Climate and health public engagement

Leadership program

Topic area: Climate change and health intersection

Session title: Co-benefits of climate change mitigations

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Outline

01 Concepts and significance *(5 min)*

02 Overview of existing evidence *(20 min)*

03 Methodological framework *(15 min)*

04 Case studies *(20 min)*

05 Group exercise *(30 min)*

01 Concepts and significance

1. Why is it important to assess co-benefits from climate change mitigations?

01 Concepts and significance

Climate change mitigations

"A human intervention to reduce the sources (abatement) or enhance the sinks of GHGs (sequestration)" - IPCC

- Policies, legislations, e.g. carbon price
- Technology innovation, e.g. renewable energy
- Mitigation at individual level, e.g. international travelling



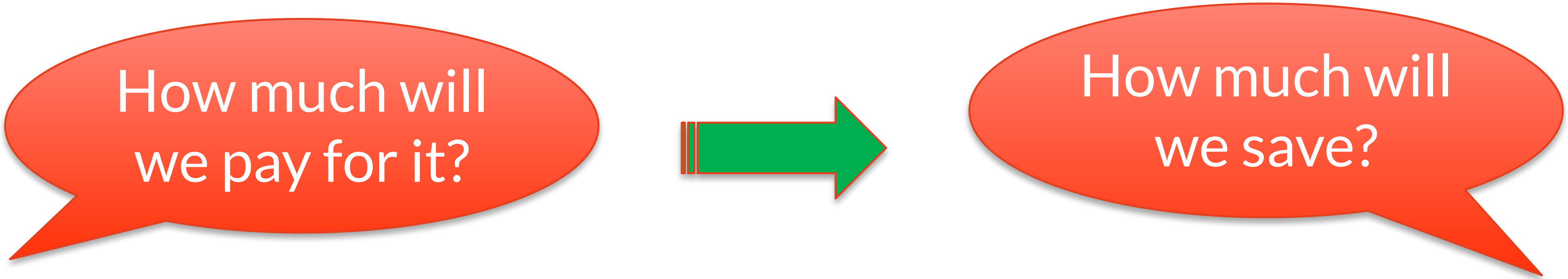
“Co-benefits” of climate change mitigations

– Positive benefits (externalities) to environment, health, economy, and society that are beyond GHG emission reduction.

  - Improved air quality
  - Reduced health costs
  - Mental health benefits from more green spaces
  - Increased work productivity from energy efficiency technique
  - Job creation from investment in renewable energy
  - ...

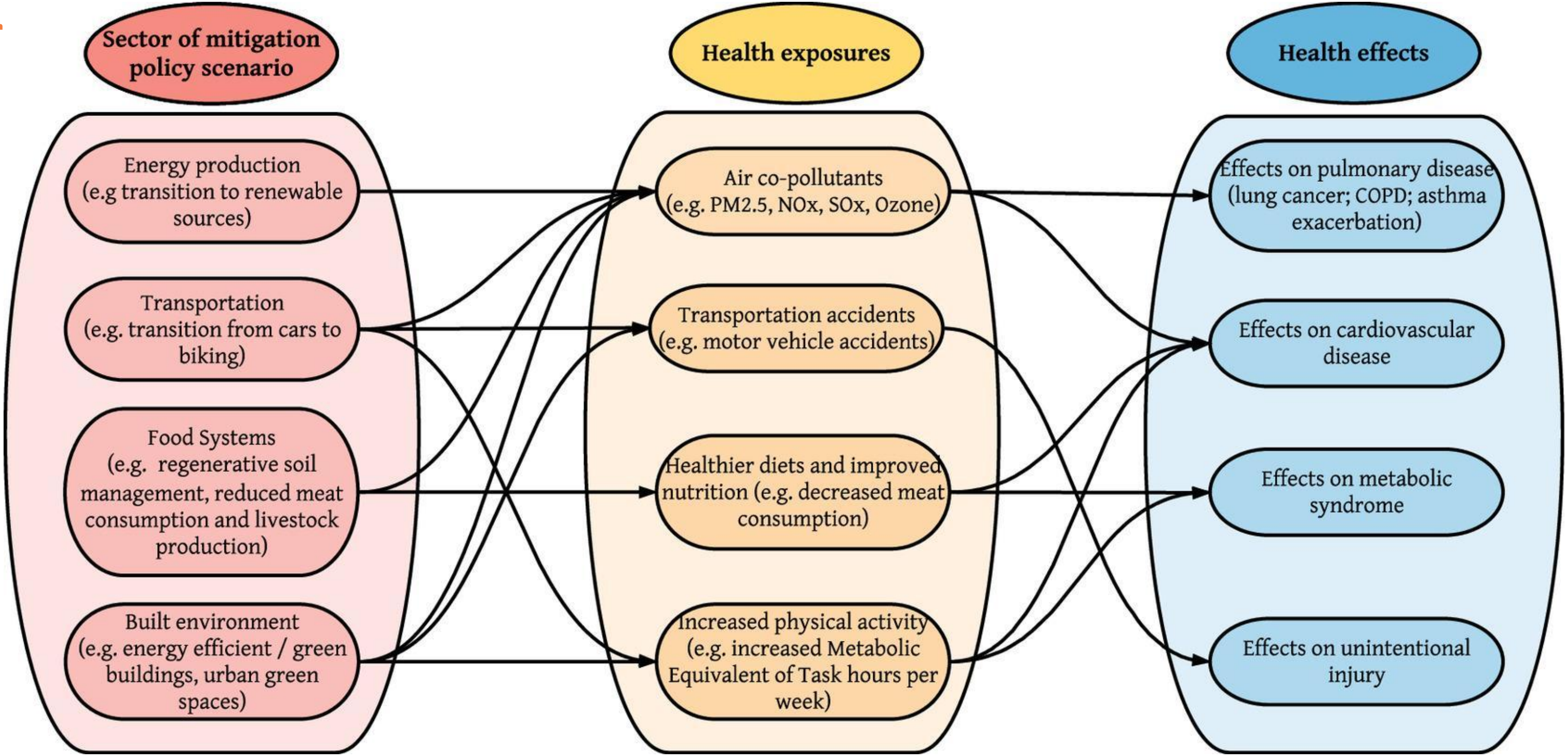
To accelerate optimal mitigation policies

- Go beyond the direct financial assessment of mitigation options
- Provide a full picture of future scenarios to aid decision-making
- Help leaders/decision makers weigh pros and cons in a data-driven way so they can make complex decisions in a systematic manner



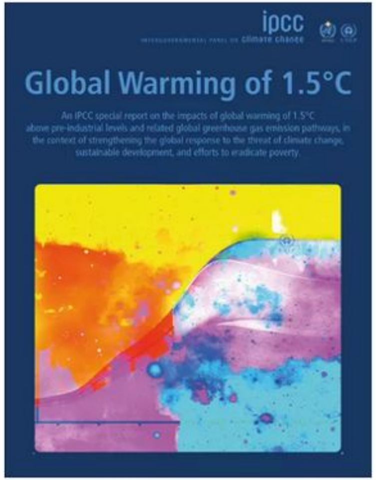
02 Overview of existing evidence

2. What environment, health, and economic co-benefits can we achieve through climate change mitigation based on current evidence?



(Hess et al, 2020)

A global perspective



By limiting warming to 1.5 °C, not 2 °C, we could have 420 million fewer people being exposed to frequent extreme heat waves, and 10 million fewer people losing their home due to sea level rising.

THE LANCET
Planetary Health

Compared with the current pathways scenario, the sustainable pathways scenario resulted in an annual reduction of 1.18 million air pollution-related deaths, 5.86 million diet-related deaths, and 1·15 million deaths due to physical inactivity, across the nine countries, by 2040.

A global perspective

nature climate change

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Published: 22 September 2013

Co-benefits of mitigating global greenhouse gas emissions for future air quality and human health

J. Jason West, Steven J. Smith, Raquel A. Silva, Vaishali Naik, Yuqiang Zhang, Zachariah Adelman, Meridith M. Fry, Susan Anenberg, Larry W. Horowitz & Jean-Francois Lamarque

Nature Climate Change **3**, 885–889 (2013) | Cite this article

East Asian co-benefits are 10–70 times the marginal cost in 2030

- A 25%–190% ↑ in fruit and vegetable consumption, and 56%–78% ↓ in meat consumption could result in
  - a reduction of 11.4–8.1 Gt/year GHG emission
  - 5.1 million global deaths avoided
- Shifting the global population to vegetarian diets, and increasing produce consumption by 54% would result in
  - a reduction of 11.4–3.4 Gt /year of food-related GHG by 2050
  - 8.1 million deaths avoided
  - economic benefits at $1–31 trillion, or 0.4% –15% of global GDP in 2050

PNAS PNAS PNAS PNAS

Analysis and valuation of the health and climate change cobenefits of dietary change

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Edited by David Tilman, University of Minnesota, St. Paul, MN, and approved February 9, 2016 (received for review November 22, 2015)

What we eat greatly influences our personal health and the environment we all share. Recent analyses have highlighted the likely dual health and environmental benefits of reducing the fraction of animal-sourced foods in our diets. Here, we couple for the first time, to our knowledge, a region-specific global health model based on dietary and weight-related risk factors with emissions accounting and economic valuation modules to quantify the linked health and environmental consequences of dietary changes. We find that the impacts of dietary changes toward less meat and more plant-based diets vary greatly among regions. The largest absolute environmental and health benefits result from diet shifts in developing countries whereas Western high-income and middle-income countries gain most in per capita terms. Transitioning toward more plant-based diets that are in line with standard dietary guidelines could reduce global mortality by 6–10% and food-related greenhouse gas emissions by 29–70% compared with a reference scenario in 2050. We find that the monetized value of the improvements in health would be comparable with, or exceed, the value of the environmental benefits although the exact valuation method used considerably affects the estimated amounts. Overall, we estimate the economic benefits of improving diets to be 1–31 trillion US dollars, which is equivalent to 0.4–13% of global gross domestic product (GDP) in 2050. However, significant changes in the global food system would be necessary for regional diets to match the dietary patterns studied here.

sustainable diets | dietary change | food system | health analysis | greenhouse gas emissions

The diets investigated in these studies include diets with a pro rata reduction in animal products (ruminant meat, total meat, dairy) (11, 13, 14), specific dietary patterns that include reduced or no meat (such as Mediterranean, "pescatarian," and vegetarian diets) (11, 12), and diets based on recommendations about healthy eating (7, 11). The health consequences of adopting these diets have not been explicitly modeled or quantitatively analyzed, but instead inferences have been drawn from information available in the epidemiological literature (16). In the most comprehensive study to date, Tilman and Clark (12) analyzed the GHG emissions of a series of diets that differed in their animal-sourced food content and presented their results alongside a series of observational studies of the health consequences of adopting the different diets.

Here, we use a region-specific global health model to link the health and environmental consequences of changing diets. We also make a first attempt, to our knowledge, to estimate the economic value of different dietary choices through their effects on health and the environment. For the health analysis, we built a comparative risk assessment model to estimate age and region-specific mortality associated with changes in dietary and weight-related risk factors (4, 17). The specific risk factors influence mortality through dose–response relationships, which allow us to compare different dietary scenarios based on their exposure to those risk factors. Given the availability of consistent epidemiological data, we focused on changes in the consumption of red meat, and of fruits and vegetables, which together accounted for more than half of diet-related deaths in 2010 (4), and also on the fraction of people who are overweight or obese through excess calorie consumption, which too is associated strongly with chronic disease mortality (18, 19).

Energy generation sector (Air pollution control/energy efficiency improvement)

- In India, cleaner household cooking energy (advanced biomass stoves) could avoid

- App. 570,000 premature deaths in poor women and children
- > 4% of India's estimated GHG emissions
- worth more than US$1 billion

(Venkataraman et al. 2010)

Energy generation sector (Air pollution control/energy efficiency improvement)

– Estimate of the Integrated Environmental Strategies (IES) of reducing air pollutants and GHG in Seoul Metropolitan Area (Chae and Park, 2011)

- health benefits from avoided premature deaths under IES is 14 trillion Korean won and cost saved is 3.6 trillion won
- benefit of air quality management is 14 trillion won and cost saved is 0.3 trillion won
- benefit under GHG reduction is 1.5 trillion won and cost saved is 6.4 trillion won

(1USD = 1300 Korean won)

Energy generation sector
(Air pollution control/energy efficiency improvement)

- Compared with BAU in 2020, adopting energy efficiency and fuel substitution measures in four cities (México City, São Paulo, Santiago, and New York) could
  - reduce GHG emissions by approximately 13%
  - result in a 10% reduction in exposure to PM_{10} and O_3
  - prevent about 64,000 (95% CI:18,000–116,000) premature deaths

(Cifuentes et al, 2001)

Energy generation sector (Air pollution control/energy efficiency improvement)

- A policy of GHG reduction in the Mexican economy by 77% would save 3,000 lives and 417,000 cases of non-fatal diseases per year, at a savings of $0.6 billion per year in cost of illness (Crawford-Brown et al, 2012)
- In the US, reduced exposure to $PM_{2.5}$ would yield economic benefits of $6- $30 billion in 2020 due to reductions in adverse health outcomes, equivalate to $40-$198 per metric ton of CO_2 in health benefits (Bulbus et al, 2014)

Transportation sector

- A saving of over NZ$1 million per 1000 commuter cyclists per year in New Zealand (Lindsay et al, 2011)
- A 35 % increase in bicycle trips resulted 113 (76–163) annual deaths avoided in Warsaw (Rojas-Rueda et al, 2016)
- Implementing ambitious policies promoting clean energy and vehicles could save US$250 billion annually in the US (Shindell et al, 2016)

Transportation sector

- In Greater Kuala Lumpur, Malaysia, the MRT would reduce 183 deaths and 9587 DALYs in population per year and reduce 337,800 t of CO_2 equivalent/ year from private transport

(Kwan et al. 2017)

Agriculture and food sector

- Lower livestock production would result in 40% lower nitrogen emissions & 25-40% reduction in GHGs in the US (Westhoek, 2014)
- Reducing red-meat assumption with plant-based diet could result in decreased carbon footprint and obesity/overweight in China (Wang et al, 2021)
- Mediterranean diet model would save 5 million years of life lost prematurely in Italy, and save 8000–14000 Gg CO_2 eq/year (Farchi et al, 2017)

03 Methodological framework

3. How can we evaluate co-benefits to inform policy change? – A quantitative challenge

Challenges to the quantitative assessment

- A multiple-objective/multiple-impact framework is essential
  - social cost-benefit analysis; integrated assessment modelling; multicriteria analysis
- A lack of understanding of the net welfare effect of a given policy, especially in developing countries
- Scale is important for understanding which groups are affected by the co-benefits (city level estimate could be the opposite at the national level)
- Transdisciplinary team
- Advanced modelling skills and data availability

(Ürge-Vorsatz et al, 2014)

A methodological framework

ehp Environmental Health Perspectives

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Vol. 128, No. 11 | Commentary

Guidelines for Modeling and Reporting Health Effects of Climate Change Mitigation Actions

is companion of

Jeremy J. Hess, Nikhil Ranadive, Chris Boyer, Lukasz Aleksandrowicz, Susan C. Anenberg, Kristin Aunan, Kristine Belesova, Michelle L. Bell, Sam Bickersteth, Kathryn Bowen, Marci Burden, Diarmid Campbell-Lendrum, Elizabeth Carlton, Guéladio Cissé, Francois Cohen, Hancheng Dai , Alan David Dangour, Purnamita Dasgupta, Howard Frumkin, Peng Gong, Robert J. Gould, Andy Haines, Simon Hales, Ian Hamilton, Tomoko Hasegawa, Masahiro Hashizume, Yasushi Honda, Daniel E. Horton, Alexandra Karambelas, Ho Kim, Satbyul Estella Kim, Patrick L. Kinney, Inza Kone, Kim Knowlton, Jos Lelieveld, Vijay S. Limaye, Qiyong Liu, Lina Madaniyazi, Micaela Elvira Martinez, Denise L. Mauzerall, James Milner, Tara Neville, Mark Nieuwenhuijsen, Shonali Pachauri, Frederica Perera, Helen Pineo, Justin V. Remais, Rebecca K. Saari, Jon Sampedro, Pauline Scheelbeek, Joel Schwartz, Drew Shindell, Priya Shyamsundar, Timothy J. Taylor, Cathryn Tonne, Detlef Van Vuuren, Can Wang, Nicholas Watts, J. Jason West, Paul Wilkinson, Stephen A. Wood, James Woodcock, Alistair Woodward, Yang Xie, Ying Zhang, and Kristie L. Ebi See fewer authors

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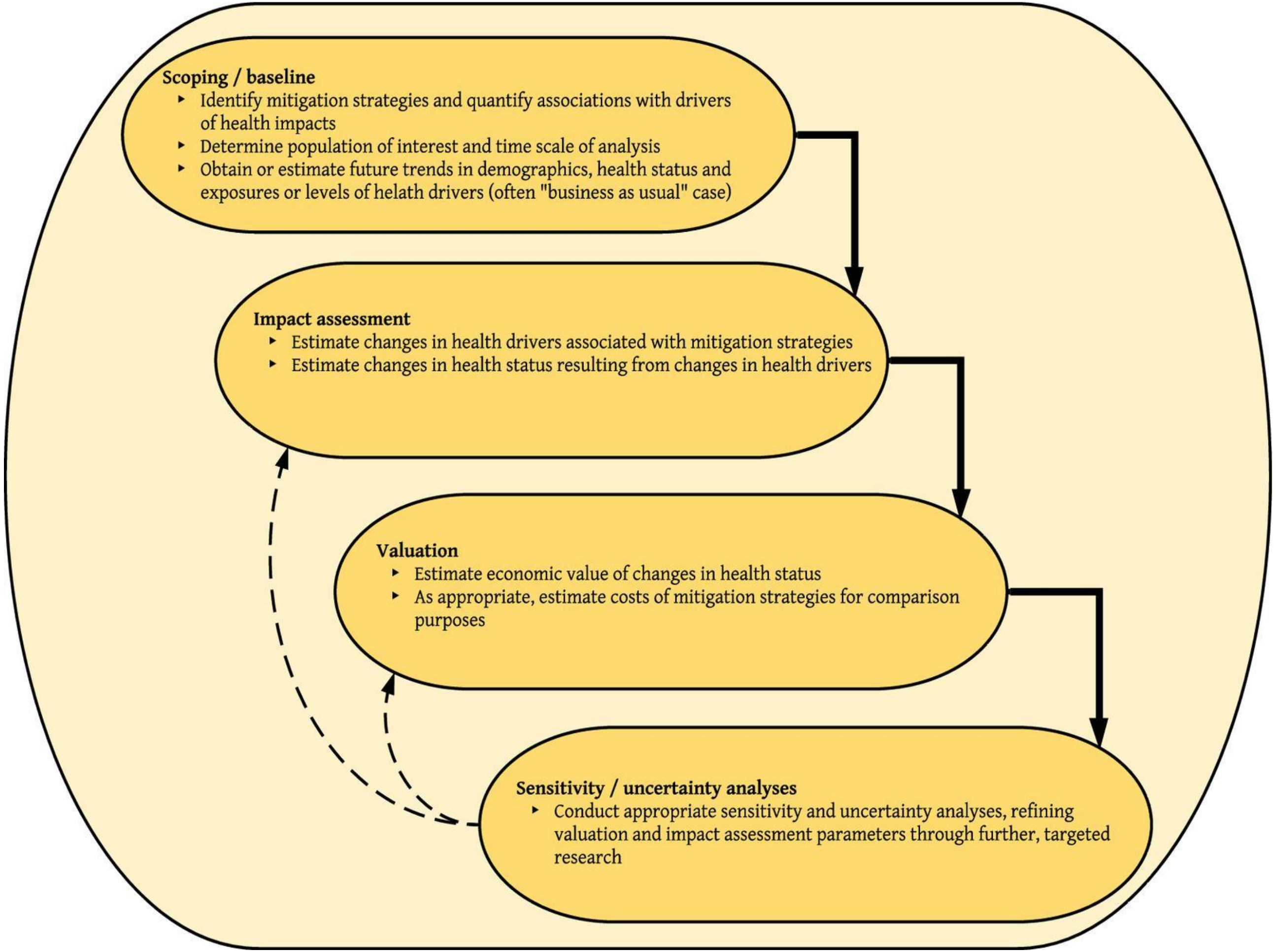
- To encourage specific modelling practice in quantitative estimations
- To maximize the likelihood of implementing of the most beneficial mitigation actions
- To help improve the reporting and comparability of evidence

Engagement, modeling, parameterization, reporting and synthesis considerations for health co-benefit studies of climate mitigation



Stakeholder engagement

5 Recommendations:

1. Specify the primary decision maker(s) and/or target audience(s).
2. List and describe strategies used to facilitate stakeholder engagement and communication with the target audience throughout the HEM development and dissemination process.
3. As relevant, describe involvement with knowledge brokers, research uptake officers, policy advisors, and other stakeholders at multiple stages of planning and implementation (e.g., their role in selecting model inputs such as health metrics).
4. As relevant, describe collaboration(s) with stakeholders (whether at the affected community level, in academia, or in government) in health-determining sectors (e.g., finance, energy, transportation, housing, industry, food systems, and agriculture).
5. As relevant, describe engagement between mitigation and adaptation experts relevant to various phases of effort, from planning to implementation and dissemination, including any efforts to avoid unintended consequences.

Modelling approaches

23 recommendations on 8 aspects

- Describing mitigation policies, scenarios and sectors involved
- Specifying geographic area and scale
- Population and demographic considerations (e.g. population size, target population, account or equity, projections)
- Counterfactual scenarios (e.g. proportion of the population exposure, use of SSPs/RCPs for emissions)
- Time frames and horizons (baseline year and projections)
- Exposure-response functions (e.g. justification, subpopulation)
- Health metrics appropriate for the causal pathways (e.g. DALYs, mortality)
- Baseline health estimates (e.g. justify data sources)

Parameterization and reporting

13 recommendations on 4 aspects

- Health outcome reporting (various health indicators)
- Accounting for variable policy uptake (best, second best...)
- Discounting (including at least rates of 0% and 3%)
- Data and code transparency (legal and ethical approval)

* Sensitivity analysis is essential to understand model uncertainties and variability

Further considerations

- Require additional resources for implementation and capacity building, especially to support efforts in LMICs
- Further innovations to streamline the methodological framework is critical
- Policy- /action- oriented research: It’s not only about research but how to translate research into policy changes and action.

04 **Case studies**

4. Case studies in Australia and China

Traffic-related air pollution and health co-benefits of alternative transport in Adelaide, South Australia

(Xia et al, 2015)

– Key findings:

In the city with 1.4 million people in 2030, by shifting 40% of vehicle kilometers travelled (VKT) by passenger vehicles to alternative transport,

- annual average $PM_{2.5}$ would decline by 0.4 μg/m^3 compared to BAU
- estimated health benefits due to improved air quality: 13 deaths and 118 DALYs avoided per year
- further health benefits from increased physical activity: 508 deaths and 6569 DALYs avoided per year

Study setting

- A population of 1.1million in 2010
- >80% of the residents travel by private motor vehicle
- Nearly 40% of private car trips <10km
- Relatively low level of air pollution, but exposure and impact of $PM_{2.5}$ ↑
- Established partnerships between the University, EPA, Dept of Health, Dept of transport, Bureau of Meteorology

04 Case studies

Methodological framework

1. Developed experimental scenarios based on baseline VKT

2. Used the Motor Vehicle Emission Inventory to calculate changes in the GHG and $PM_{2.5}$ emissions generated by motor vehicles

3. Conducted health impact assessments based on the comparative risk assessment approach

T. Xia et al. / Environment International 74 (2015) 281–290

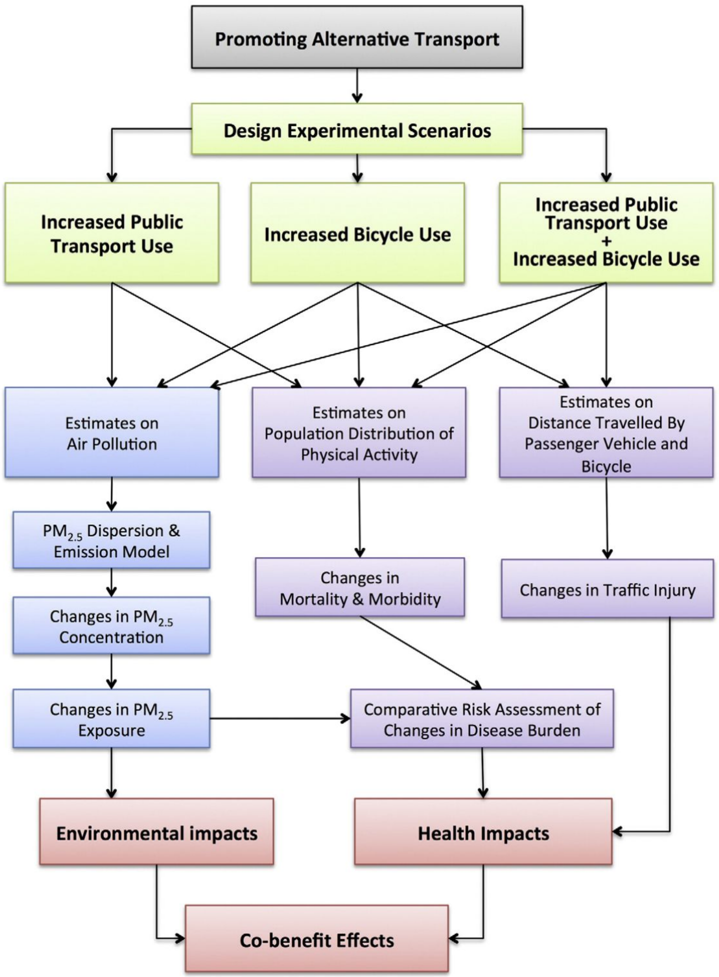


Fig. 1. Theoretical framework model.

Methods

Scenarios:	referred to the '30-Year Plan for Greater Adelaide'; five scenarios of reductions in passenger vehicle VKT (5%-40%)
Timeframe:	2010 as baseline, projections in 2030
Data sources:	EPA, SA Health, ABS, BoM (hourly data for temp, rh, wind), Physical Activity Among South Australian Adults survey, global and national BoD studies,
Models:	traffic-related $PM_{2.5}$ and CO_2 emission model, $PM_{2.5}$ dispersion model (1 km × 1 km inner grid and 30 km × 30 km outermost grid); Comparative Risk Assessment model
Health metrics:	premature death and DALYs
Sensitivity analysis	tested 5 assumptions

Discussion

- The first city-level co-benefit study on active transport in Australia
- The largest health benefits would occur when increased public transport and cycling are combined, which is estimated to result in a 55% reduction of total disease burden attributed to physical inactivity.
- The possible change of road traffic fatalities because of the shift in travel mode was considered.

Implications for change

- Local databases and scenarios are more relevant and useful to decision-making at a sub-national level, but justified alternative data sources are acceptable
- Roundtable discussions and workshops with various stakeholders in EPA, Dept of Health, Transport, NGOs for cycling, etc.
- Lead to more investment in sustainable public transportation and cycling lanes in the city
- Contribution to the research field: ≈ 200 citations in Google Scholar

Analyses of air pollution control measures and co-benefits in the heavily air-polluted Jinan city of China, 2013–2017 (Cui et al, 2020)

– Key findings:

- ↓ 72.6% for SO_2, ↓ 43.1% for $PM_{2.5}$, and ↓ 34.2% for PM_{10}
- Avoided 2,317 (95%CI: 1,533–2,842) premature deaths and 15,822 (95%CI: 8,734–23,990) related morbidity in 2017
- A total economic benefit of US$ 317.7 million (95%CI: 227.5–458.1)
- Further benefits projected for a scenario of $PM_{2.5}$ concentrations down to 15 $\mu g/m^3$

Study setting

- One of the most heavily air-polluted cities in China, 7 million residents in 2013, GDP per capita US$15k
- A series of national policies to reduce air pollution was implemented in 2013

  * the Air Pollution Prevention and Control Action Plan (APPCAP) sets specific concentration targets to be achieved by 2017
- Efforts in assessing co-benefits from the air pollution control measures at a national level but not a city level

04 Case studies

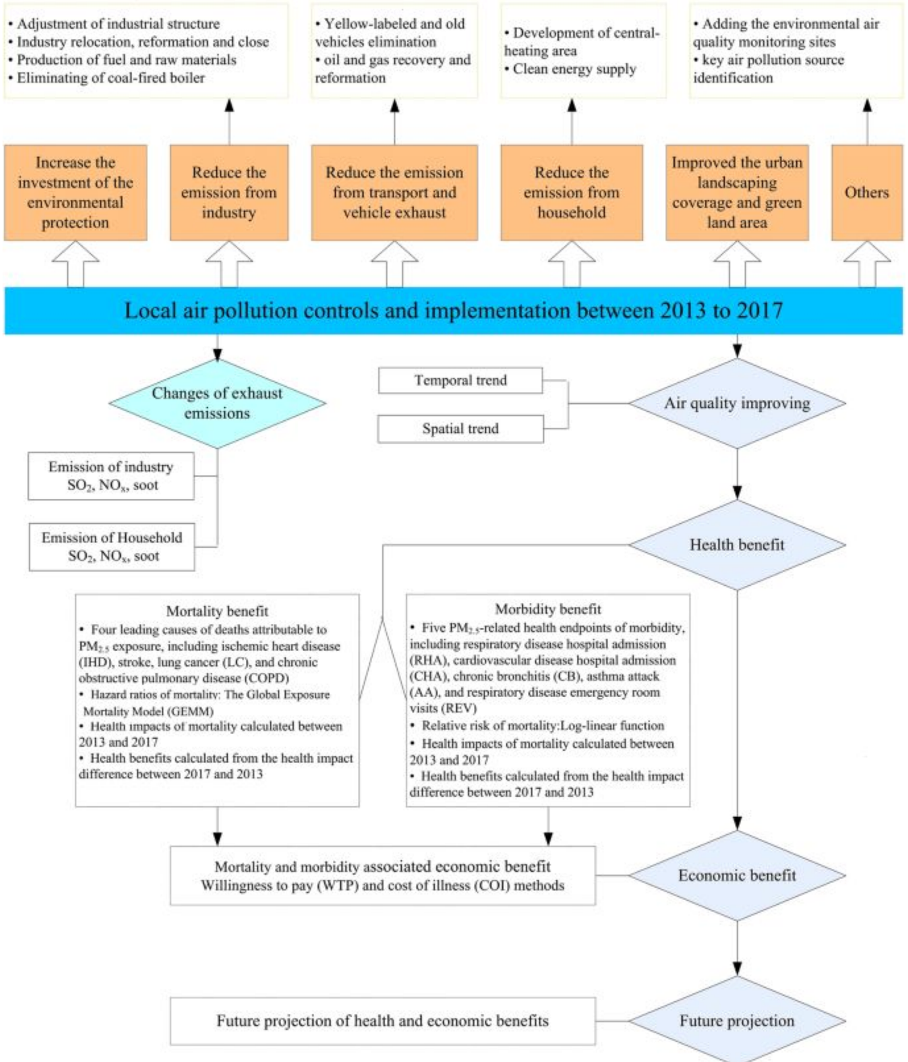
Methodological framework

-Reviewed air pollution control policies and measures

-Assessed the changes in exhaust emissions and ambient air pollutants

-Quantified reduction in mortality and morbidity from improved air pollution

-Estimated associated economic benefits in US$



Methods

Timeframe:	2013-2017
Policy:	National and local air pollution control measures
Data sources:	EPA ($PM_{2.5}$, PM_{10}, SO_2, NO_2 and CO, O_3), Statistic Yearbook, Jinan CDC (mortality and morbidity)
Models:	- for hazard ratio of mortality: global exposure mortality model, - for Relative Risks of morbidity: log-linear function, - for economic benefits: willingness to pay (WTP) and cost of illness (COI) methods
Health metrics:	4 cause-specific mortalities; 5 $PM_{2.5}$-related morbidities; premature deaths and DALYs

Discussion

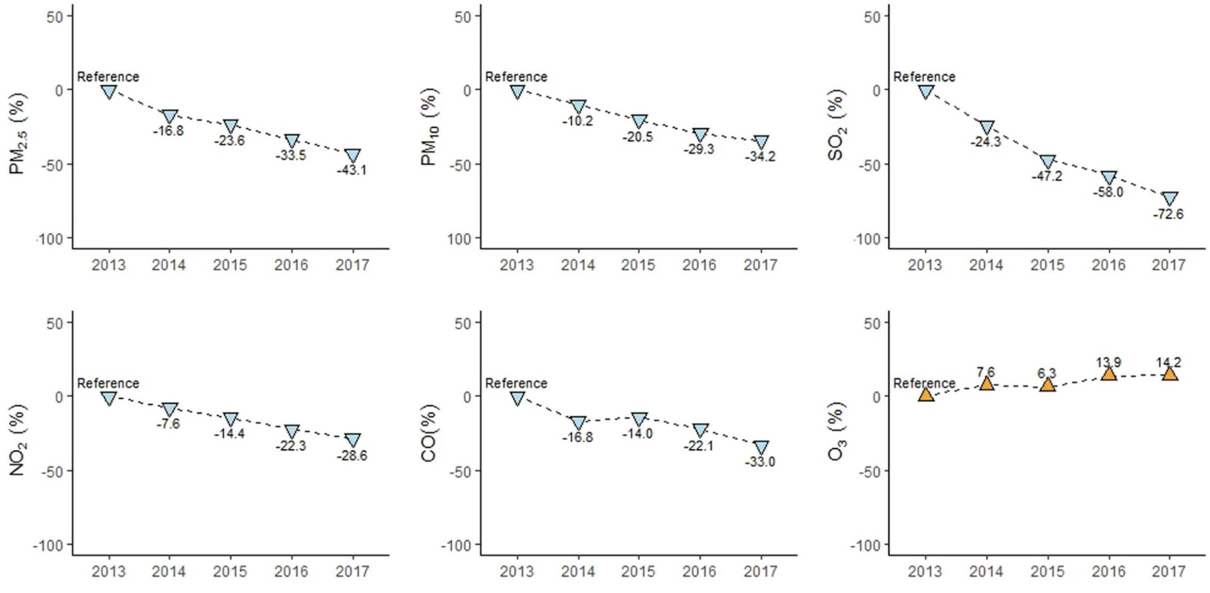
– Significantly increased investment on the environmental protection and innovation: a total of US$1.5 billion 2013-17, with an increasing average annual rate of 25%

Air pollution control measures in Jinan and directly-related effectiveness, 2013–2017. (**a**) Changes in total environmental investment and average investment per person. (**b**) Changes in adjustment of industrial structure. (**c**) Changes in fuel and raw materials production. (**d**) Changes in centralized-heating area. (**e**) Changes in natural gas supply. (**f**) Changes in urban landscaping coverage (%) and park green area per person (m^2).

Discussion

– Decreased exposure to SO_2 , $PM_{2.5}$, PM_{10}, CO, and NO_2 , except O_3 (a14.2% increase in 2017)

From: Analyses of air pollution control measures and co-benefits in the heavily air-polluted Jinan city of China, 2013–2017



Percent changes (%) in annual mean concentration of air pollutants in Jinan, 2013–2017.

Implications for change

- Provided much needed co-benefit evidence to accelerate mitigation efforts at a municipal level
- Further co-benefits could be achieved if PM2.5 could drop to WHO air quality standard (<5 $\mu g/m^3$)
- Missed the opportunity to examine health inequity due to a lack of AP monitoring data in rural areas
- Engage policymakers for research implementation should consider local political, economic and cultural contexts

Take home messages

- Climate change mitigations can bring tangible environmental, health and economic co-benefits.
- More evidence from local co-benefit analyses with standardized methodological frameworks is in need and can be more influential in spurring policy action on climate.
- More investment and resources are required to facilitate the inclusion of the values of co-benefits in policymaking to address climate, health, economy, and equity through multi-sectorial collaborations.

Take action now!

05 **Group exercise**

5. Group exercise: facilitating the translation of co-benefit research for change

Group exercise

- One scenario is provided for group discussion on how you could engage with co-benefit evaluation and take actions for policy change based on the evidence

❖ Some key questions to discuss:

- *Who are the stakeholders to engage?*
- *How can the findings be effectively communicated?*
- *What could be potential barriers and enablers?*

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