LIFEINDEXAIR

Technical Report

Design of the Operational Platform of the LIFE Index-Air Tool

March 2017

THIS PROJECT IS FUNDED BY THE LIFE PROGRAM FROM THE EUROPEAN UNION

TÉCNICO LISBOA · universidade de aveiro · Technical University of crete · DEMOKRITOS NATIONAL CENTRE FOR SCIENTIFIC RESEARCH · NATIONAL INSTITUTE FOR HEALTH AND WELFARE

WWW.LIFEINDEXAIR.NET

Objective and scope

In the framework of Action B1.1, the operational platform (OP) of the Index-Air Tool has been designed, defining the requirements for the development of the different modules of the Tool. The Index-Air Tool will analyse data on air pollution from particulate matter (PM) and calculate population exposure, human dose and related burden of disease, through the application of specialised models. The overall objective is to design a user-friendly tool, in support of policy makers and other relevant stakeholders with no scientific expertise, for the development of effective strategies for air pollution control and the protection of public health.

1 Responsibilities

- The design of the Index-Air Tool OP has been performed by NCSR-D, in collaboration with all other partners, who are responsible for the different modules of the Tool and have provided the necessary information with respect to the requirements and specifications of each module.
- The staff from NCSR-D team involved in the OP design are: Kostas Eleftheriadis, Lila Diapouli and Athina-Cerise Kalogridis.

2 Design of the Operational Platform

2.1 Introduction

The LIFE Index-Air Tool is an integrated tool in support of policy making and mitigation strategies for air quality management and protection of public health. It will incorporate 4 modules which are being developed in parallel, in the framework of Actions B2 – B5. The Tool's operational platform has been designed taking into account the distinct requirements and specifications of each one of the four modules, as well as the overall objectives of the Tool, which are:

1. To be able to include a very large amount of data and a number of modelling tools;
2. To have a fast response and be simple and user friendly, in order to ensure its continuous use by stakeholders;
3. To be accessible also to the general public, in order to increase awareness and promote citizens' involvement in air quality management;
4. To include information on the spatial distribution of air pollution concentrations and related exposures;

5. To allow the inclusion in the future of new data from the project areas or data from other areas, thus promoting its sustainable application and reproducibility;
6. To allow for visualization of its output (e.g. concentrations levels, population exposure, human dose data and burden of disease), as well as exporting of all results for further analysis;
7. To provide the possibility to forecast changes in PM concentrations, exposures and burden of disease, based on different policy scenarios.

The final design of the Tool's OP, as approved by all project partners on March 2017, includes the following calculations steps (denoted henceforth as Calculation Levels):

- **Calculation Level 1**: Modelling of ambient concentrations based on PM emissions
- **Calculation Level 2**: Exposure model, for the assessment of individual and population exposure
- **Calculation Level 3**: Dosimetry models, for the assessment of respiratory deposition and internal doses
- **Calculation Level 4**: Methodology for calculating the burden of disease
- **Calculation Level 5**: Built-up of policy making scenarios.

These Calculation Levels will be connected by a circular procedure (Figure 1), which will allow the Tool to quantify ambient concentrations, indoor concentrations, individual exposures, population exposure, internal dose and burden of disease for the base scenario (current status of emissions) and for alternative scenarios, built through Calculation Level 5. For each Calculation Level, input and output parameters, as well as sequence of operations, have been defined, as shown in detail below.

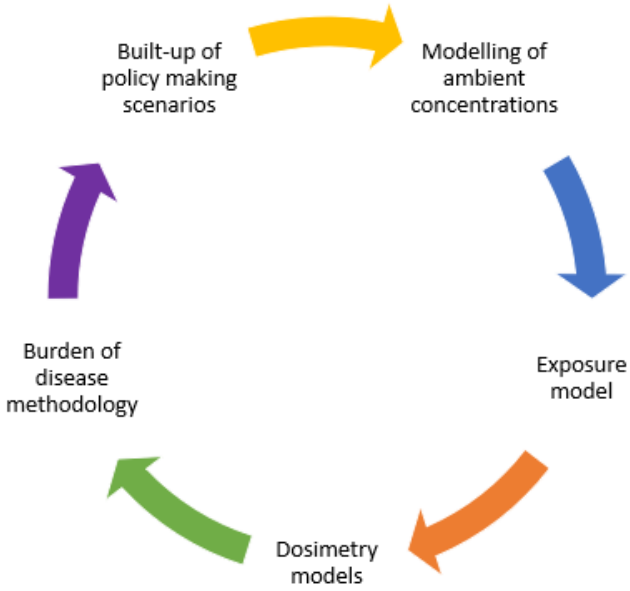

Figure 1. Calculation procedure of LIFE Index-Air tool.

2.2 Calculation Level 1: Modelling of ambient concentrations based on PM emissions

Calculation Level 1 will include the computational algorithm for the ambient concentrations of PM_{10}, $PM_{2.5}$ and selected chemical components, at each project city. A schematic representation of Calculation Level 1 is provided in Figure 2. A separate calculation step (based on artificial neural networks, ANN) has been foreseen, outside the the Tool, in order to link emissions of atmospheric pollutants and respective ambient concentration levels (marked by a dashed line in Figure 2).

The input data in Calculation Level 1 will include annual gridded emissions for gaseous pollutants (precursors of PM) and PM_{10}, $PM_{2.5}$ and selected chemical components.

The output will be gridded 1 h average ambient concentrations of PM_{10}, $PM_{2.5}$ and selected chemical components. This output will be used for the subsequent calculation of indoor concentrations and exposures (Calculation Level 2), dose (Calculation Level 3) and Burden of Disease (Calculation Level 4).

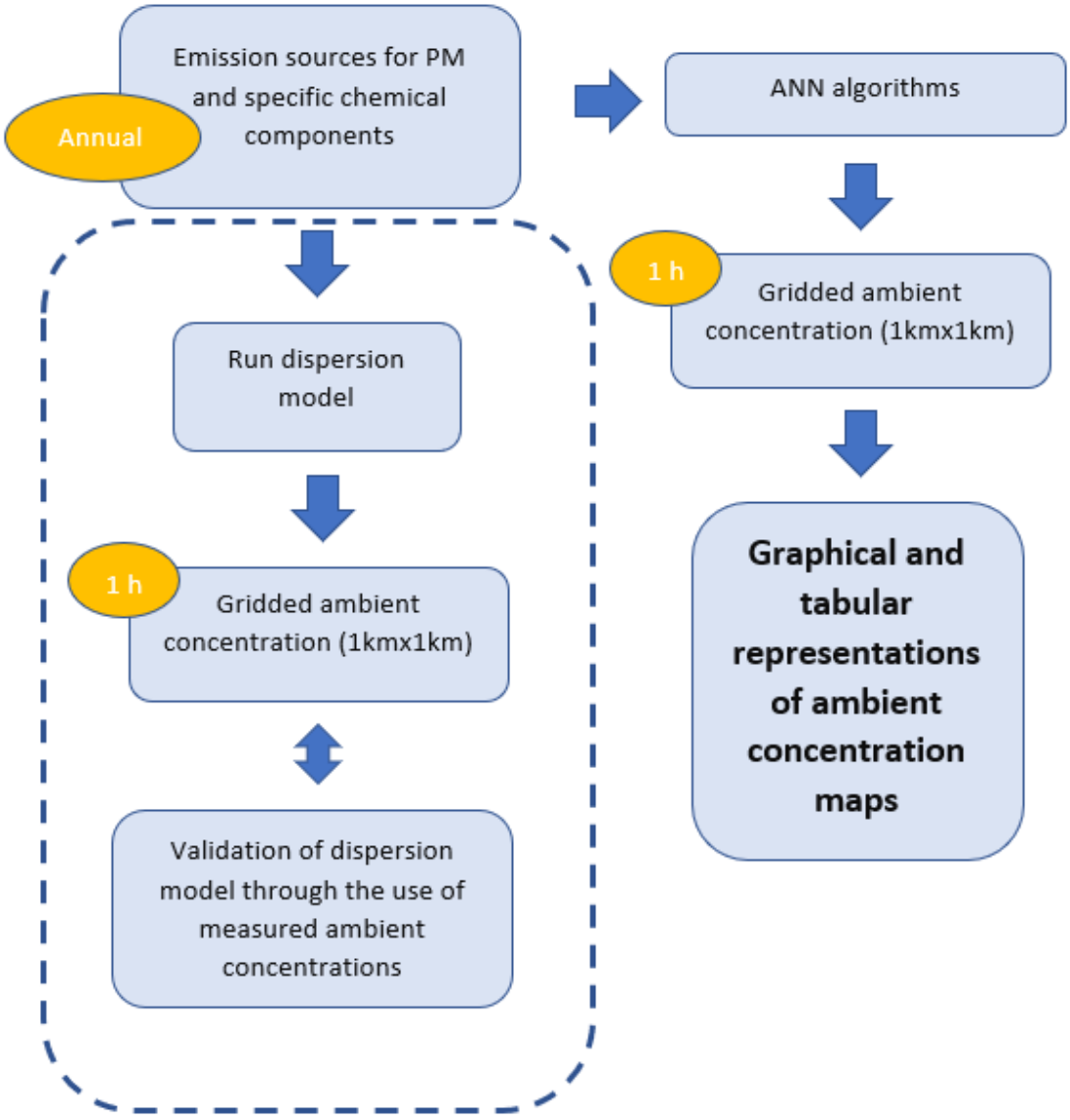

Figure 2. Schematic representation of Calculation Level 1

.

2.3 Calculation Level 2: Exposure model, for the assessment of individual and population exposure

Calculation Level 2 will include the computational algorithm for the indoor concentrations of PM_{10}, $PM_{2.5}$ and selected chemical components in residences, schools and transport modes, at each project city. In addition, it will include the computational algorithms for individual and population exposures at PM_{10}, $PM_{2.5}$ and selected chemical components, at each project city. A schematic representation of Calculation Level 2 is provided in Figure 3.

The input data in Calculation Level 2 will include: (i) gridded 1 h average ambient concentrations of PM_{10}, $PM_{2.5}$ and selected chemical components (from Calculation Step 1); (ii) Infiltration parameters for residences, schools and transport modes (average values for each

microenvironment, city and PM size fraction); (iii) average time activity patterns for each city and separately for weekends and weekdays; (iv) gridded census data for each city.

The output will be: (i) gridded 1 h average indoor concentrations of PM_{10}, $PM_{2.5}$ and selected chemical components (to be used in subsequent calculations of exposure); (ii) gridded 1 h average individual exposures for each city; (iii) gridded population exposures for each city. This output will be used for the subsequent calculation of human dose (Calculation Level 3) and Burden of Disease (Calculation Level 4).

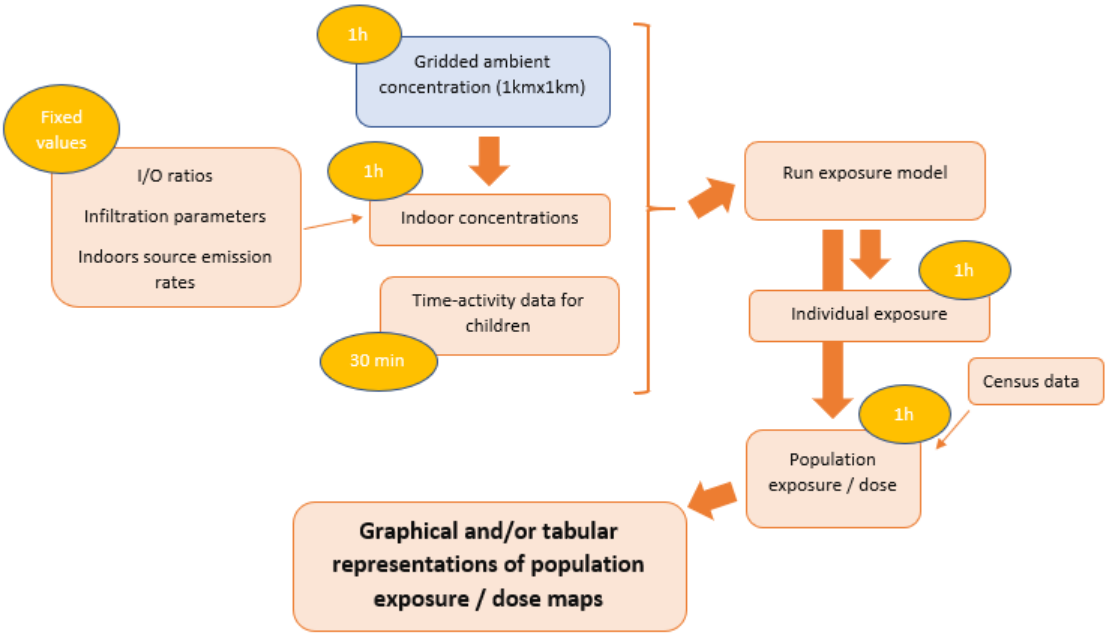

Figure 3. Schematic representation of Calculation Level 2.

2.4 Calculation Level 3: Dosimetry models to assess respiratory deposition and internal doses

Calculation Level 3 will include the computational algorithms for respiratry deposition and internal doses of PM_{10}, $PM_{2.5}$ and selected chemical components. A schematic representation of Calculation Level 3 is provided in Figure 4.

The input data in Calculation Level 3 will include: (i) gridded 1 h outdoor concentrations of PM_{10}, $PM_{2.5}$ and selected chemical components (from Calculation Step 1); (ii) gridded 1 h indoor concentrations of PM_{10}, $PM_{2.5}$ and selected chemical components (from Calculation Step 2); (iii) gridded 1 h average individual exposures to PM_{10}, $PM_{2.5}$ and selected chemical components (from Calculation Step 2); (iv) size distributions of PM_{10}, $PM_{2.5}$ and selected chemical components (average distributions at each city); (v) aerosol density and shape factor (average values); (vi) a typical diurnal cycle of wind speed data for each city; (vii) average time activity patterns for each city and separately for weekends and weekdays.

The output will be gridded 1 h average values of: (i) Deposited dose in five regions of the respiratory tract; (ii) Retained mass in each compartment of the respiratory tract; (iii) Mass transferred to the oesophagus and lymph nodes; (iv) Blood dose; (v) Dose in the human body (e.g. kidney, liver). This output will be used for the subsequent calculation of the Burden of Disease (Calculation Level 4).

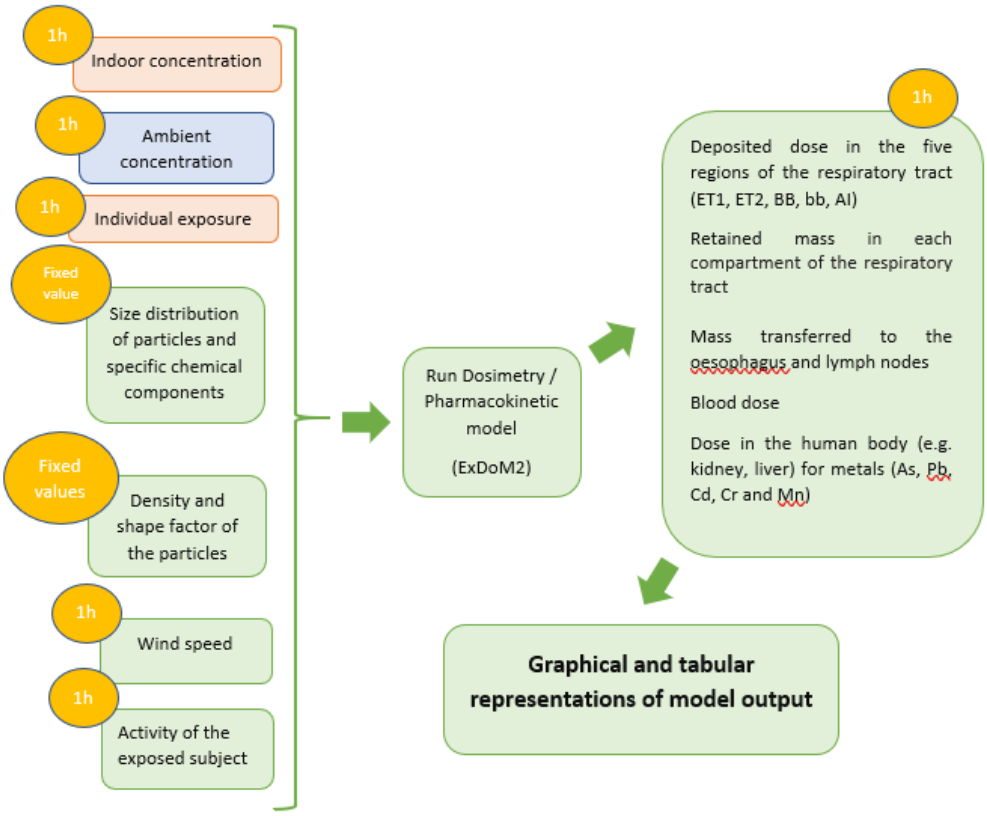

Figure 4. Schematic representation of Calculation Level 3.

2.5 Calculation Level 4: Methodology for calculating burden of disease

Calculation Level 4 will include the computational algorithms for the Burden of Disease (BoD). A schematic representation of Calculation Level 4 is provided in Figure 5.

The input data in Calculation Level 4 will include: (i) gridded 1 h outdoor concentrations of PM_{10}, $PM_{2.5}$ and selected chemical components (from Calculation Step 1); (ii) gridded 1 h population exposure to PM_{10}, $PM_{2.5}$ and selected chemical components (from Calculation Step 2); (iii) gridded 1 h average doses of PM_{10}, $PM_{2.5}$ and selected chemical components (from Calculation Step 3); (iv) annual value of background BoD, for each city; (v) census data.

The output will be annual averages of (i) the burden of disease attributable to a given risk factor (EBD) in DALY (disability-adjusted life year); (ii) the background burden of the disease (BOD), in DALY; (ii) the attributable fraction of the disease (attributable to the risk factor) (PAF).

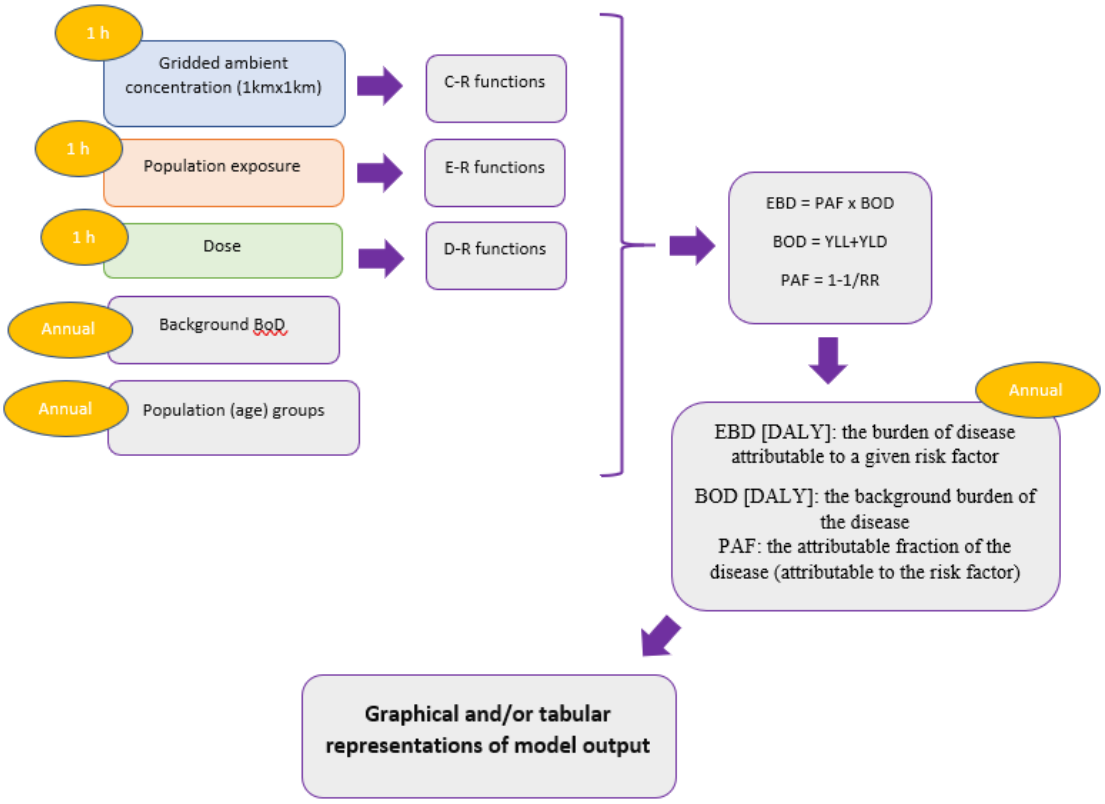

Figure 5. Schematic representation of Calculation Level 4.

2.6 Calculation Level 5: Built-up of policy making scenarios

Calculation Level 5 will allow the user to change selected input data (with respect to the strength of emission sources and/or time activity patterns of the studied population subgroup), and repeat all the computations included in Calculations Levels 1 – 4. A schematic representation of Calculation Level 5 is provided in Figure 6.

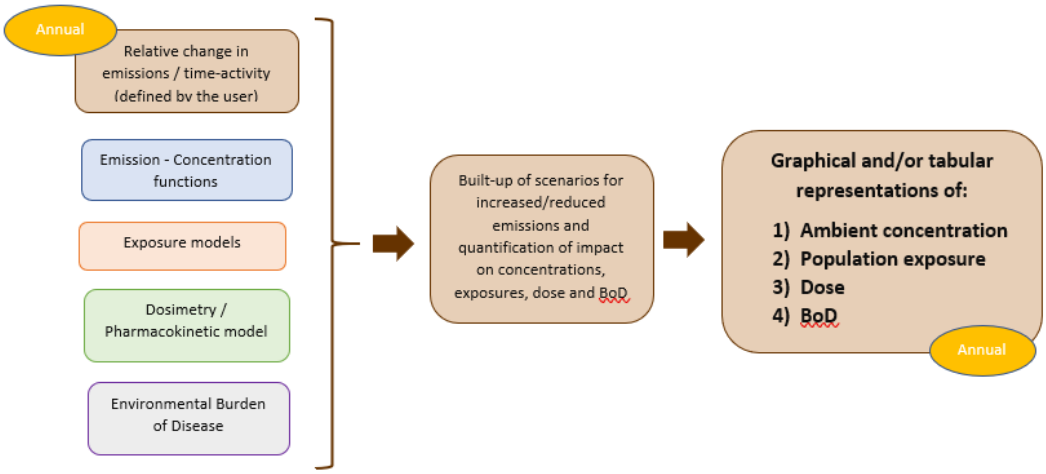

Figure 6. Schematic representation of Calculation Level 5.

3 Conclusions

The designed operational platform clearly defines the role of each parameter and calculation algorithm to be incorporated in the Index-Air Tool and the sequence of computational operations to be performed within the Tool. The Calculation Levels developed and the circular computational procedure linking them allows for:

- ✓ the quantification of key parameters with respect to the exposure of citizens to PM pollution and the relevant health risks;
- ✓ the assessment of exposure mitigation strategies (targeting emissions and/or daily practices of citizens), through a quantitative measure of their impact on PM concentration levels, exposures, doses to the human organism and overall burden of disease.