Impacts of air pollution on the health of children and young people

Discussion and action workshop
Simon Lenton
12 Sept. 2017

BBC Today programme topics
11 Sept 2017

• “Britain flouting duty to protect citizens from toxic air pollution”
  UN Special Rapporteur

• Cleaning products linked to adult onset asthma

• Bangladesh monsoon aftermath continues to displace people
The aim of this workshop

- raise awareness about air pollution and relationship to climate change.
- examine the evidence of harm to health.
- implications for children and young people.
- discuss ways forward:
  - national
  - NHS
  - local
  - personal

Structure

Quiz

Information

Discussion re: actions

Q. “Every breath you take”

What is the chance that you have just inhaled at least one nitrogen molecule from Julius Caesar's dying breath?

<5%  50%  >95%

Bonus
Who had a hit of the same name and in which year?
A. Every breath you take

Mathematician Prof. Paulos, estimates there's a 98.2% chance that at least one of the molecules in that breath came from Julius Caesar's dying breath.

John Allen Paulos is Presidential Scholar of Mathematics at Temple University, Philadelphia. "Innumeracy: Mathematical Illiteracy and its Consequences"

Breathing

The average adult takes

17,000-30,000 breaths per day,

673 million breaths in a lifetime

inhales about 7 or 8 liters of air per minute,

total about 11,000 liters of air per day,

"Uncertainty is the only certainty there is and knowing how to live with insecurity is the only security.”

John Allen Paulos

Every breath you take

"Every Breath You Take" was performed by The Police album Synchronicity.

Written by Sting, the single was the biggest US and UK hit of 1983.

448 million views on You Tube!!!
Unintended consequences!

TYPICAL INVENTOR - FAILING TO SEE THE CONSEQUENCES OF HIS OWN CREATION.

Fossil fuels + engines
Air pollution
Climate change
An international issue

Pollution knows no boundaries

Trump on climate change

Donald Trump tweet: "The concept of global warming was created by and for the Chinese in order to make U.S. manufacturing non-competitive."

Later he tweeted: "It's really cold outside, they are calling it a major freeze, weeks ahead of normal. Man, we could use a big fat dose of global warming!"
Q. Name the major air pollutants

Indoor

Outdoor

Urban

Rural

Indoor air pollution

- Carpet.
- New electronics and other plastic products.
- Glues and adhesives.
- Heating equipment (kitchen stoves, fireplaces).
- Paints
- Upholstered furniture and pressed-wood products
- Cleaning products
- Perfumes/fragrances
Rural air pollutants

Pesticides/insecticides
Sulphur dioxide
Nitrogen oxides
Carbon monoxide
Ozone
Volatile organic compounds
Particulates

Outdoor air pollution

Sulphur dioxide
Nitrogen oxides
Carbon monoxide
Ozone
VOCs
Particulates
Health effects

Particulate matter
The most health-damaging particles are those with a diameter of 10 microns or less, \( \leq \) PM10. Chronic exposure to particles contributes to the risk of developing cardiovascular and respiratory diseases, including lung cancer.

Particulate pathophysiology
Ozone

Ozone occurs in two layers of the atmosphere. The layer closest to the Earth's surface is the troposphere. Here, ground-level or "bad" ozone is an air pollutant that is harmful to breathe and it damages crops, trees and other vegetation. It is a main ingredient of urban smog.

Formation. The majority of tropospheric ozone formation occurs when nitrogen oxides (NOx), carbon monoxide (CO) and volatile organic compounds (VOCs), react in the atmosphere in the presence of sunlight. NOx, CO, and VOCs are called ozone precursors.

Ozone (O3) Excessive ozone causes breathing problems, trigger asthma, reduce lung function and cause lung diseases.

Several European studies have reported that the daily mortality rises by 0.3% and that for heart diseases by 0.4%, per 10 µg/m3 increase in ozone exposure.
Stratospheric oxone

The ozone layer acts as a filter for the shorter wavelength and highly hazardous ultraviolet radiation (UVR) from the sun, protecting life on Earth from its potentially harmful effects.

Because ozone is unstable, ultraviolet light quickly breaks it up, and the process begins again. Ozone and oxygen molecules in the stratosphere absorb ultraviolet light from the sun, providing a shield that prevents this radiation from passing to the earth's surface.

High energy UV radiation hits oxygen molecules and each decompose into two free oxygen atoms. Each oxygen atom combines with one oxygen molecule each and forms ozone molecules.

Health effects

Nitrogen dioxide (NO₂)
Symptoms of bronchitis in asthmatic children increase in association with long-term exposure to NO₂. Reduced lung function growth is also linked to NO₂ at concentrations currently measured (or observed) in cities of Europe and North America.

Sulphur dioxide (SO₂)
SO₂ causes inflammation of the respiratory tract aggravation of asthma and chronic bronchitis and makes people more prone to infections of the respiratory tract. Hospital admissions for cardiac disease and mortality increase on days with higher SO₂ levels.
Volatile organic compounds

**Volatile organic compounds (VOC)** means any **compound** of carbon, *excluding* carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, and ammonium carbonate, which participates in atmospheric photochemical reactions.

**Health effects** include eye, nose, and throat irritation; headaches, loss of coordination, nausea; and damage to the liver, kidney, and central nervous system. Some organics can cause cancer in animals; some are suspected or known to cause cancer in humans.
Polycyclic Aromatic Hydrocarbons (PAHs)

Polycyclic Aromatic Hydrocarbons (PAHs) are a group of chemicals that occur naturally in coal, crude oil and gasoline. PAHs also are present in products made from fossil fuels, such as coal-tar pitch, creosote and asphalt. When coal is converted to natural gas, PAHs can be released.

Epidemiology

A "Pyramid of Effects" from Air Pollution
Most vulnerable

- live in deprived areas with higher levels of air pollution
- live, learn or work near busy roads
- age – young and elderly
- with pre-existing medical conditions.

Foetal effects

- Preterm birth
- IUGR
- Stillbirth
- Autism
- ADHD
- Later life
Polycyclic aromatic hydrocarbons (PAHs)

- PAH are neurotoxins that readily cross the placenta and damage the foetal brain, by inducing inflammation, oxidative stress, and vascular injury.
- Bradley Peterson suspects that the connection between PAHs and later behavioral and cognitive symptoms such as inattention, hyperactivity and slow processing speed may be due to how PAHs disrupt the normal communication between nerves in the left side of the brain.
Outdoor air pollutants

Sources of Air Pollutants

- Tyres

UK tyre market

### MILLIONS OF TYRES

<table>
<thead>
<tr>
<th>Type</th>
<th>Original Equipment</th>
<th>Replacement</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Car</td>
<td>10</td>
<td>32</td>
<td>42</td>
</tr>
<tr>
<td>Van</td>
<td>1</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Truck</td>
<td>0.5</td>
<td>1</td>
<td>1.5</td>
</tr>
</tbody>
</table>

500,000 tonnes of tyres enter the UK waste stream every year.
Climate change
Q. Name the climate change gases

Climate change science

- Carbon dioxide
- Methane: coal, natural gas and oil, livestock and other agricultural practices, decay of organic waste
- Nitrous oxide; agricultural and industrial activities, combustion of fossil fuels and solid waste.
- Fluorinated gases: Hydrofluorocarbons, perfluorocarbons, sulfur hexafluoride, and nitrogen trifluoride are synthetic, powerful greenhouse gases
- Water vapour

CFCs drift slowly upward to the stratosphere, where they are broken up by ultraviolet radiation, releasing the chlorine that catalytically destroys ozone.
How do climate change gases work?

https://youtu.be/sTvqljlvTg

Climate change
What do chickens produce?

Think outside the box!
Permaculture thinking

Permaculture design

Work with nature!
Economics - intention

Materials

INPUT

Energy

Transformation

Goods

OUTPUT

Costs

OUTPUT

OUTCOME

Services
Unintended consequences

*reality*

[Diagram showing the flow of materials, services, goods, and output with subcategories of social, environmental, and ecological impacts.]

Whole life costs

“Value”

One of the great mistakes is to judge policies and programs by their intentions rather than their results.

(Milton Friedman)

[Quote image source: izquotes.com]
Burying my head in the sand over climate change is much easier now that half the world's turned to desert!
What proportion of UK food in 2015 comes from overseas?

- 30%
- 50%
- 70%

UK food supply

- 50% UK's food and feed now comes from overseas.
- >2/3 of the land needed to produce the UK's food and feed is based abroad therefore 64% of the related greenhouse gases are emitted on foreign soil.
- Since 1986, the size of this land has grown by 23% to match increasing demand, with associated CO₂ emissions rising by 15%.
- By the mid-2040s, the UK will only be able to produce enough food to feed 53% of its population.
- 1.3 billion tons of food is lost and wasted annually between farm and fork, producing 3.3 Gigatons of carbon dioxide equivalent each year.
Gases by sector

Global surface area allocation for food production

The breakdown of Earth surface area by functional and allocated uses, down to agricultural land allocation for livestock and food crop production, is measured in millions of square kilometres. Area for livestock farming includes grazing land for animals, and arable land used for animal feed. The relative production of food calories and protein for final consumption from livestock versus plant-based commodities is also shown.
Development that relies on robbing the future to fuel the present, that demands perpetual growth on a finite planet is to challenge the very basis of capitalism; to inform us that our lives are dominated by a system that cannot be sustained – a system that is destined, if it is not replaced, to destroy everything.
Sterns main conclusions

- The benefits of strong, early action on climate change outweigh the costs.
- Serious, irreversible impacts from climate change associated with business-as-usual (BAU).
- Climate change threatens the basic elements of life for people around the world – access to water, food production, health, and use of land and the environment.
- The impacts of climate change are not evenly distributed – the poorest countries and people will suffer earliest and most.
- Emissions have been, and continue to be, driven by economic growth; yet stabilisation of greenhouse gas concentration in the atmosphere is feasible and consistent with continued growth.

The direct-indirect spectrum

<table>
<thead>
<tr>
<th>Air pollution</th>
<th>Climate change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Particulates</td>
<td>Water vapour</td>
</tr>
<tr>
<td>Nitrous oxides</td>
<td>Carbon dioxide</td>
</tr>
<tr>
<td>Sulphur dioxides</td>
<td>Methane</td>
</tr>
<tr>
<td>VOCs</td>
<td>Nitrous oxides</td>
</tr>
<tr>
<td>PAHs</td>
<td>Hydrocarbons</td>
</tr>
</tbody>
</table>

Common factors

- Human activity
- Energy use
- Food production
Air quality (AQ) v Climate change (CC)

What to do???
National response

A Breath of Fresh Air

1 Increase cross-departmental collaboration to promote a joined-up approach to tackling air pollution and climate change

2 Phase-out coal power stations by 2025

3 Expand existing clean air zones and extend their use to other cities

4 Better monitor air pollution in areas where vulnerable populations are focused

5 Retain or improve air quality standards that the previous EU regulations afforded us

6 Better inform and support health professionals to take local action and provide advice to patients.
What was the 2013 NHS Carbon footprint in England?

a) 15 million tonnes,
b) 25 million tonnes,
c) 35 million tonnes

Which element of the NHS creates the greatest emissions?
NHS procurement emissions 2004

Breakdown of NHS England 2004 procurement emissions, NHS Sustainable Development Unit

Breakdown NHS carbon footprint

Pharmaceuticals are 22% of the NHS England carbon footprint of which:
- 79% is primary care and community services
- 13% is acute services and 5% is mental health services

Medical instruments are 13% of the NHS England carbon footprint of which:
- 75% is acute service
- 13% is primary care and community services

Building energy use (gas and electricity) is 18% of the NHS England carbon footprint of which:
- 72% is in acute services
- 51% of which is electricity consumption
- 45% of which is gas consumption
NHS carbon footprint

www.sdu.nhs.uk

NHS actions – see SDU website

Health system design
Sustainable development (SD) medicine and health

Medicine is more than saving lives when illness presents, public health is about making the right investment decisions to protect against hazards and to promote well-being. The first rule is to “do no harm” and this applies equally to health systems as it does to individual treatments.

Health Care Without Harm's (HCWH) Now it’s time for the health sector to take a leadership role “the health sector is one of the most trusted and respected sections of society, and it is also one of the largest employers and consumers of energy.

This presents both a responsibility and an opportunity to be an “early mover” to achieve climate neutrality in its own operations, and to demonstrate that this can go hand-in-hand with improved effectiveness and cost savings"

NHS SDU

Sustainable healthcare

• promotes well-being, protects from hazards
• prioritises prevention
• creates balance between economic, environmental and social constraints
• designs services effectively/efficiently BACCH FFF
• uses resources responsibly,
• reduces waste
• embraces low carbon technologies
Q. What can I / you do?

Locally

Personally
Local action

Ways forward - local

• Planning – whole communities.
• Recycling – everything!
• Expand active travel networks esp. “school run”
• Promote active leisure.
• Local transport networks.
• Promote insulation, renewable energy
Personal action

- Talk + read about air pollution and climate change
- *The Lancet Planetary Health*
- Discuss at work – join green group?
- NHS system design
- Conserve energy - at home, at work, everywhere.
- Buy quality – think whole life costs.
- Carpool, use public transportation, bike, or walk
- Keep engines tuned, tyres properly inflated.
- Use environmentally safe paints/cleaning products.
- Mulch or compost organic waste.
- Reduce meat consumption
OF COURSE IF WE LEFT THE LAND TO ITSELF IT WOULD REVERT TO WOODLAND ANYWAY, BUT WHERE’S THE PROFIT IN THAT?

Thank you
Supplementary slides

Boys will be boys!!!
Petrol v diesel

• Petrol

Emissions of lead catalytic converters lower CO, HC and NOx emissions use slightly more fuel and become less efficient petrol cars with catalysts still produce more CO and HC than diesel cars NOx and particulates are much lower than diesel cars particulate emissions from petrol cars are so low that they are not routinely measured

Soon emissions will be similar for both

• Diesel

Diesel fuel contains more energy per litre than petrol greater fuel economy Reduced maintenance requirements Diesel fuel contains no lead and emissions of the regulated pollutants (carbon monoxide, hydrocarbons and nitrogen oxides) are lower than those from petrol cars without a catalyst. diesels have higher emissions of NOx and much higher emissions of particulate matter. Cold Start Emissions Cleaner Petrol and Diesel City Diesel reduces particulate emissions by 34 - 84%

Emissions for Road Vehicles
(per vehicle kilometre)

<table>
<thead>
<tr>
<th>Vehicles</th>
<th>Carbon monoxide</th>
<th>Hydrocarbons</th>
<th>Oxides of nitrogen</th>
<th>Particulate matter</th>
<th>Carbon dioxide</th>
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</thead>
<tbody>
<tr>
<td>* Petrol car without a catalyst</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>---</td>
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<td>Petrol cars with a catalyst</td>
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<td>19</td>
<td>23</td>
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<td>100</td>
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<tr>
<td>Diesel cars without a catalyst</td>
<td>2</td>
<td>3</td>
<td>31</td>
<td>100</td>
<td>85</td>
</tr>
</tbody>
</table>
Why is Venus hot and Mars cold?

Both Venus’s and Mars’s atmospheres are about 95 percent carbon dioxide. Mars has 10,000 times less Carbon Dioxide in its atmosphere than Venus. “Venus’s atmosphere hot (730K) and Mars’s atmosphere minus 125 degrees C is cold.”
Meat!

- The DRI (Dietary Reference Intake) is 0.8 grams of protein per kilogram of body weight, or 0.36 grams per pound (1). This amounts to 56 grams (2oz) per day for the average sedentary man. 46 grams per day for the average sedentary woman.
- Human numbers are rising at roughly 1.2% a year, while livestock numbers are rising at around 2.4% a year. By 2050 the world's living systems will have to support about 120m tonnes of extra humans, and 400m tonnes of extra farm animals.
- Raising these animals already uses three-quarters of the world's agricultural land.
- A third of our cereal crops are used to feed livestock; this may rise to roughly half by 2050. More people will starve as a result, because the poor rely mainly on grain for their subsistence, and diverting it to livestock raises the price.
- Factory farms in the US generate 13 times as much sewage as the human population does. Livestock farming creates around 14% of the world's greenhouse gas emissions; slightly more than the output of the world's cars, lorries, buses, trains, ships and planes. If you eat soya, your emissions per unit of protein are 20 times lower than eating pork or chicken, and 150 times lower than eating beef.

Roughly how many people die prematurely each year in London because of air pollution?

a) 4.5K,
b) 9.5k,
c) 14.5k
nuclear power provides 21% UK power
Almost 300m tonnes of plastic is produced each year and, with just 20% recycled or incinerated, much of it ends up littering the air, land and sea. 8.3bn tonnes of plastic has been produced since the 1950s, with the researchers warning that plastic waste has become ubiquitous in the environment.
Agriculture contribution to GHG

Globally agriculture contributes to GHG increases in four main ways:

• CO₂ releases linked to deforestation
• Methane releases from rice cultivation
• Methane releases from enteric fermentation in cattle
• Nitrous oxide releases from fertilizer application

Together, these agricultural processes comprise 54% of methane emissions, roughly 80% of nitrous oxide emissions, and virtually all carbon dioxide emissions tied to land use changes.

Hurricane Harvey

Up to 4 Sept 2017 there were 26 stories in the UK national press on the South Asian flooding while there were 695 articles on Harvey.

To date, 50 people have been killed, around one million residents have been displaced and 200,000 homes have been damaged in Hurricane Harvey stretching for over 300 miles.

In South Asia, 'the worst monsoon floods in a decade' have killed over 1,400 people across India, Nepal and Bangladesh. Around 41 million people have been displaced.
Some glacier and ice cap facts

- Bering Glacier in Alaska is the largest glacier in North America. This NASA satellite view shows how a glacier is similar to a river. Credit: NASA Earth Observatory
- Glacial ice covers 10-11 percent of all land.
- According to the National Snow and Ice Data Center (NSIDC), if all glaciers melted today the seas would rise about 230 feet (70 meters).
- During the last ice age (when glaciers covered more land area than today) the sea level was about 400 feet (122 meters) lower than it is today. At that time, glaciers covered almost one-third of the land.
- During the last warm spell, 125,000 years ago, the seas were about 18 feet (5.5 meters) higher than they are today. About three million years ago the seas could have been up to 165 feet (50.3 meters) higher.
- Largest surface area of any glacier in the contiguous United States: Emmons Glacier, Washington (4.3 square miles or 11 square kilometers)

Ice caps and global water distribution

- Even though the amount of water locked up in glaciers and ice caps is a small percentage of all water on (and in) the Earth, it represents a large percentage of the world's total freshwater. As these charts and the data table show, the amount of water locked up in ice and snow is only about 1.7 percent of all water on Earth, but the majority of total freshwater on Earth, about 68.7 percent, is held in ice caps and glaciers.
The Lancet
Planetary Health

Our polluted world: the need for a global pollution strategy.

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