Reducing NCD risks and addressing Global Environmental Change in the Anthropocene Epoch

Andy Haines
23% of all global deaths are linked to modifiable environment factors.
That is roughly 12.6 million deaths a year.
TOP 10 CAUSES OF DEATH FROM THE ENVIRONMENT

8.2 million out of 12.6 million deaths caused by the environment are due to noncommunicable diseases.

1st
STROKE 2.5 million

2nd
ISCHAEMIC HEART DISEASE 2.3 million

3rd
UNINTENTIONAL INJURIES 1.7 million

4th
CANCERS 1.7 million

5th
CHRONIC RESPIRATORY DISEASES 1.4 million

6th
DIARRHOEAL DISEASES 846 000

7th
NEONATAL CONDITIONS 270 000

8th
INTESTINAL INFECTIONS 567 000

9th
MALARIA 259 000

10th
INTENTIONAL INJURIES 246 000

World Health Organization
#EnvironmentalHealth
Estimates of annual air pollution deaths

(WHO 2014)
Outdoor air pollution has grown 8% globally in the past five years, with billions of people around the world now exposed to dangerous air, according to new data from more than 3,000 cities compiled by the World Health Organisation (WHO).
Annual average global mortality (1997–2006) due to Landscape fire smoke

Reproduced from Johnston and colleagues 2012; by permission of Environmental Health Perspectives.
Commission on Planetary Health
Human health and well-being in the Anthropocene
Unsustainable environmental trends

- **Tropical forest loss**
  - Global tropical forest loss compared with 1700 baseline (%)
  - 1800-2000

- **Water shortage**
  - World population affected by water shortage (millions)
  - 1800-2000

- **Ocean acidification**
  - Global ocean acidification (mean hydrogen ion concentration: nmol/kg)
  - 1800-2000

- **Temperature change**
  - Temperature anomaly, °C
  - 1800-2000

- **Biodiversity**
  - Global vertebrate biodiversity (index value; 1970=1)
  - 1800-2000
Planetary boundaries

(Steffen et al Science 2015)
Trends in Ecological Footprint and biocapacity per person between 1961 and 2010
The Anthropocene epoch
Effects of multiple environmental changes on food availability and quality

- Land degradation and soil erosion
- Water scarcity
- Loss of pollinators
- Overfishing/Ocean acidification
- Climate change
  - CO₂ fertilization
  - Ozone
  - Pests, mold and fungi
CLIMATE CHANGE: Poor Countries Projected to Fare Worst  MODELLED CHANGES IN CEREAL GRAIN YIELDS, TO 2050

UN Devt Prog, 2009
Global and regional health effects of future food production under climate change: a modelling study  
Springmann et al Lancet 2016
Full pollinator service loss would lead to an estimated 1.42 million (1.38–1.48) additional deaths per year.
Carbon dioxide fertilisation reduces nutrient concentration - meta analysis of 7761 observations (Loladze eLife 2014;3:e02245)

http://elife-publishing-cdn.s3.amazonaws.com/02245/elife-02245-fig2-v3.jpg
## Ocean acidification

### Groups

<table>
<thead>
<tr>
<th>Molluscs</th>
<th>Echinoderms</th>
<th>Crustaceans</th>
<th>Finfish</th>
<th>Corals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clams, scallops, mussels, oysters, pteropods, abalone, conchs and cephalopods (squid, cuttlefish and octopuses)</td>
<td>Sea urchins, sea cucumbers, starfish</td>
<td>Shrimps, prawns, crabs, lobsters, copepods (zooplankton), etc.</td>
<td>Small (herrings, sardines, anchovies), large (tuna, bonitos, billfishes), demersal (flounders, halibut, cod, haddock), etc.</td>
<td>Warm and cold water coral</td>
</tr>
</tbody>
</table>

### Vulnerability

- **Adults and juveniles have shown reduced calcification, growth and survival rates. Some species may become locally extinct.**
- **Few species studied. Vulnerability in early life stages. Some species may become locally extinct.**
- **Less affected than other groups. Thermal tolerance of some crabs is reduced with acidification.**
- **Indirect effects due to changes in prey and loss of habitats such as corals likely. Possibly some direct effects on behaviour, fitness and larval survival.**
- **Reduced calcification, increased bio-erosion, synergistic effects of warming and acidification.**

### Sensitivity (percent of species affected)

![Graph showing sensitivity of species affected](image_url)

- *Commercial value for fisheries represents the sum of capture fisheries and aquaculture in 2010 in US dollars.*
- *Today’s estimated value of global goods and services provided by coral reefs, such as coastline protection, tourism, biodiversity and food.*
- *Adapted from Wittmann and Pörtner, 2013. These data are for business-as-usual trajectories of CO₂ levels.*
Cities are engines of economic growth and social change, with annual economic activity of about US$62 trillion, 85% of global GDP in 2015 and 71–76% of global energy-related greenhouse gas (GHG) emissions.  

The rate of increase in the annual number of extreme heat events between 1956 and 2005 in the most sprawling metropolitan regions in the USA was more than double the rate of increase observed in the most compact metropolitan regions (Stone, Hess and Frumkin Env Health Perspect. 2010)
Inability to work due to thermal stress

- (Dunne et al. 2012)
Climate Change and the Emergent Epidemic of CKD from Heat Stress in Rural Communities: The Case for Heat Stress Nephropathy  


Hot spots of kidney failure

- Countries with reported cases of CKDu
- Countries that first reported cases

Mexico and Central America
Some of the first reports came from El Salvador and Nicaragua.

Egypt
The disease has been reported in El-Minia governorate in Upper Egypt.

India and Sri Lanka
The southern Indian states of Andhra Pradesh and Odisha are the worst affected.
Saltwater intrusion and hypertension in coastal Bangladesh

- High levels of salinity in drinking water for ~ 40 million people
- For each 100mg/l decrease in sodium concentration systolic/diastolic blood pressure reduced by 0.95/0.57 mm Hg
- Odds of hypertension 16% lower for each 100mg/l drinking water sodium reduction
Safeguarding health and protecting the environment
Health Economic Benefits of reducing air pollution through low carbon policies

- Marginal benefits of avoided mortality $50-380/tCO2 exceed abatement costs.
  (West et al Nature Climate Change 2014)

- Global 36% vs 18% renewables --- avoided health costs of $230bn/year by 2030.
  (IRENA 2014)
Tax and Subsidy reform

Pre-tax and Post-tax Energy Subsidies, 2011-15

- Post-tax subsidies, billions US$ (left-side axis)
- Pre-tax subsidies, billions US$ (left-side axis)
- Pre-tax subsidies, percent of global GDP (right-side axis)
- Post-tax subsidies, percent of global GDP (right-side axis)
Health impacts and policies for SLCP abatement
Measures reducing emissions from incomplete combustion (black carbon and co-emissions)

- Improved biomass stoves
- Modern coke ovens
- Remove big smokers / DPF
- Cooking with clean fuel
- Pellet biomass heating stoves
- Improved brick kilns
- Coal briquettes replacing coal
- Reduce agricultural burning
- Reduce flaring
Benefits for Public Health

Rapid SLCP mitigation can provide important benefits for public health, saving millions of lives every year.

HEALTH BENEFITS
FROM GLOBAL IMPLEMENTATION
OF SLCP MEASURES

2,400,000
(0.7-4.6 MILLION)
DEATHS AVOIDED ANNUALLY
FROM REDUCED PM2.5 OUTDOOR
AIR POLLUTION BY 2030

+ ADDITIONAL HEALTH BENEFITS
FROM REDUCED PM2.5 INDOOR
AND O3 AIR POLLUTION

% of total prevented annual premature deaths from outdoor air pollution thanks to large scale implementation of BC measures by 2030

- Latin America and Caribbean
- N. America and Europe
- Africa
- S., W. and Central Asia
- NE, SE Asia and Pacific

01. Residential
02. Industry
03. Transport
04. Agriculture
05. Fuel
06. Waste
07.
08.
09.
10.
11.
12.
13.
14.
15.
16.
Cookstoves – Traditional and Modern

Traditional Biomass Stove

Per meal

~15x less black carbon and other particles
~10x less ozone precursors
~5x less carbon monoxide

Gasifier Stove with Electric Blower (battery recharged with cell phone charger)
Health benefits of a proposed Indian stove programme- 150 million improved stoves over 10 years *(Wilkinson, Smith et al Lancet 2009)*

<table>
<thead>
<tr>
<th></th>
<th>Deaths from ALRI</th>
<th>Deaths from COPD</th>
<th>Deaths from IHD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avoided in 2020 (%)</td>
<td>30.2%</td>
<td>28.2%</td>
<td>5.8%</td>
</tr>
<tr>
<td>Total avoided 2010-20</td>
<td>240,000</td>
<td>1.27 million</td>
<td>560,000</td>
</tr>
</tbody>
</table>

ALRI=acute lower respiratory infections. COPD=chronic obstructive pulmonary disease. IHD=ischaemic heart disease.
Developing sustainable and healthy cities

- Public transport/walking and cycling
- Access to clean energy
- Green spaces – biodiversity, reduced heat island and mental health benefits
- Watershed conservation
- Increased resilience to floods, storms and droughts
Urban trends

Parnell et al.
GEC. 2011
Increased active travel and low carbon transport
(Woodcock et al 2009, Jarrett et al 2012)

Figure 1: Potential annual NHS expenditure averted by year and health outcome from Increased Active Travel scenario
Carbon dioxide emissions, weight and physical activity (Goodman et al, Env. Health 2012)

- Survey of 3463 UK adults in 3 sites
- CO2 emissions were significantly higher in overweight or obese participants
- Lower active travel, larger car engine size but mostly due to greater distance travelled by motor vehicle.
Gender-stratified multivariate linear regression models adjusted for age, days per week of moderate leisure PA, urban/rural area, ethnicity, household income quintiles, Townsend area deprivation quintiles, highest educational qualification, alcohol intake, smoking status, non-work active travel, walking for pleasure, job involves standing/walking, manual job, shift work, self-rated health, limiting longstanding illness.
SMART Transport adoption

(Source: EMBARQ 2013)
Psychological and emotional outcomes from exposure to natural versus synthetic environments

<table>
<thead>
<tr>
<th>Outcome type</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attention</td>
<td>Attention (4 studies)</td>
</tr>
<tr>
<td>Pleasurable moods</td>
<td>Energy (5 studies)</td>
</tr>
<tr>
<td></td>
<td>Tranquillity (7 studies)*</td>
</tr>
<tr>
<td>Displeasurable moods</td>
<td>Anxiety (6 studies)*</td>
</tr>
<tr>
<td></td>
<td>Anger (7 studies)</td>
</tr>
<tr>
<td></td>
<td>Fatigue (4 studies)</td>
</tr>
<tr>
<td></td>
<td>Sad or depressed (4 studies)</td>
</tr>
<tr>
<td>Physiological outcomes</td>
<td>Systolic BP (6 studies)</td>
</tr>
<tr>
<td></td>
<td>Diastolic BP (5 studies)</td>
</tr>
<tr>
<td></td>
<td>Pulse (5 studies)</td>
</tr>
<tr>
<td></td>
<td>Cortisol (4 studies)</td>
</tr>
</tbody>
</table>

Pooled effect size (Hedges g)
Reducing food waste and promoting sustainable healthy diets

Nearly 30% of the world’s total agricultural land is used to produce food that is never eaten.

We are using grains to feed animals!
<table>
<thead>
<tr>
<th>Mitigation action</th>
<th>SLCP-related climate benefit</th>
<th>Potential health benefit</th>
<th>Main health benefit(s)</th>
<th>CO₂ reduction co-benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Promoting healthy low-GHG (plant-based) diets</td>
<td>High</td>
<td>High</td>
<td>Reduced diet-sensitive chronic diseases</td>
<td>Medium-high</td>
</tr>
<tr>
<td>Reducing food waste</td>
<td>Medium-high</td>
<td>Low-medium</td>
<td>Reduced food insecurity/undernutrition</td>
<td>Medium-high</td>
</tr>
</tbody>
</table>

![Graph showing kg CO₂ per kg food for various foods](image)
Sustainable healthy economies

- Raw materials
- Design
- Recycling
- Production remanufacturing
- Residual waste
- Collection
- Circular economy
- Distribution
- Consumption use, reuse, and repair
Global environmental change can affect NCD risks through a range of pathways.

Policies to reduce environmental change can yield health co-benefits.

Thank you for your attention.

Andy Haines
Professor of Public Health and Primary Care