214,000) in the USA
- Responsible in adults for cardiovascular disease, stroke, COPD, lung cancer and diabetes
- Responsible in children for premature birth, low birthweight, stillbirth, asthma, and impaired lung development
- Emerging evidence for links to brain injury with loss of cognitive function (IQ loss), memory deficits, behavioral dysfunction, reductions in brain volume and increased risks of ADHD, and autism spectrum disorder (ASD)





# AIR POLLUTION

## Research Recommendations

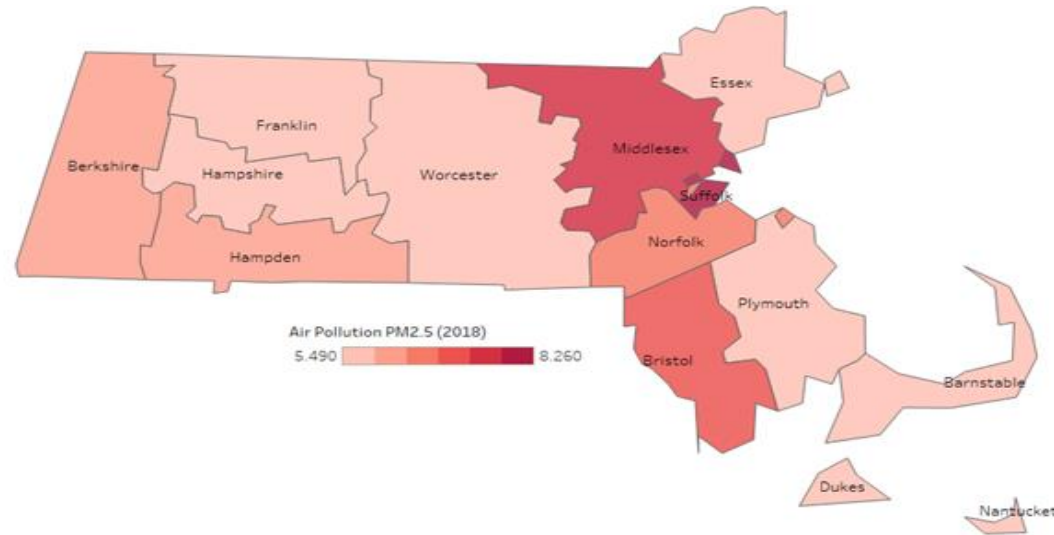
- Identify and quantify emissions from air pollution sources at the state and local level – both particulate emissions and toxic emissions
- Produce fine-grained, highly localized maps of air pollution levels
- Document and quantify the health consequences of air pollution at the local level
- Document the economic costs of air pollution, noting that these are “externalized” costs

## Advocacy Recommendations

- Emphasize that all climate advocacy actions of the preceding slide are relevant. They produce a **double benefit** by also reducing air pollution
- Work individually and through national organizations to urge EPA to reduce the PM<sub>2.5</sub> air pollution standard from 12 $\mu\text{g}/\text{M}^3$  to at least 5 $\mu\text{g}/\text{M}^3$
- State and local advocacy are at least as important as advocacy at the national level



# HEALTH IMPACTS OF AIR POLLUTION IN THE CITIES AND TOWNS OF MASSACHUSETTS



**Annual average PM<sub>2.5</sub> concentration in Massachusetts in 2019 was 6.3 µg/M<sup>3</sup>**

**Responsible for an estimated 2,780 deaths a year - in every city and town**

**Responsible for loss of over 2 million IQ points per year in children**

**“All politics are local”**



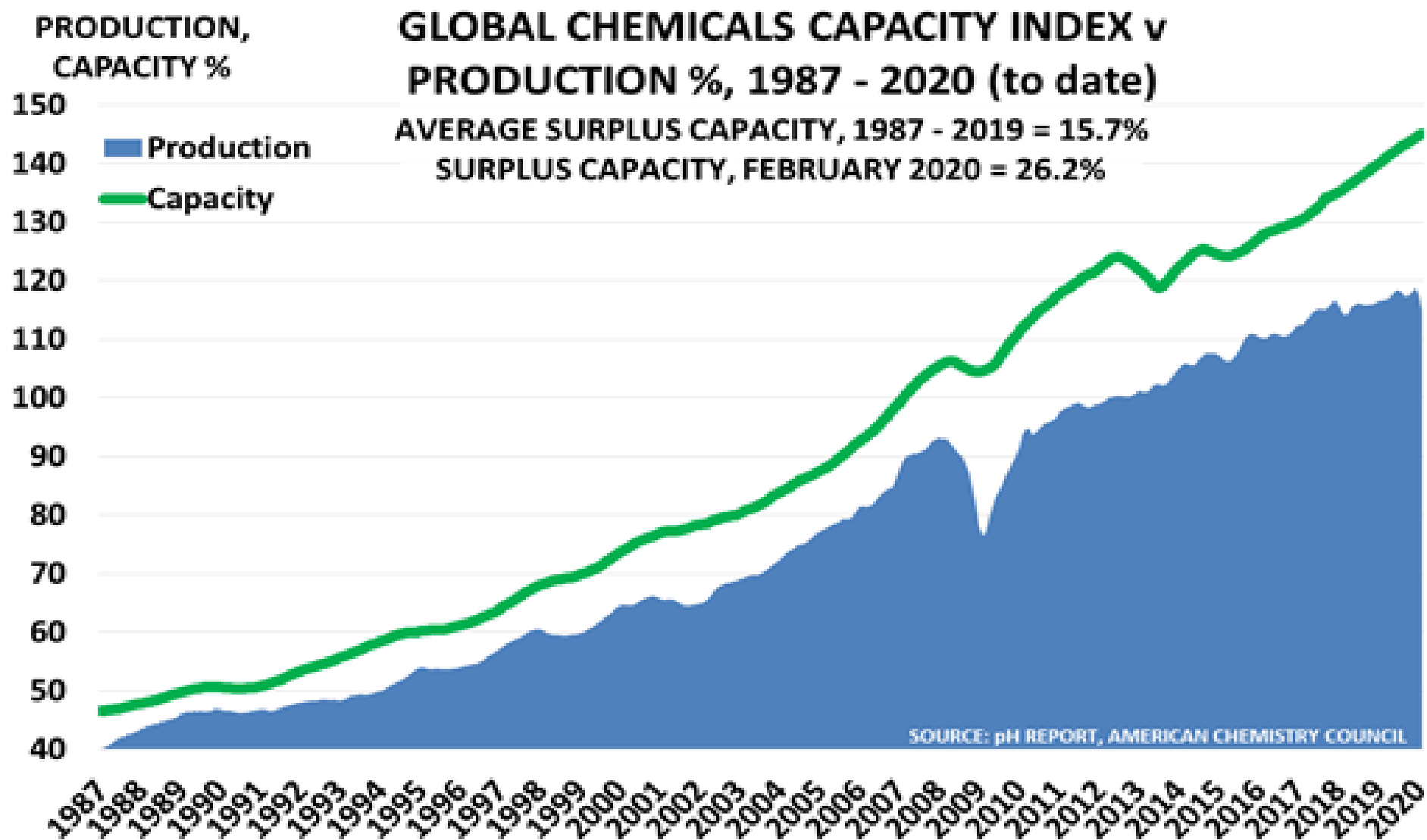
# CHEMICAL POLLUTION, INCLUDING PESTICIDES AND PLASTICS

## Key Facts

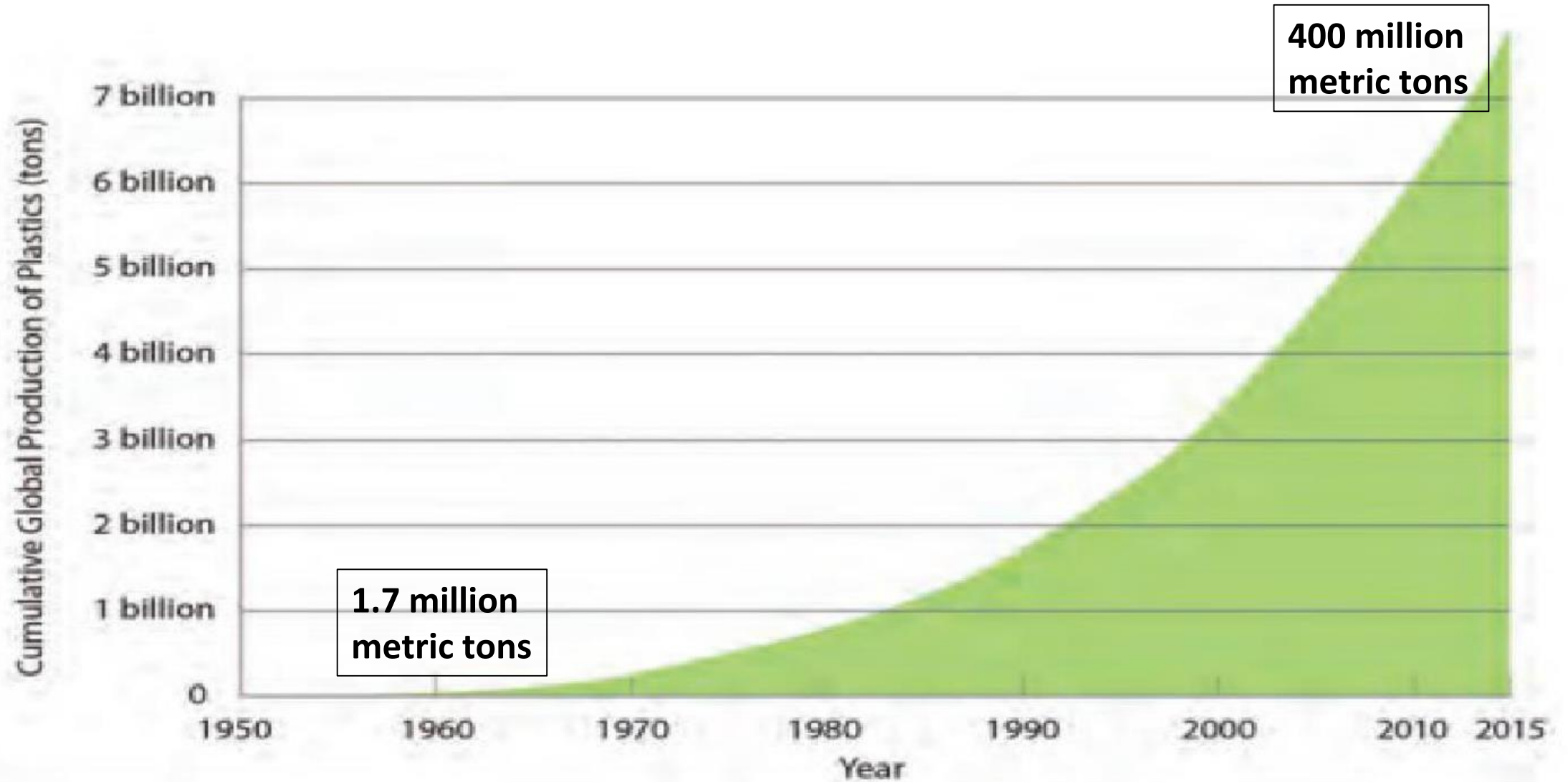
- More than 350,000 chemicals and chemical mixtures have been invented since 1950. Novel materials. Never previously existed on earth.
- More than 98% of chemicals and plastics are produced from fossil fuels.
- Plastic production has grown from 1.7 MMt in 1950 to more than 400 MMt today and is on track to double by 2040.
- Plastic is more than polymer. It contains multiple toxic additives – up to 50% by weight
- Single-use plastic now accounts for about 40% of total production – the fossil fuel industry's Plan B
- Chemicals and plastic are widely disseminated in the environment – from the high Arctic to the ocean depths.
- Nearly universal human exposure – including pregnant women and newborn infants
- Disproportionately heavy exposure of the poor and minorities – environmental injustice
- Global chemical production is increasing by 3.5% annually. Doubling time of 25-30 yrs
- **The great majority of chemicals in commerce have never been tested for safety or toxicity**



# GLOBAL PRODUCTION OF MANUFACTURED CHEMICALS



# GLOBAL PLASTIC PRODUCTION



# OCEAN POLLUTION

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## PLASTIC WASTE

THE TIP OF THE POLLUTION-BERG



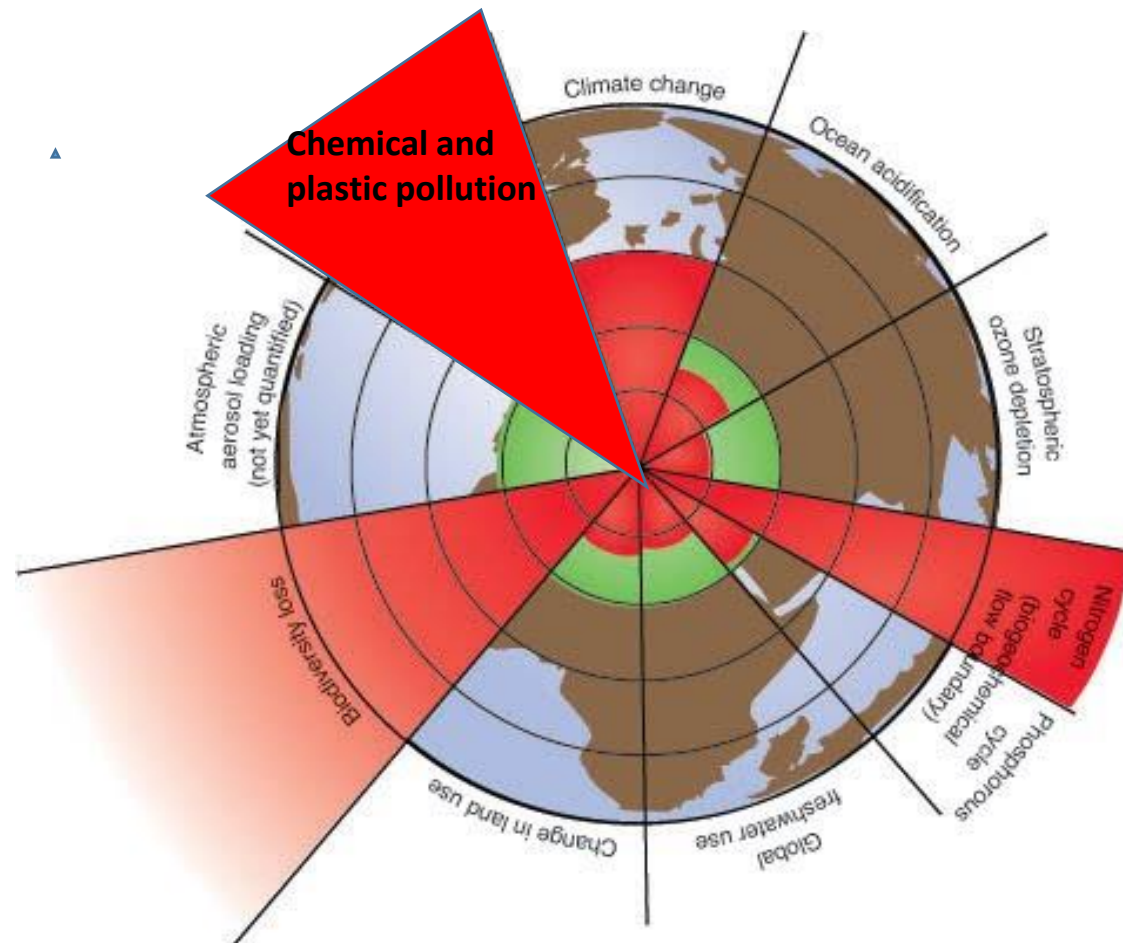
The Ocean has been badly damaged by plastic

- 8–12 MMt of plastic waste enters the ocean each year
- Macroplastics kill whales, turtles, fish and birds
- Macroplastics break own into into microscopic particles that contaminate the water column, coat the sea floor, and enter the food web



# CHEMICAL AND PLASTIC POLLUTION MAY BE EXCEEDING ITS PLANETARY BOUNDARY

The Stockholm Environment Institute has introduced the concept of planetary boundaries to define the “safe operating space for humanity”, the conditions necessary for human societies to survive and thrive.





# CHEMICAL POLLUTION CAUSES DISEASE IN CHILDREN

- Lead, mercury, and PCBs cause neurodevelopmental disorders
- Organophosphate pesticides cause neurodevelopmental disorders
- Brominated flame retardants cause neurodevelopmental disorders
- Pesticides reduce fertility
- Phthalates are associated with birth defects of the male reproductive organs and with neurodevelopmental delays
- Early-life exposure to DDT linked to adult breast cancer
- PFAS are linked to immune dysfunction and to decreased infant and fetal growth
- **What other associations between disease in children and widely used, but untested chemicals are still to be discovered?**



# CHEMICAL POLLUTION, INCLUDING PESTICIDES AND PLASTICS

## Research Recommendations

- The importance of prospective, multi-year birth cohort epidemiologic studies to discover still undiscovered etiologic associations – the bigger the better and with harmonized metrics of both exposure and outcome
- Continue development of high-speed, multi-chemical analyses
- Continue development of high-throughput toxicological studies

## Advocacy Recommendations

- Need for fundamental revision of chemical policy to cut the Gordian knot of the failed risk assessment/risk management paradigm
- Chemicals must be proven safe before they are allowed on markets
- The Precautionary Principle needs to be incorporated into law
- Need for a UN High Commission on Chemicals and Plastic Pollution analogous to the IPCC



# **THE GOOD NEWS:**

## **DISEASE IN CHILDREN CAUSED BY POLLUTION CAN BE PREVENTED**

### **Essential ingredients:**

- Scientific discovery
- Willingness of scientists to translate science into policy
- Willingness of elected officials to act on and not ignore science
- Key elements of pollution prevention: laws, policies and standards that are based on science backed by monitoring and enforcement, and encouraged by incentives

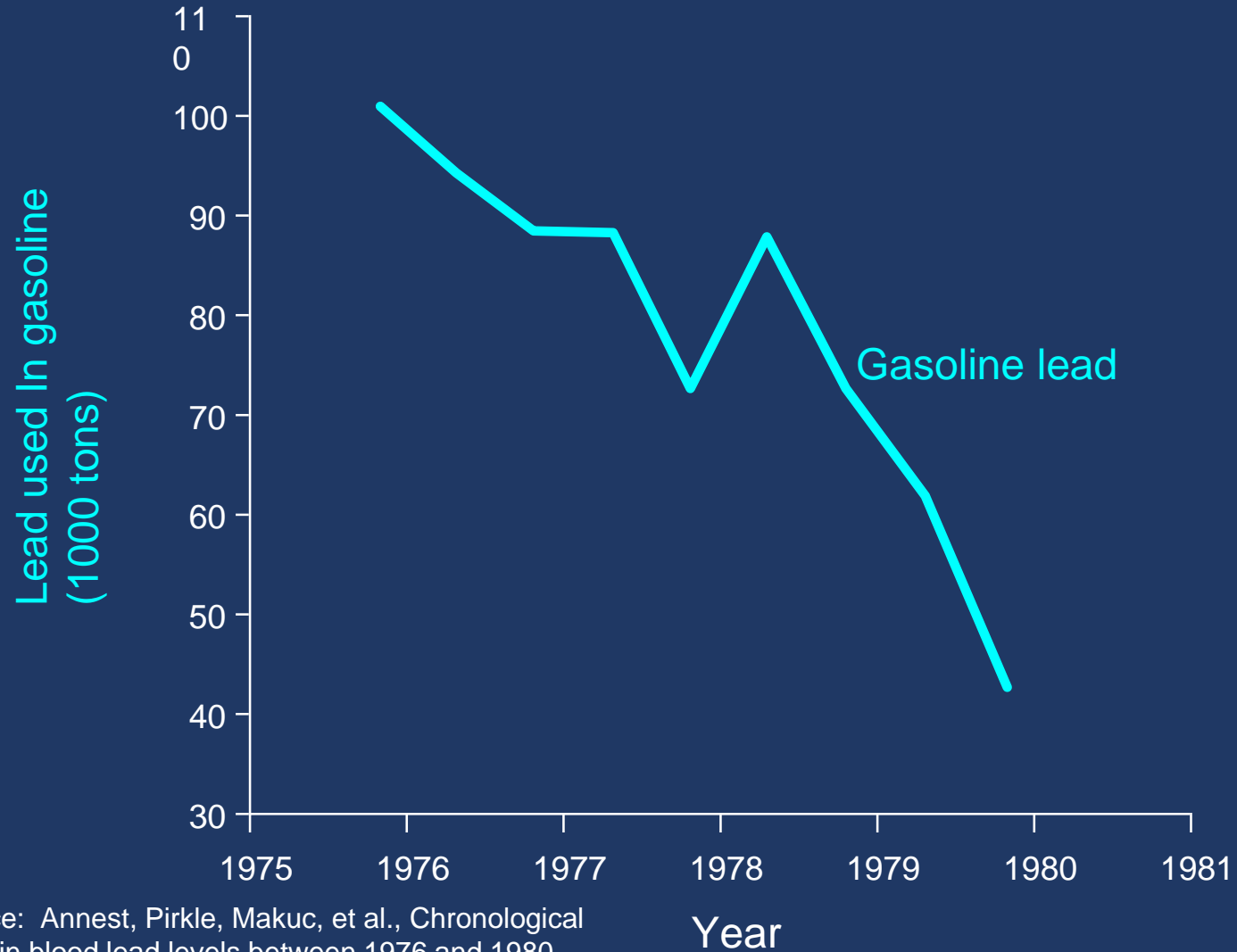


# SUCCESSES IN POLLUTION PREVENTION

- Banning of DDT
- Removal of lead from gasoline
- Control of air pollution in the United States – 74% reduction in air pollutant emissions since passage of the Clean Air Act in 1970
- Clean-ups of Boston Harbor and the Chesapeake Bay
- Reductions in children's exposures to multiple highly toxic pesticides under the Food Quality Protection Act of 1996
- Elimination of in-home use of chlorpyrifos
- Preservation of the earth's stratospheric ozone layer through the United Nations' Montreal Protocol



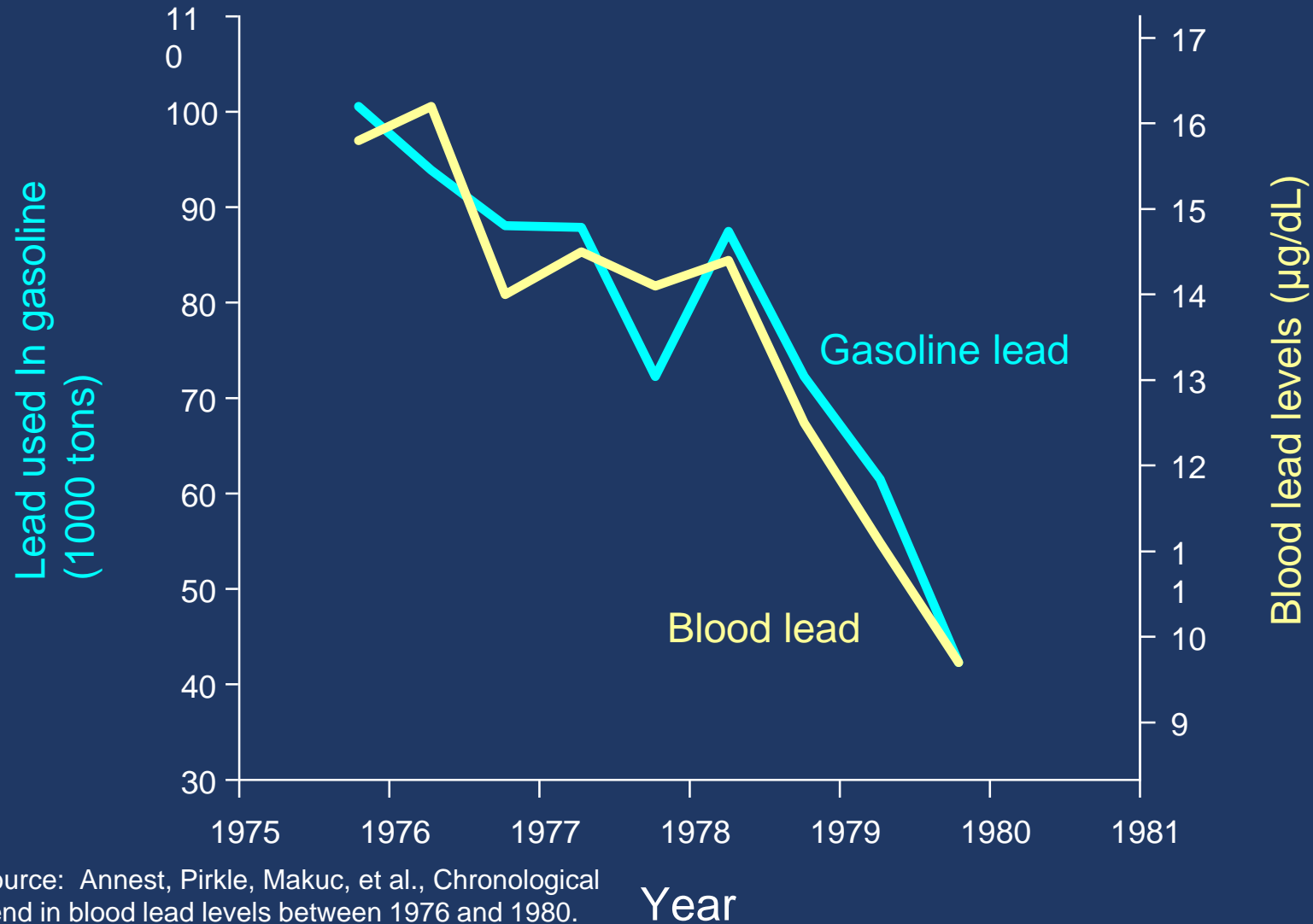
# LEAD USE IN GASOLINE IN THE USA DECLINED FROM 1976 THROUGH 1980



Source: Annest, Pirkle, Makuc, et al., Chronological trend in blood lead levels between 1976 and 1980. NEJM 1983; 308:1373-7.

# LEAD IN GASOLINE AND LEAD IN BLOOD, USA

NHANES II, 1976-1980



Source: Annest, Pirkle, Makuc, et al., Chronological trend in blood lead levels between 1976 and 1980. NEJM 1983; 308:1373-7.

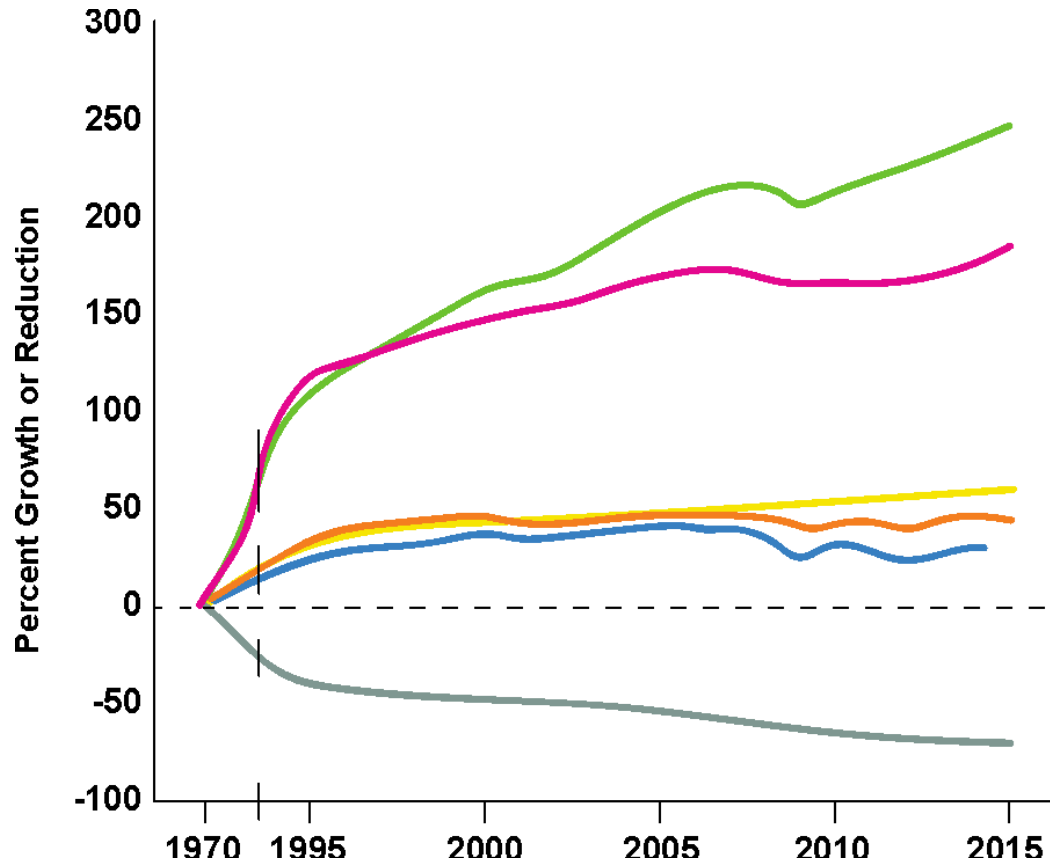
# **POLLUTION PREVENTION PREVENTS DISEASE, SAVES LIVES AND IS HIGHLY COST-EFFECTIVE**

- Every dollar invested since 1970 in air pollution control has yielded an estimated economic return of \$30.
  - Reduced expenditures for pollution-related disease.
  - Increased economic productivity of a healthier, longer-lived population.
- Removal of lead from gasoline has enhanced children's cognitive function and increased economic productivity.
  - Estimated economic benefit of \$200 billion per year over the lifetimes of each cohort off babies born in the USA since 1980 = \$8 trillion total benefit since 1980.
  - Lead-free children are more intelligent, more creative and have increased lifetime earnings.
- Clean-ups of polluted bays and harbors have restored commercial fisheries, increased tourism, and enhanced the economic value of coastal lands.





# AIR POLLUTION CONTROL YIELDS GREAT ECONOMIC BENEFITS

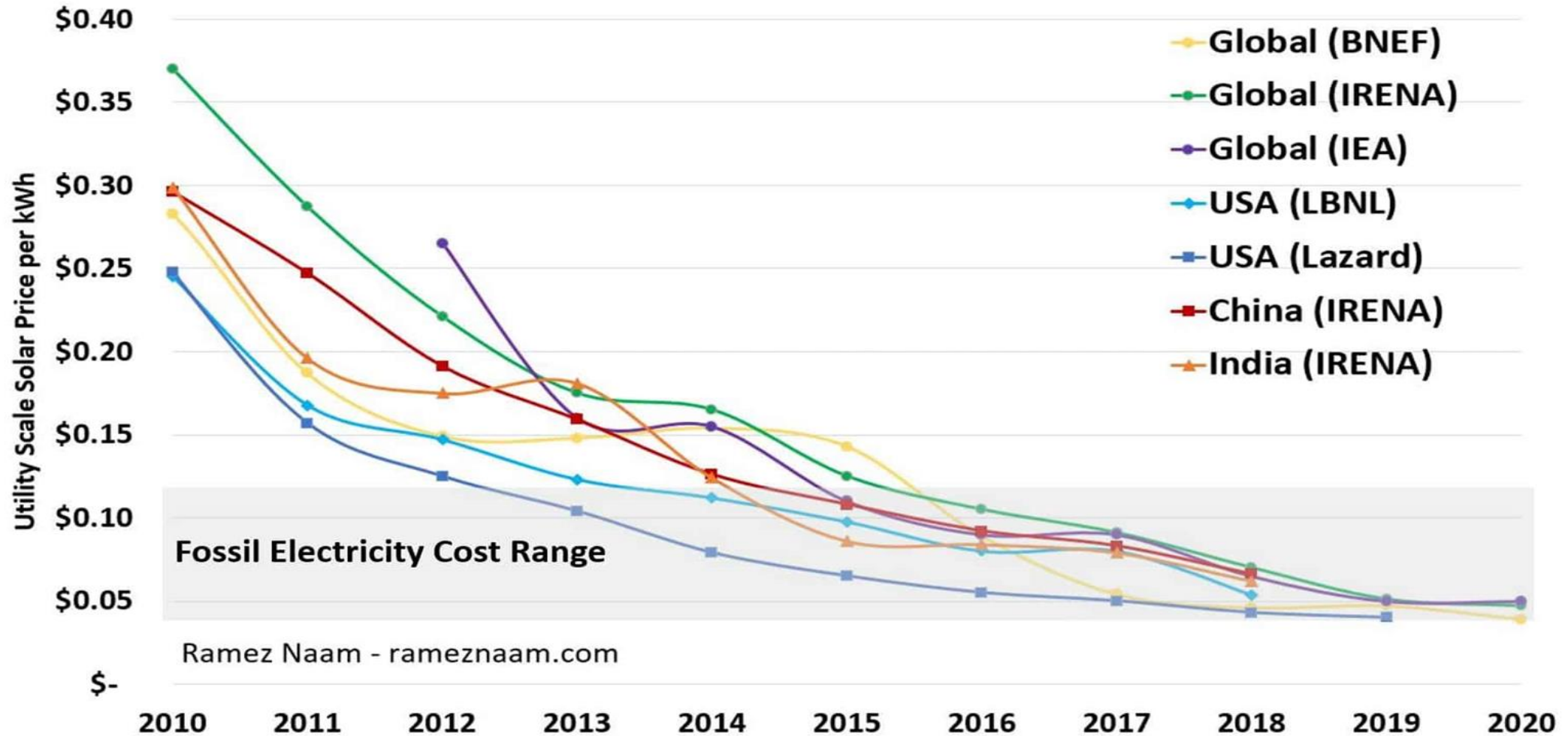


**GDP GREW  
BY 250%, WHILE  
AIR POLLUTION  
FELL BY 74%**

- Gross domestic product
- Vehicle miles traveled
- Population
- Energy consumption
- CO<sub>2</sub> emissions
- Aggregate emissions (six common pollutants)



# ONE MORE PIECE OF GOOD ECONOMIC NEWS: THE COST OF PRODUCING ELECTRICITY FROM SUNSHINE HAS FALLEN BY 90% SINCE 2010



# UNSOLICITED ADVICE FOR YOUNG SCIENTISTS IN CHILDREN'S ENVIRONMENTAL HEALTH

- Don't be afraid to take on the big, 'wicked' problems.
  - To be sure, there is risk, but that is where you will make the biggest difference.
- Be willing to move beyond your comfort zone and advocate for children's environmental health
  - Translate science into policies to protect children's health by partnering with journalists, elected officials and community leaders.
  - Always base your advocacy on science. Never exaggerate. Be sparing in your use of adjectives. It's OK to say, "I don't know".
- Be willing to look beyond NIH for funding
  - National and local foundations are often better positioned than NIH to support advocacy work
- Never accept funding from polluting industries
  - They will seduce you with sweet talk, but ultimately corrupt you
  - Reference: David Michaels, *Doubt Is Their Product*





**THANK YOU!**