Public Health England

Decision support for environmental health hazards

Modelling risk for prioritisation of interventions for environmental hazards to human health using Multi-Criteria Decision Analysis

Giovanni Leonardi (PHE/LSHTM), Mae Woods (PHE/LSHTM), Helen Crabbe (PHE), Rebecca Close (PHE), Mike Studden (CIEH), Zaid Chalabi (LSHTM)

HC1   Helen Crabbe, 06/08/2013

Lead partners

- Epidemiology Department, Centre for Radiation, Chemical and Environmental Hazards (CRCE), Public Health England, Chilton, Oxfordshire, UK.

- London School of Hygiene and Tropical Medicine, Department of Social and Environmental Health Research, London, UK.

Acknowledgements

Sustrans, Plymouth City Council, Radon Research Group at PHE

Project overview

- Multidimensional hazard management

- Multi Criteria Decision Analysis (MCDA)

- List of example criteria and options

- Eliciting qualitative evidence through questionnaires

- Mathematical analysis of uncertainty

- The decision support tool demonstration

- Questionnaire

Outdoor air pollution and heavy duty vehicle controls

Expert in public health

Models of relative risk

The public – "What about me?"

What about hospital admissions?

Do we need to budget?

How robust is the evidence?
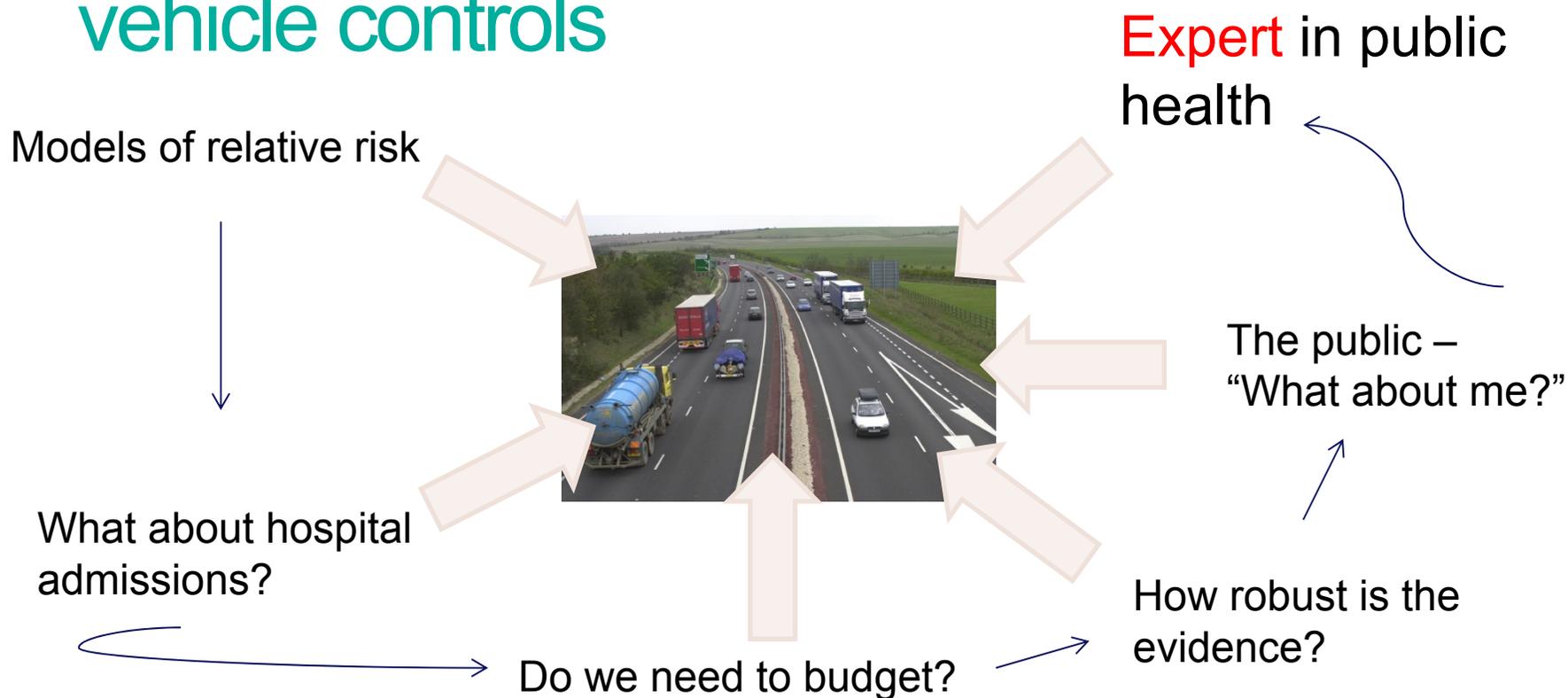
Decision making and MCDA

Mathematically based

- Criteria are multidimensional. MCDA is a mathematical tool which can support decisions on the ranking of options

Model outputs are transparent

- Open to scrutiny, repeatable and relevant to practitioner needs

Objectives

- What *criteria* do the public and health authorities consider when making a decision on which environmental hazards to prioritise?

- What interventions are plausible?

- MCDA takes these criteria into account and produces a quantitative ranking of prioritization

Criteria

- **Seven** *criteria* that will influence the decision

Hazards and interventions

- **Five** *hazards* and their associated *interventions*

1. Outdoor air quality and heavy duty vehicle controls

2. Basement membranes and their use to control levels of indoor radon

3. The quality of indoor air and fitting carbon monoxide alarms

4. Municipal incineration as a waste management option

5. The obesogenic environment. Encouraging cycling through the provision of cycle routes

Table 1 Environmental public health hazards, example associated interventions and health effects modelled for the case study

Hazard	Example interventions	Health effects modelled
Radon	Domestic buildings requiring remediation (e.g. retrofitting of active sumps, passive or active ventilation)	Lung-cancer mortality
Outdoor air pollution	Implementing local air quality management, emissions control (vehicular and industrial) and education	Chronic obstructive pulmonary disease
Indoor Carbon Monoxide	Fitting carbon monoxide alarms, servicing of gas appliances, ventilation, increasing awareness	Cardiovascular disease
Obesogenic environment	Encouraging walking and cycling, provision of cycle routes, encouraging the use of public transport, increased access to green spaces and fitness facilities, planning disincentives for fast food restaurants	Chronic obstructive pulmonary disease, all-cause mortality

A combination of models and expert opinion

Quantitative metrics

Qualitative judgement

Integrate with Criteria of importance

Ranking of options

Table 2 Explanation of the quantitative and qualitative criteria used in the MCDA model for this case study

Quantitative criteria

Mortality based on mortality models of relative risk from a change in exposure to the hazard following intervention. Morbidity based on hospital admission models of relative risk from a change in exposure to the hazard following intervention.

Qualitative criteria

Criteria	Application	Explanation
'Robust Evidence'	Is there robust evidence for the risk?	What is the level of evidence on the risk, i.e. it is robust, plentiful, consistent, accepted by the scientific community
'Wellbeing'	Impact on wellbeing	With the intervention in place, what impact does this have on wellbeing and happiness in particular
'Sustainability of intervention'	Is the intervention sustainable?	Is the intervention sustainable in terms of economic, social, and environmental impacts? Does it require a lot of resources to keep in place and maintain? Are there social and environmental costs for its implementation and running?
'Level of regulation'	How regulated is the intervention	Is the intervention subject to regulation? Is it enforceable in law? Are there penalties for failure? E.g. emissions tests.

Data were provided by Sustrans, GIS corporate datasets at PHE and the radon research group at PHE.

Data that were used in the quantitative analysis include:

A road junctions (thick bold lines), local cycle routes, national cycle network

national cycle route networks (triangles)

proportion of homes that exceed the action level for radon.

Hazard Intervention Map

Legend
- ▲▲▲▲▲ Cycle Routes
- 1-3%
- 3-5%
- 5-10%
- 10-30%
- >30%
- —— A Roads

N
W   E
S
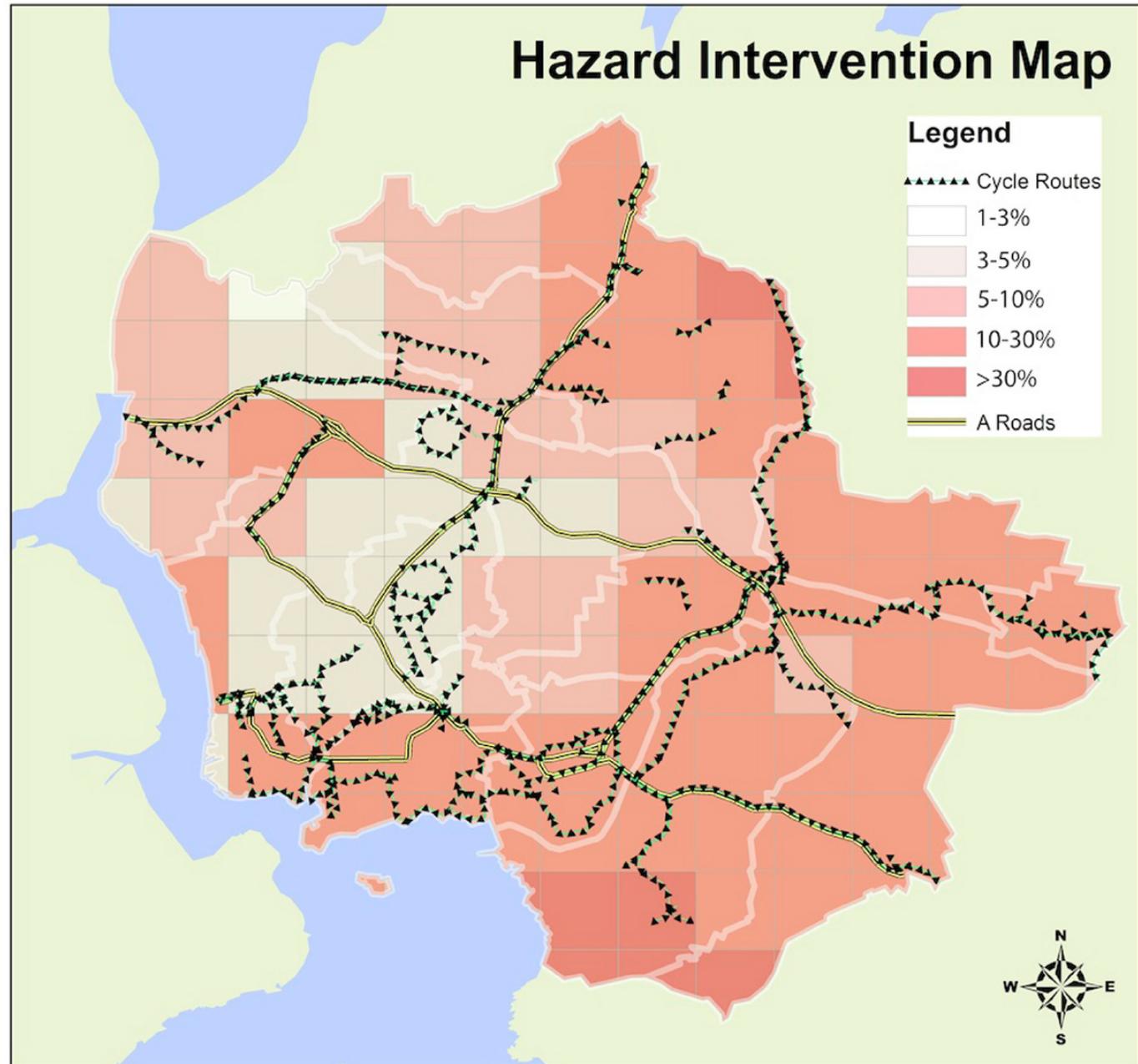
Centre for Radiation, Chemicals and Environmental Hazards. Chilton, Didcot, Oxon. OX11 0RQ.

© Crown copyright and database rights 2013 Ordnance Survey 100016969.

1.5   0.75   0   1.5 Miles

Map produced using PHEGIS. Contact PHEGIS Team, ERD/MRA, Porton Down. 01980-616937 or gis@phe.gov.uk

Modelling health criteria

△ Small change

Disease outcome

Mortality   Morbidity

Environmental hazard

Exposure → Burden

△ Exposure

Intervention(s) → △ Burden
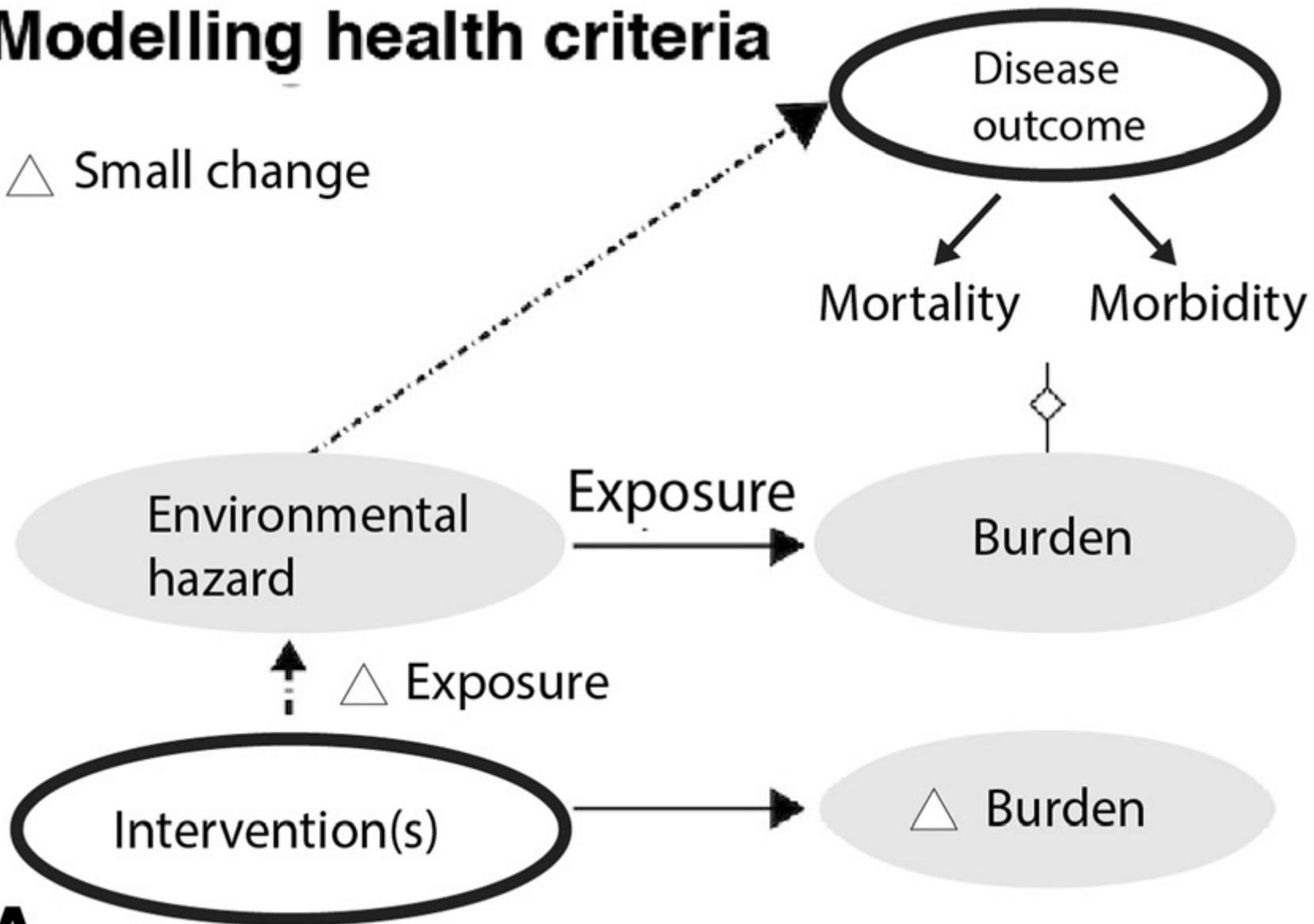
A

Qualitative

Using probabilistic methods to account for variation in expert opinion

After elicitation: consider
Risk averse
Risk neutral
Risk taking

Source: http://www.tonyohagan.co.uk/shelf/
Eliciting Expert beliefs in substantial practical applications. A. O'Hagan. The Statistician, Vol. 27, No. 1. (1998). Pp. 21-35

Distribution of ratings

Cumulative ratings

Rating scale

25 responses will lie below this mark

Mid point separating upper and lower responses

75 responses will lie below this mark
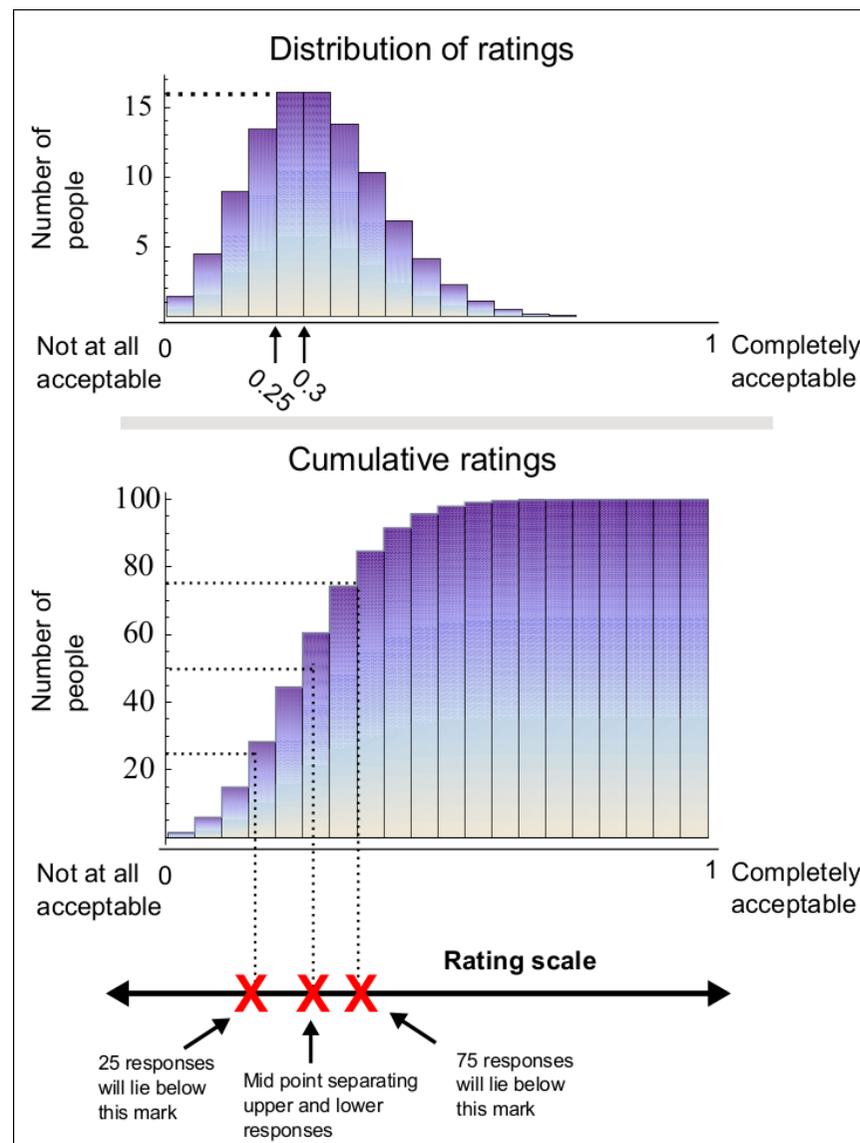
Ranking interventions
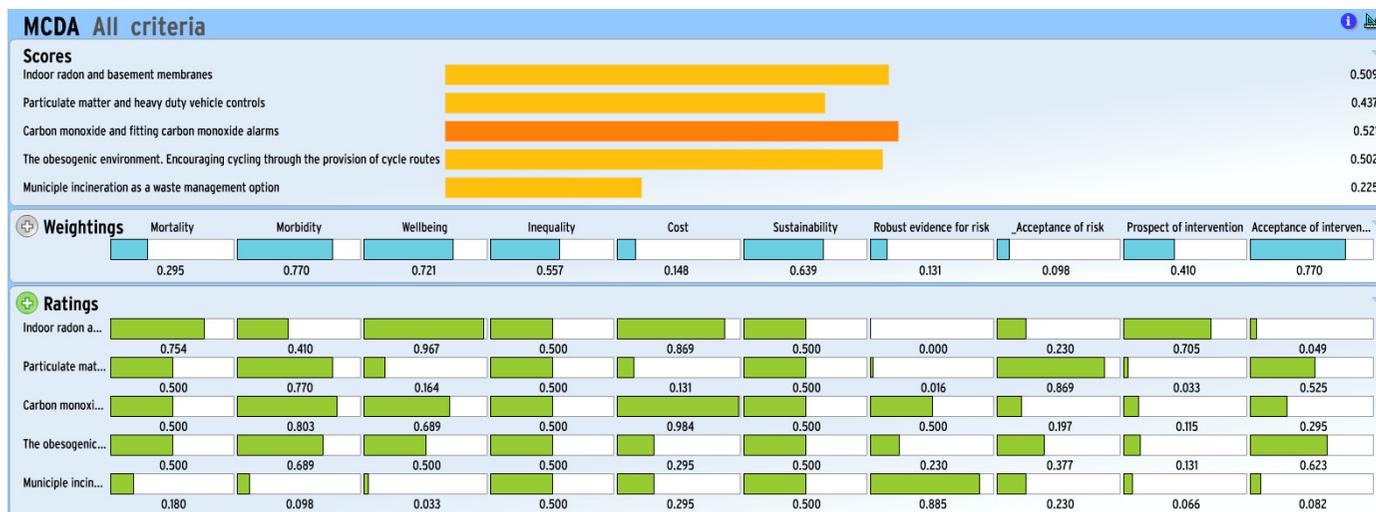
**Scores**
The option with the highest score has the best score

Weightings
Relative importance of the criteria (Stakeholders)

Evidence matrix
Models or expert opinion

In this example, carbon monoxide is ranked the highest. These numbers are only for illustrative purposes but show how the data will be loaded into the tool

Mortality

Morbidity

C

D
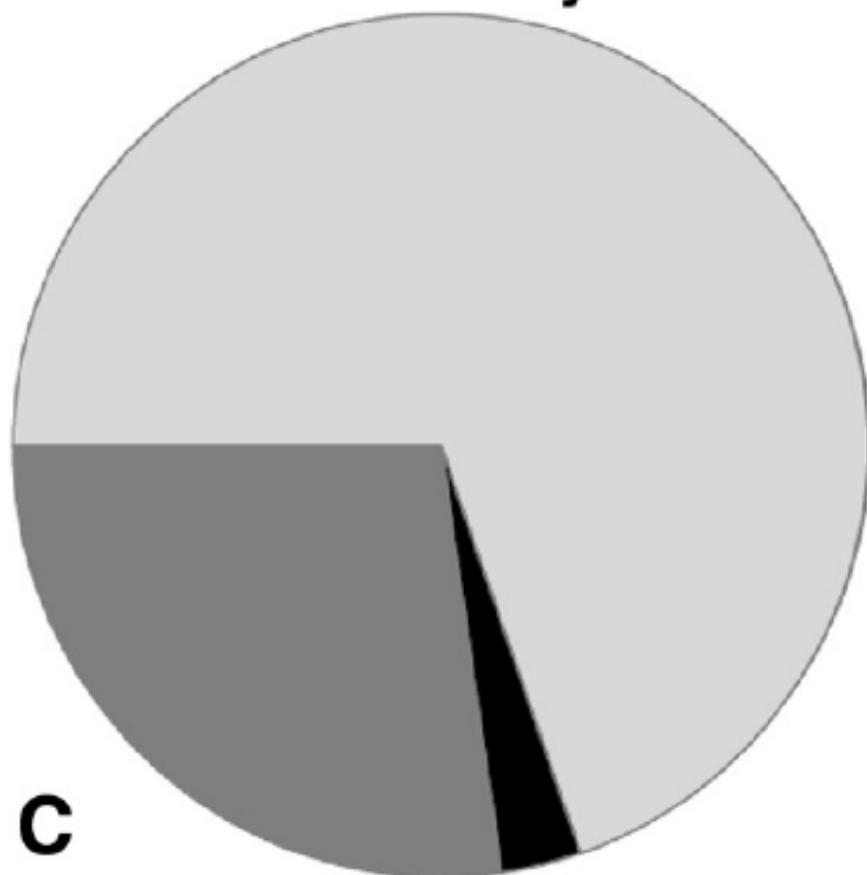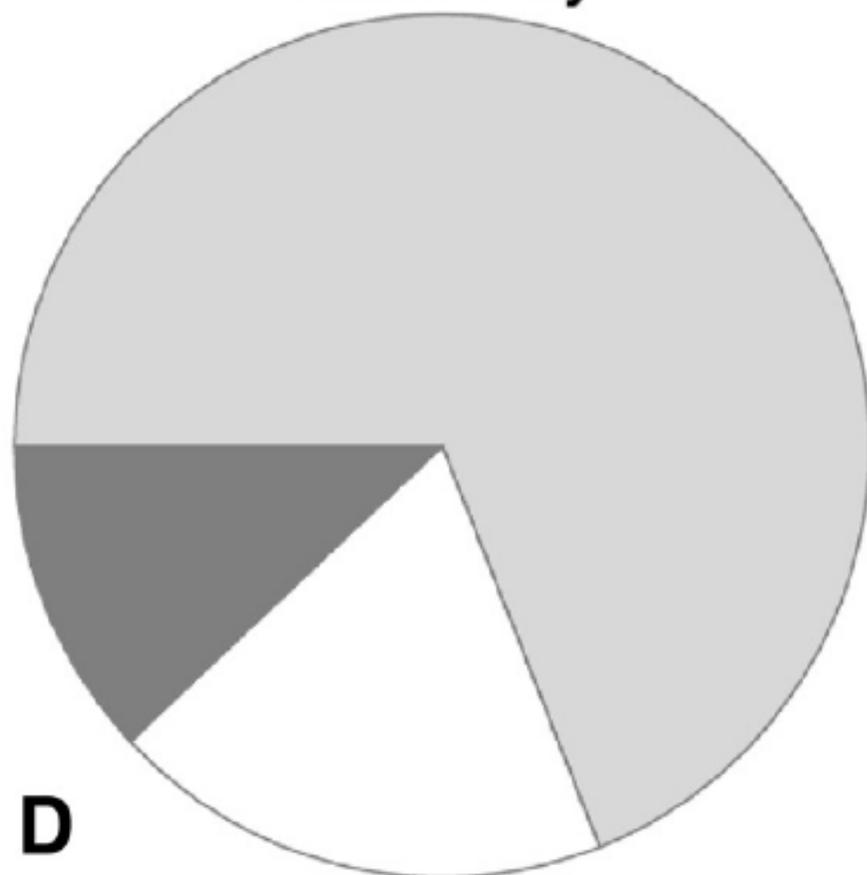
Outdoor air quality and heavy goods vehicle controls

Remediation to control levels of indoor radon

The quality of indoor air and fitting carbon monoxide alarms

The obesogenic environment. Encouraging cycling through the provision of cycle routes

Environmental Health

CrossMark

Decision support for risk prioritisation of environmental health hazards in a UK city

Mae Woods[1,3*], Helen Crabbe[1], Rebecca Close[1], Mike Studden[1], Ai Milojevic[2], Giovanni Leonardi[1,2], Tony Fletcher[1,2] and Zaid Chalabi[2]

Abstract

Background: There is increasing appreciation of the proportion of the health burden that is attributed to modifiable population exposure to environmental health hazards. To manage this avoidable burden in the United Kingdom (UK), government policies and interventions are implemented. In practice, this procedure is interdisciinary in action and multi-dimensional in context. Here, we demonstrate how Multi Criteria Decision Analysis (MCDA) can be used as a decision support tool to facilitate priority setting for environmental public health interventions within local authorities. We combine modelling and expert elicitation to gather evidence on the impacts and ranking of interventions.

Methods: To present the methodology, we consider a hypothetical scenario in a UK city. We use MCDA to evaluate

Summary

- Multi Criteria Decision Analysis (MCDA) is a tool that can be used to support decision making for a range of public health options

- At PHE and the LSHTM we are using the tool to include quantitative and qualitative evidence to support local authorities

- Eliciting qualitative evidence

- Mathematical analysis of uncertainty

- Ranking of possible interventions in Plymouth used as example to show method

- Real pilots needed – volunteers and partners sought

- Any questions?