

# **Towards Healthy Air in Dwellings in Europe**

## **THADE Project**

### **Report**

# **MAPPING POLLUTANTS IN DWELLINGS**

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<b>ABSTRACT.....</b>	<b>3</b>
<b>INTRODUCTION .....</b>	<b>3</b>
<b>5.1. RESTRICTIONS AND FLOW DIAGRAM .....</b>	<b>3</b>
5.1.1. Geographical distribution and resolution.....	4
5.1.2. Pollution sources included .....	5
5.1.3. Modelling of concentrations and exposure .....	6
5.1.4. The Standard Dwelling .....	7
5.1.5. Local conditions in interactive mode .....	7
<b>5.2. INTERFACING WITH PRIMARY DATABASES .....</b>	<b>8</b>
<b>5.3. AWARENESS AND UNDERSTANDING .....</b>	<b>8</b>
<b>5.4. GAPS OF KNOWLEDGE .....</b>	<b>9</b>
<b>5.5. TOWARDS A HEALTHY INDOOR AIR .....</b>	<b>9</b>
<b>REFERENCES.....</b>	<b>9</b>

## **ABSTRACT**

Mapping in the THADE project is aimed at communicating understanding and stimulating awareness of indoor conditions in European dwellings. After delimitating the geographic area to be mapped and the resolution to be handled, we made up a list of pollution sources that are common, health relevant and known in enough detail for geo-spatial mapping. Both indoor concentrations and expected exposures are modelled using algorithms derived from building physics and epidemiology. The resulting maps come in two types: geo-spatial and pertaining to one dwelling. In the last case the consumer or policy maker using the mapping program may tailor the standard dwelling to a local type and interactively assess different intervention measures to increase indoor air quality.

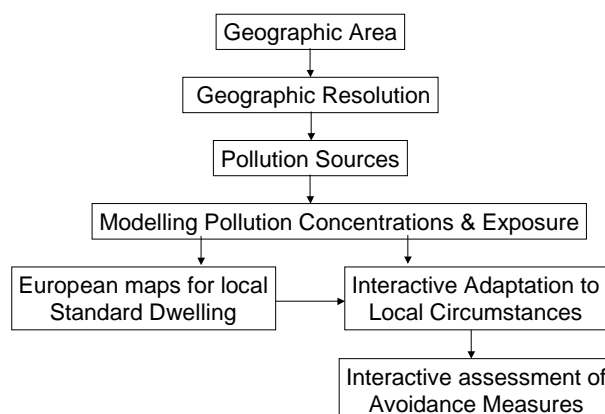
## **INTRODUCTION**

European dwellers live in a sub-optimal indoor environment (Report 2). However, most people are not aware of the risks of their OWN living environment, and neither are policy makers. Graphic representations may be useful in increasing both awareness and understanding of risks and possible solutions. In one of the THADE meetings, EFA-member Elisabeth Bell even took 'to MAP' as an abbreviation of to Make Available to People the knowledge needed to arrive at concrete actions for healthy indoor air. We agree with this aim of the mapping operation in THADE. Taking into account European diversity as to nature and extent of pollutant exposure, the 2nd core question of THADE, "What measures can be taken to improve poor air quality at home?" , may only be answered for different European regions when both consumers and policy makers have a clear view on their local situation.

Therefore mapping at a geo-spatial level of exposure, disease prevalence, and effective preventive measures has been performed as a means of communication between science and policy making. For communication with the consumer this mapping is combined with interactive intervention-simulations that is hoped to increase understanding of the mechanisms of noxious exposure and the benefits of household and building interventions. As far as health effects are concerned we will restrict ourselves to asthma, allergies and COPD (chronic bronchitis and lung emphysema).

### **5.1. RESTRICTIONS AND FLOW DIAGRAM**

Several restrictions are inherent to the chosen approach (Figure 1).

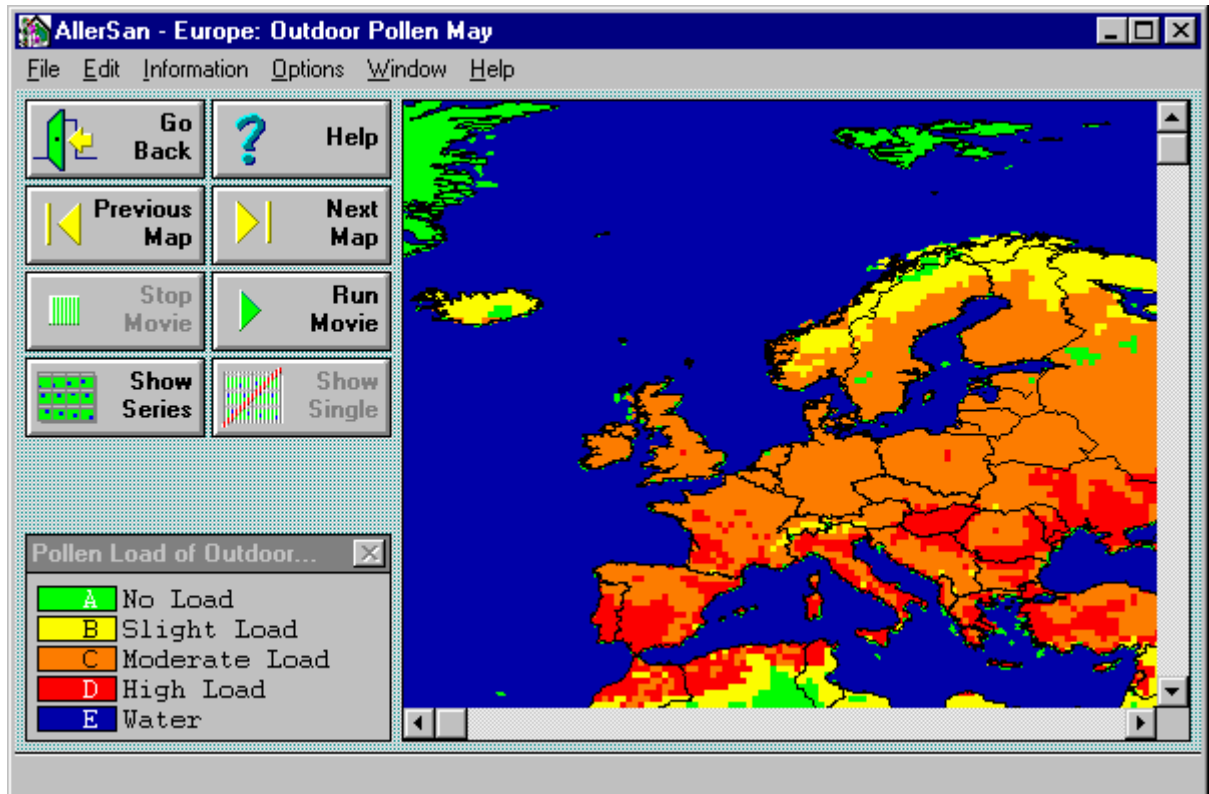


**Figure 1: Flow Diagram of the Mapping Operation**

### **5.1.1. Geographical distribution and resolution**

First of all the geographic area to be included had to be delimited. The best approach would probably have been to take the whole of geographic Europe. However, information from the regions east of Moscow were not readily available. This has forced us to only include the western and central part of the continent (Figure 2).

Secondly the geographic resolution in degrees latitude and longitude had to be chosen, taking into account the accuracy of our knowledge. It was found that overall this is currently no better than 10 x 10'. Only those pollutants were mapped geographically for which a resolution of at least 10 x 10 could be reached. In some cases mapping by country was still possible. In the course of the THADE-project a tool has been constructed to use simple excel sheets for inputting of geo-spatial data<sup>1</sup>. It is hoped that the use of this tool will improve the possibilities of interfacing with databases of primary research results, such as EUROHEIS<sup>2</sup>, to increase resolution, validity and scope of AllerSan as a tool for consumers, professionals and policy makers. As soon as such an interface is available the mapping program AllerSan will be further updated and made available through EFA.



**Figure 2: Geographic area mapped in the THADE project. It shows an outdoor pollutant (pollen) in the month of May that was used in modelling of indoor allergen levels.**

### 5.1.2. Pollution sources included

The next step in the mapping process is the selection of pollution sources to be included. Only those pollutants were mapped that adhere to the following conditions:

- (i) Of common occurrence in at least some regions of Europe;
- (ii) Of known relevance to health-relevant indoor air quality;
- (iii) Concentrations have been reported under a number of different circumstances as to make it possible to model exposure on a European scale.

The resulting list of pollutants consists of irritants, allergens and oncogens arising from body odours, furnishings, smoking, cooking, damp, pets, cockroach, soil and outdoor air. Since servicing dwellings with potable water and sewer systems was not included in the mapping, we could not take into account relevant infectious agents, such as Legionella, causing Veteran's disease (related to handling of potable and hot water) or the SARS coronavirus (related to ventilation and sewer systems and their use). Some pollutants have been left out because of too incomplete data on a geo-spatial level of the

indoors. These include carbon monoxide, man-made fibres, some specific volatile organic compounds and species of window plants.

To increase the effectiveness of communication with the user in the interactive module (local circumstances in dwellings) pollutants were aggregated in 3 classes: irritants, allergens and oncogens, and a color code was devised to show the health potency of the situation and its changes.

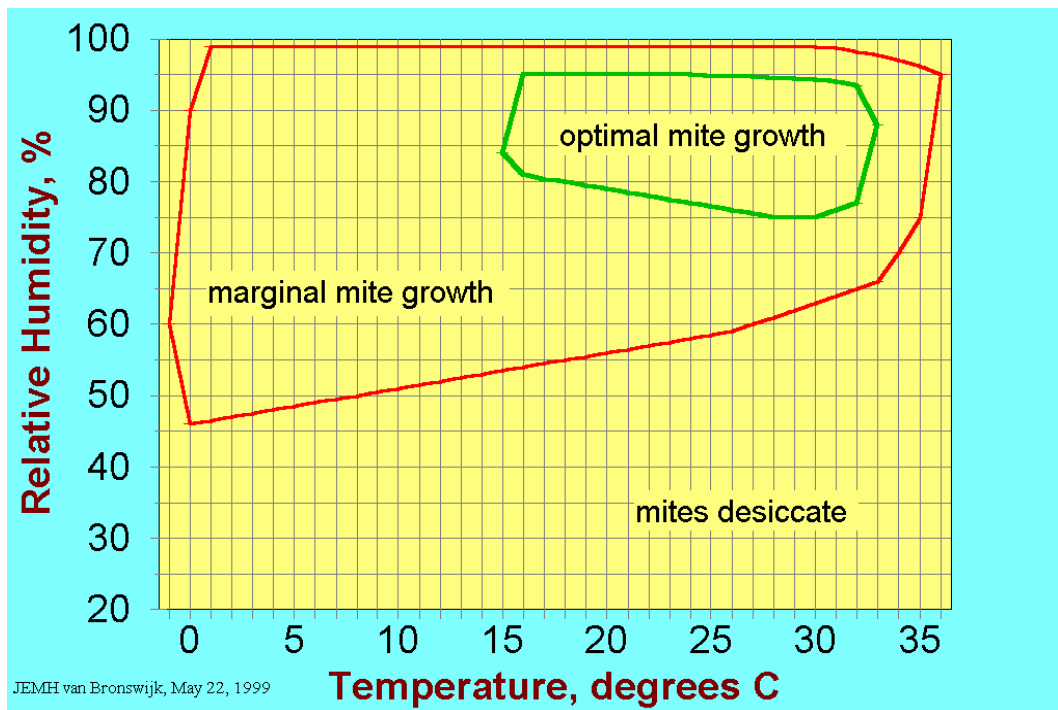
### **5.1.3. Modelling of concentrations and exposure**

The next step of the mapping process included the modelling on a European and a seasonal scale of concentrations and exposure indoors. To this end pollutants were distributed over 3 classes depending on the nature of their relationship with the built environment:

- (i) Pollutants that enter the dwelling from the outside (from soil or air) and do not show seasonal presence (e.g. radon gas from the soil); their values may be derived from published literature with interpolation and extrapolation when needed;
- (ii) Pollutants that enter the dwelling from the outside but have strong seasonal fluctuations; in these cases we reduced seasonal fluctuation to monthly fluctuations and mapped the pollutants for each month;
- (iii) Pollutants that arise within the dwelling, such as body odours or house-dust mites; in these cases the main determinants were identified and mapped (see Figure 3 for an example).

Simulation tools were adapted from published models in the building physics discipline.

To go from concentrations to actual exposure other factors had to be taken into account, as are included in published epidemiological models. Overall algorithms to assess exposure include: Indoor production of pollutant (may be nil for some pollutants), Infiltration of pollutant from outside (may be nil for some pollutants), ventilation and infiltration in m<sup>3</sup> / hour (also in relation to prevailing wind direction and pressure), room space / person, and length of stay indoor. Epidemiology literature was taken to calculate health outcomes, such as loss of healthy years in a life span (DALY) and Population Attributable Risk (Report 3).



**Figure 3: Relationships between survival and growth of house-dust mites on one side and temperature and moisture conditions on the other, as has been used in calculations of indoor mite concentrations**

#### 5.1.4. The Standard Dwelling

After modelling of concentrations and exposure, the flow diagram splits. One way is towards showing geo-spatial maps applied to a standard dwelling. The standard dwelling has been defined as having a total volume of 350 m<sup>3</sup>, 3 Inhabitants, a floor Surface 100 m<sup>2</sup> with 50 m<sup>2</sup> of carpet and 50 m<sup>2</sup> of PVC covering, 2 Bedrooms, 1 Kitchen, and 1 Living Room, with ceilings, walls and room partitions plastered or painted. The living room is furnished with one 3-seat coach, 2 padded arm chairs, 1 table and 4 non-padded chairs. The bedrooms contain 3 beds in total and the kitchen has 1 Cooking Place.

#### 5.1.5. Local conditions in interactive mode

The other way in the flow diagram goes towards the interactive updating and changing of the local indoor situation, although most users of the mapping program will enter the interactive module through by clicking on their home pixel on an geo-spatial map. The first and automatic simulation takes the parameters of today and the geographic conditions of the chosen pixel. The user may change all local circumstances except for Longitude and Latitude. To perform the simulations for another geographic locality s/he has first to return to one of the geo-spatial maps and select other coordinates.

## **5.2. INTERFACING WITH PRIMARY DATABASES**

The mapping approach we chose includes a certain amount of interpolation, extrapolation and guessing, since well-detailed geo-databases that cover most of Europe are non-existent or have a restrictive use. Since the mapping tool is meant to remain free of charge for consumers, the use of commercial databases to import data is hardly possible.

As mentioned before AllerSan now contains a subroutine for easy transport of data to graphic representation with the aid of an excel sheet. This does not only ease data import for graphic representation and calculations in interactive mode, it also supports the algorithms that require a number of those sheets for calculations (e.g. assessing the level of ventilation with sheets of prevailing wind directions, wind pressure and outdoor temperatures).

One of the primary data databases that we studied in more detail is the outdoor knowledge structure of the EU project group on EUROHEIS (A European Health and Environment Information System for Disease and Exposure Mapping and Risk Assessment). This group has built a database that is professional-oriented, and aims to improve the understanding of the links between environmental exposures, especially outdoor exposures, health outcomes and risk through the development of an integrated information system for the rapid assessment of relationships between environment and health.

We contacted dr. Lars Jarup (l.jarup@imperial.ac.uk), but time was too short to agree upon a workable interface between the research data structure of Oracle-based EUROHEIS and the more aggregated, consumer and policy oriented goal of AllerSan. Differences in resolution, data structure and program architecture are extensive, but should not prevent data transport in the future. Including EUROHEIS data on outdoor air pollution and allergic or hyper-reactive disease could strongly increase the power of AllerSan and its use on the regional level, while still providing the European overview as a comparison. On the other hand, it will also mean a revision of the algorithms used to simulate individual indoor climates and their management; a major operation that will be left to a future funded project.

## **5.3. AWARENESS AND UNDERSTANDING**

As stated above our mapping is meant to Make Available to People the knowledge needed to arrive at a Healthy Indoor Air. In this respect it intends to raise awareness among patients and policy makers alike through an interactive process. Not only may

the user rapidly retrieve information of Europe at large or of a specific 1 x 1° Latitude and Longitude square, he or she may also simulate individual indoor spaces researching the specific effects of lifestyle and technology changes.

It must be said that the user-interface AllerSan could still be improved by graphically designing the interactive building part, and by introducing a higher level of user-adaptivity. Although these improvements are left to future projects, the profits are already clear of such an approach in fostering awareness among patients, patient organisations and policy makers.

#### **5.4. GAPS OF KNOWLEDGE**

Freely available knowledge appeared fragmentary. Data collected in other EU-funded projects, by EUROSTAT, or by organisations and collectives preparing special maps (e.g. of pollen in the outdoor air) are not available without charges. We recommend that in future projects charges for use of data be waived or funded.

In addition we need a more in depth analysis of geo-spatial distribution of climatic, technological and life-style factors relevant to asthma, other allergies and COPD. Currently environment-disease relationships found in one country or one region are quickly generalized to larger regions, sometimes even to a complete continent, without validation. Cultural and climatic diversity in Europe is an asset, but it could become a threat to health when it is not respected by advocating inflexible measures for the whole of Europe. Mapping our European diversity will help to select the best measures to improve indoor air for each region.

#### **5.5. TOWARDS A HEALTHY INDOOR AIR**

By using our mapping approach to show geo-spatial diversity as well as variation within single dwellings due to lifestyle and technology, priorities for action on a European, national and regional level may be assessed.

Due to aging of the population and the resulting increase in the prevalence of chronic bronchitis and lung emphysema, the need for awareness and understanding of indoor air processes will augment also. We hope that our mapping approach will support solutions on both policy and practical levels.

#### **REFERENCES**

1. Programmed by E.J. Hansen MSc (Denmark)
2. <http://www.euroheis.org>