Process of estimating marginal social costs

REACH marginal social costs are estimated using the GBD methodology of predicting ambient PM2.5-attributed mortalities. Input data for the REACH-Southern Africa domain is provided as an example.

Data needed

1. Population by age group (under age 5 yr and above age 25 yr) and location

This site has age-specific population data for many countries. Check to see if the countries in your modeling region are covered.

https://www.census.gov/geographies/mapping-files/time-series/demo/international-programs/subnationalpopulation.html

1. Download GBD country-specific mortality rates by cause of disease:

<https://vizhub.healthdata.org/gbd-results/>

1. Age groups 25 yr + (see image on left below)
   * ischemic heart disease (IHD)
   * stroke
   * chronic obstructive pulmonary disease (COPD)
   * lung cancer (LC)
   * type II diabetes (DM)

Rename file to IHME-GBD\_2021\_DATA\_mortality\_rates.csv and add to *~/GBD\_mortality/inputs* folder

1. Age groups under 5 yr and above 25 yr (see image on right below)
   * lower respiratory infections (LRI)

Rename file to IHME-GBD\_2021\_DATA\_LRI\_under5.csv and add to *~GBD\_mortality/inputs* folder

A screenshot of a medical survey

AI-generated content may be incorrect.A screenshot of a medical survey

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Steps

1. Prepare a file with population by age group and location

* See script *00\_popbyage.R* for example

1. Compute baseline mortalities

* Edit and run *01\_mortality\_bycause.R*

1. Adjust country names and year for coexposure factors

* Edit *domain\_inputs.R*

1. Calculate baseline PM2.5 attributable mortalities:

* Edit and run *02\_basePM25\_deaths.R*

1. Marginal social costs

* *new\_mort.R*: Calculate new PM2.5 mortalities based on 1 tonne addition of a PM2.5 precursor to a source location. The difference in mortalities resulting from this addition and the baseline is the marginal social cost (mortalities/tonne)
* *GBD\_relative\_risk.R*: script with GBD concentration-response by cause of disease and interpolates RR for REACH PM2.5 estimates

Edit and run the following scripts for the marginal social costs

* PM\_damage.R: primary PM2.5 marginal social costs
* NH3\_damage.R: NH3 marginal social costs
* NOX\_damage.R: NOX marginal social costs
* SO2\_damage.R: SO2 marginal social costs
* VOC\_damage.R: VOC marginal social costs

Note about calculating total PM2.5-attributed deaths. Estimate from script (*02\_basePM25\_deaths.R*) and not from multiplying emissions by the marginal social costs. The marginal social cost approach assumes a linear relationship between emissions and mortality, whereas the concentration-response functions are non-linear.

References

GBD PM2.5 attributable mortality method:

McDuffie, Erin E., Randall V. Martin, Joseph V. Spadaro, Richard Burnett, Steven J. Smith, Patrick O’Rourke, Melanie S. Hammer, et al. 2021. “Source Sector and Fuel Contributions to Ambient PM2.5 and Attributable Mortality across Multiple Spatial Scales.” Nature Communications 12 (1):3594. <https://doi.org/10.1038/s41467-021-23853-y>.

GBD relative risk is obtained from:

McDuffie, E., Brauer, M., Martin, R., Spadaro, J., Burnett, R., Hammer, M., & van Donkelaar, A. (2021). GBD-MAPS-Global: Analysis Input Dataset [Data set]. Zenodo. <https://doi.org/10.5281/zenodo.4642700>