AERIOBIOLOGICAL INFORMATION SYSTEMS AND ALLERGIC RESPIRATORY DISEASE MANAGEMENT

LAYMAN’S REPORT
The most important biological component of ambient air is pollen, and its allergen is the main cause of airborne allergic respiratory diseases. Reasons for the increase in allergic responses to pollen allergen exposure are elusive, but environmental and lifestyle factors appear to drive the trend.

In Europe, emissions of many air pollutants have decreased over past decades, resulting in some improved air quality. Nevertheless, this does not always produce a corresponding drop in atmospheric concentrations; especially for particulate matter (PM) and ozone (O₃), which have significant impact on human health. A growing body of evidence shows that chemical air pollutants and anthropogenic aerosols can alter the impact of allergenic pollen and that pollen production rises in higher atmospheric CO₂ concentrations.

Changes in the plant flowering season due to climate change will probably mean an increase in the duration and severity of the pollen season, alongside a higher frequency of episodes of urban air pollution. These elements indicate that environmental factors involved in exacerbations of allergic respiratory diseases will have a more pronounced effect in coming decades.
What is AIS LIFE about?

The project AIS LIFE project – Aerobiological Information Systems and allergic respiratory disease management has been approved for funding within the LIFE+ programme. The Coordinator is from the University of Florence, Department of Agrifood Production and Environmental Sciences. With partners from 3 EU countries (Italy, France, Austria) the project’s overall aim is to develop the information base for policy on environment and health, in terms of improved management of pollen-related allergic respiratory diseases.

The main objective of AIS LIFE project is to improve the knowledge and the management of respiratory diseases due to pollen allergy through the distribution of two aerobiological information systems and the development of two cases study in Italy and France.

What is the aim of AIS LIFE?

The AIS project has proposed a series of realistic objectives, within its proposed time frame and means, in order to develop the information base for policy on environment and health focusing pollens and their interactions with air pollution, in view of improving management of pollen-related allergic respiratory diseases.

Keywords: information system, public awareness campaign, atmospheric pollution, risk management
Why monitoring pollen is important?

Pollen monitoring is very important to know the real exposure to pollen. The method used in AIS Life is the same than in all the European countries using Hirst pollen traps Lanzoni.

The methodology used follows the new TS of CEN (CEN/TS 16868). This European Standard specifies the procedure to continuously sample and analyse the concentration of airborne pollen grains and fungal spores in ambient air using the volumetric Hirst type sampler.

This European Standard describes both the sampling and the analysis procedures for the purpose of allergy networks.

The knowledge of pollen exposure permits:

- to help physicians in diagnosing allergic rhinitis, conjunctivitis, asthma,
- to prevent exacerbation of symptoms by using more effective drugs
- to help the patients in the preventive measures.

In AIS Life, the different Hirst pollen traps are located in Paris, Lyon, Pisa and Vienna. The analyses are made by the local teams.

Most common pollens and related plants

- ambrosia
- gramineae
- betula
- poaceae
- urticaceae
What was the strength of AIS LIFE to address the problem?

**AIS Life technological innovation**

Technology has improved pollen forecasting and dissemination of pollen information. However, clinical impact of such information is still debated. AIS compares, for the first time, a high-tech system (web-based symptoms diary + smartphone application) and a low-tech one (aerobiological and air pollutants forecasts and medical recommendations) in terms of effectiveness in patients affected by allergic respiratory diseases. The system will include information on ultrafine particles, which represent a technological innovation in this field.

**Project specific objectives**

1. To improve pollen-related allergic respiratory disease management in the general population, through the permanent uptake of Aerobiological Information Systems in three European countries, contributing to disease control, improved quality of life and direct/indirect reductions in health system costs.

2. To assess exposure to pollen at the general population level, by considering pollen count and allergens and their interaction with particulate matter pollution.

3. To provide a comprehensive evaluation of the use and effectiveness of Aerobiological Information Systems in different contexts, in terms of environmental, social and economic impact (including potential reduction of costs socio-economic costs of respiratory allergies in Europe).

4. To increase awareness among target groups identified across Europe (local communities, local health agency, legislators, end-users) on the importance of integrated information on aerobiological / chemical / clinical forecasts for health improvement among people suffering from pollen allergies.

5. To provide input to public health policy on the environment and health, in the project areas and beyond, in line with the recommendations of the Environment and Health Action Plan).
### What are the key results of the AIS LIFE Project?

<table>
<thead>
<tr>
<th><strong>Key Result</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Establishment and consolidation of 1 multidisciplinary, transnational network of experts in medicine, epidemiology, biology, environmental chemistry and computer information systems, working in the field of environment and health, with particular attention to allergic respiratory health.</strong></td>
</tr>
<tr>
<td><strong>Three Integrated Information Systems (IIS) and 3 enhanced Personalised Information Systems (PPI) developed, implemented and disseminated (including computerised means) in Italy, France and Austria.</strong></td>
</tr>
<tr>
<td><strong>One centralised database with AIS data from the 3 countries to obtain baseline measures for assessment of future trends in pollen exposure and pollen-related diseases.</strong></td>
</tr>
<tr>
<td><strong>Three educational campaigns (Italy, France and Austria) with investigated patients (c.700) on the use of the Aerobiological Information Systems, promotion of improved life styles and prevention of respiratory allergic diseases.</strong></td>
</tr>
<tr>
<td><strong>Three assessment reports (Italy, France and Austria) on the effectiveness of user-friendly access to the IIS and PPI in improving allergic respiratory disease management and on the potential long term implementation of the systems by identified stakeholders.</strong></td>
</tr>
<tr>
<td><strong>One map of urban and rural environments through land use and allergic plants data, agro-climatic indices in Tuscany 7. One report with recommendations for plant occupation of public green areas in France (Paris and Lyon), through the assessment of potential danger of exposure to pollens in public green spaces of citizens.</strong></td>
</tr>
<tr>
<td><strong>One carefully designed and widespread communication campaign, to disseminate activities and results to all identified target groups and to involve stakeholders actively.</strong></td>
</tr>
<tr>
<td><strong>Increasing knowledge about the effects of interaction between pollens and chemicals on allergic symptoms across Europe, in order to guide environmental and health policy decisions.</strong></td>
</tr>
</tbody>
</table>
**POLLEN ASSESSMENTS**

Pollen sampling and monitoring in France

Aims were:

- To assess pollen counts (and allergen content) in public gardens

Pollen trap in Paris

The pollen trap is located on the roof of the Pasteur Institut in the 15th district.

Pollen trap in Lyon

The pollen trap is located on the roof of the Biomnis and Inserm Institut in the 7th district Gerland.

- On basis of the obtained results to formulate recommendations in order to protect allergic patients.

Pollen traps in Park de Choisy, Paris (1, 2) and in Park de la Tête d’Or, Lyon (3)
Pollen bulletins in Tuscany

The aerobiological data were provided in Tuscan Territory. The chosen aerobiological stations were: Pisa, Firenze, Arezzo and Grosseto.

The study considered the most common tree species in the Tuscan territory that are the highest responsible of allergy. Families considered were: Oleaceae (olive and ash), Fagaceae (Oak, beech and chestnut), Corylaceae (Hazel, hornbeam and white), Betulaceae (alder and birch), Cupressaceae (Cypress), Platanaceae (plane tree).

Aerobiological station in Pisa: The sampling procedure and the count of the airborne pollen grains and fungal spores were based on UNI 11108:2004 by Pollen Trap, VPPS 2000 (Fig. 1). Weather data were collected from a Davis Pro Vantage 2 (Fig. 2) weather station installed near the VPPS 2000, both on the flat roof of the building in the street Derna 1, 56126 Pisa, about 18 mt above ground (Fig. 3).
The record of aerobiological and meteorological station was used to create a map of pollen concentration, classified in high, medium, low or absent, for individual tree family in each area study.

Buffering was defined and used to establish 'zones' around potential sources of aeroallergens that reflects the perceived area in which those sources could affect the population. Thus, two buffers around those sources with a diameter of 5 km and 10 km were established. The buffer areas are indicated with the same colors (different tonality) according to the concentration of pollen source. For each allergic species the tendency of concentration trends (increasing, decreasing or steady) for the week to come is also provided.

The distribution of pollen concentration maps provides useful information about the level of risk to patients depending on the geographic area and the considered species.

The maps have been elaborated with the use of a geographic information system (GIS).
**Analysis of Plant Occupation of Public Green Spaces**

**Case Study in France**

The specific objectives of this case-study were to assess pollen counts and allergen content in public gardens and on basis of the obtained results to formulate recommendations in order to protect allergy sufferers.

Two types of pollen traps were used in this study: Hirst pollen trap and Sigma 2 Like passive pollen trap (SLT). The SLT pollen traps were used for analysis of local pollen dispersion.

Within this case study, 7 SLT have been set up in two towns of France (Paris/Lyon) during the pollen season, in order to assess pollen count. In addition to these SLT pollen traps, 4 Hirst pollen traps were also used for this case study (2 in Lyon and 2 in Paris). Statistical descriptive analysis were conducted to obtain the distribution of the pollens in the gardens according to the 2 sampling methods.

The first campaign of measurement was in 2015 (March-June) and the second measurement campaign in 2016 (March-June).

The results show that there are a lot of allergenic species in the green gardens in Paris and Lyon like cupressaceae, birch, plane tree, grasses...

The Index of exposure and index of source built in this case study in Paris and in Lyon (cf table 1 in Page 11) can be used as a tool for selecting the best and most suitable plant species for inclusion in new green areas. Corrective measures in specific areas of the parks suspected of being highly allergenic must be taken like avoiding the planting of mainly male trees in dioeciously species, the use of singles species to form hedges or to line avenues, and the establishment of cross reactions between species belonging to the same family, and even the replacement of certain species in cases of serious risk.

This study is just the beginning and made aware of the importance to better choose the species to plant in public garden in order to protect allergic patients.

Everyone can act and in the future we need to better train gardeners and green space managers about these problems to help them make the right choices.
### Table 1: Implementation of recommendations: Index of source and index of exposure in Paris and in Lyon

**Exemple Index for Lyon bigest parc**

**Index of exposure:** it takes into account the allergy potency of the species and the number of pollen grains.

\[
\text{Index of exposure} = \frac{\text{Allergy potency} \times \text{Number of pollen grains}}{1000}
\]

- **Index of source:** it takes into account the allergy potency and the number of species.

\[
\text{Index of source} = \frac{\text{Allergy potency} \times \text{Number of species}}{10}
\]

<table>
<thead>
<tr>
<th>Taxa</th>
<th>Pollen trap</th>
<th>SLT Tête d'Or</th>
<th>SLT Tête d'Or</th>
<th>Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Index of source</td>
<td>Index of exposition</td>
<td>Index of exposition</td>
<td></td>
</tr>
<tr>
<td>Betula (birch)</td>
<td>23</td>
<td>9</td>
<td></td>
<td>l</td>
</tr>
<tr>
<td>Carpinus (horsebeam)</td>
<td>38</td>
<td>6</td>
<td></td>
<td>l</td>
</tr>
<tr>
<td>Cupress (cypress)</td>
<td>6</td>
<td>52</td>
<td></td>
<td>l</td>
</tr>
<tr>
<td>Quercus (oak)</td>
<td>65</td>
<td>17</td>
<td></td>
<td>n</td>
</tr>
<tr>
<td>Fraxinus (ash)</td>
<td>82</td>
<td>18</td>
<td></td>
<td>l</td>
</tr>
<tr>
<td>Populus (poplar)</td>
<td>10</td>
<td>3</td>
<td></td>
<td>n</td>
</tr>
<tr>
<td>Platanus (plane tree)</td>
<td>83</td>
<td>87</td>
<td></td>
<td>r</td>
</tr>
<tr>
<td>Salix (willow)</td>
<td>5</td>
<td>1</td>
<td></td>
<td>n</td>
</tr>
</tbody>
</table>

**Exemple Index for Paris Choisy Parc**

**Index of exposure:** it takes into account the allergy potency of the species and the number of pollen grains.

\[
\text{Index of exposure} = \frac{\text{Allergy potency} \times \text{Number of pollen grains}}{1000}
\]

- **Index of source:** it takes into account the allergy potency and the number of species.

\[
\text{Index of source} = \frac{\text{Allergy potency} \times \text{Number of species}}{10}
\]

<table>
<thead>
<tr>
<th>Taxa</th>
<th>Pollen trap</th>
<th>SLT Choisy 1</th>
<th>SLT Choisy 2</th>
<th>SLT Choisy 2</th>
<th>Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Index of source</td>
<td>Index of exposition</td>
<td>Index of exposition</td>
<td>Index of exposition</td>
<td></td>
</tr>
<tr>
<td>Betula (birch)</td>
<td>0,3</td>
<td>18</td>
<td>0,3</td>
<td>14</td>
<td>l</td>
</tr>
<tr>
<td>Carpinus (horsebeam)</td>
<td>/</td>
<td>9</td>
<td>/</td>
<td>7</td>
<td>l</td>
</tr>
<tr>
<td>Cupress (cypress)</td>
<td>/</td>
<td>69</td>
<td>/</td>
<td>41</td>
<td>l</td>
</tr>
<tr>
<td>Quercus (oak)</td>
<td>0,4</td>
<td>7</td>
<td>0,4</td>
<td>6</td>
<td>n</td>
</tr>
<tr>
<td>Fraxinus (ash)</td>
<td>4,8</td>
<td>9</td>
<td>4,8</td>
<td>6</td>
<td>l</td>
</tr>
<tr>
<td>Populus (poplar)</td>
<td>1,3</td>
<td>2</td>
<td>1,3</td>
<td>1</td>
<td>n</td>
</tr>
<tr>
<td>Platanus (plane tree)</td>
<td>1,6</td>
<td>8</td>
<td>1,6</td>
<td>7</td>
<td>l</td>
</tr>
<tr>
<td>Salix (willow)</td>
<td>/</td>
<td>1</td>
<td>/</td>
<td>1</td>
<td>n</td>
</tr>
</tbody>
</table>

Legend:
- n = nothing to do
- l = limit the species
- r = remove the species
HEALTH IMPACT OF POLLEN EXPOSURE

Burden of pollen allergy in 3 European countries and validation and comparison of the effectiveness of the two Aerobiological Information Systems.

Aerobiological monitoring systems are available in many countries, but few studies have been performed to assess their impact as a preventative tool.

To bridge this gap, in 2016, 643 subjects suffering from pollen allergy were enrolled in Italy (Pisa, PI), France (Paris, PA), Austria (Vienna, VI) and invited to use either the aerobiological information systems (Integrated Information System (IIS) or the personalized pollen information (PPI) respectively implemented in the AIS project. One group of controls was also selected.

exposed to an educational intervention about pollen allergy and randomized in group A (using AIS) and group B (controls). Each subject filled in a standardized health questionnaires and modified version of the Control of Allergic Rhinitis Test (CARAT) (modified) and Rhinasthma questionnaires about health status, disease control and quality of life (QoL) associated with allergic diseases in the previous 12 months, at baseline and follow up 12 months apart.

The highest reported allergies were those to Betulaceae (73%) in VI, Graminaceae (61%) in PI and Platanaceae (28%) in PA. Allergic rhinitis was higher in VI (95%), allergic conjunctivitis and asthma in PA (69 and 54%, respectively) than in the other countries. Respiratory symptoms were significantly higher in PA (97%) than in VI (73%) and PI (65%); oculo-rhinitic symptoms were higher in VI (96%) than in PA (91%) and PI (80%); nasal symptoms did not differ among the countries. Health services and anti-allergic medicines were significantly more used in VI (67 and 94%) than in PI (26 and 78%) and PA (39 and 47%). VI and PA showed worse QoL and diseases control than PI according to Rhinasthma and CARAT scores. Overall, only 27.2% had a good/optimal QoL, 25.3% reported daily limitations at work, school or in other activities and 12.6% had a controlled allergic rhinitis and asthma. Considering temporal changes, nasal symptoms, respiratory symptoms and ocular symptoms significantly decreased in group A (subjects using AIS) while respiratory and ocular symptoms in group B. Even if not significantly, nasal, respiratory and ocular symptoms decreased more in group A (-4.5%, -40.1%, -26.3%, respectively) than in group B (-4.0%, -32.9%, -21.6%, respectively). In the table below, is reported the change in the prevalence (valid %) of past year health services (HS), use of medicines for allergic diseases (AD), and limitation in daily activities, from Phase 1 to Phase 2 in users and non-users (Controls) of Aerobiological Information System (AIS).

Medical visit or Emergency room visit or Hospital admission; 2 work/school absence or housework, assistance at sick persons/children, free time activities; * difference between phases; § difference between AIS users and Controls.

<table>
<thead>
<tr>
<th></th>
<th>AIS users (n=335)</th>
<th>p*</th>
<th>Controls (n=176)</th>
<th>p*</th>
<th>p§</th>
</tr>
</thead>
<tbody>
<tr>
<td>HS use¹</td>
<td>-15.1</td>
<td>&lt;0.001</td>
<td>-8.5</td>
<td>ns</td>
<td>0.05</td>
</tr>
<tr>
<td>Medicines for AD</td>
<td>+23.6</td>
<td>&lt;0.001</td>
<td>+27.2</td>
<td>&lt;0.001</td>
<td>ns</td>
</tr>
<tr>
<td>Any limitation²</td>
<td>-10.2</td>
<td>&lt;0.001</td>
<td>-8.0</td>
<td>0.04</td>
<td>ns</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>AIS users (n=335)</th>
<th>p*</th>
<th>Controls (n=176)</th>
<th>p*</th>
<th>p§</th>
</tr>
</thead>
<tbody>
<tr>
<td>Past year NASY1</td>
<td>-4.5</td>
<td>0.01</td>
<td>-4.0</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>Past year RS2</td>
<td>-40.1</td>
<td>&lt;0.001</td>
<td>-32.9</td>
<td>&lt;0.001</td>
<td>ns</td>
</tr>
</tbody>
</table>
In the table above the change in the prevalence (%) of Nasal symptoms (NASY), Respiratory symptoms (RS), and Oculo-rhinitic symptoms (ORSY) from Phase 1 to Phase 2 in users and non-users (Controls) of Aerobiological Information System (AIS).

Intra-group difference between phases; § inter-group difference between AIS users and Controls; at least one of runny/blocked nose, nasal itching, sneezing; 2 at least one of wheezing, shortness of breath with wheezing, chest tightness, shortness of breath, cough apart from common colds/respiratory infections; 3 at least one of itchy/red/watery eyes, foreign body sensation in eyes; bl, borderline significant, 0.05<p<0.10.

Considering only AIS users, the symptoms decrement did not differ significantly between the IIS users and the PPI users. However, higher decrements of nasal and respiratory symptoms were observed in IIS than in PPI users; on the opposite, the decrement of oculo-rhinitic symptoms was higher in PPI users.

Group A compared with group B showed: a lower incidence of nasal symptoms and ocular symptoms (1.5 vs 4.0% and 3.9 vs 7.4%; ns) and a higher remittance of respiratory symptoms (42.6 vs 35.2%; ns). QoL and allergy control significantly increased only in group A; group A vs B tended to improve QoL (+10.9 vs +5.5%, borderline) and allergy control (+12.2% vs +10.9%, ns).

Changes in use of anti-allergic medicines and daily limitations at work/school/home did not significantly differ between AIS users and controls; on the opposite, health services use decreased significantly more in AIS users than controls. Considering only AIS users, health services use decreased significantly more in PPI than IIS users.

Our data show the presence of a relevant clinical impact of pollen allergy in 3 European countries which should prompt measures to reduce such environmental exposure. Except for modest signs of improvement in AIS users, the involvement in a prospective study including an educational intervention on pollen allergy management seems to produce greater long term benefits in allergic subjects, regardless of AIS use. Further studies on larger samples and longer follow-ups are needed.
**AIS Life innovation in process and methods**

Well established methods for assessment of exposure to pollen and ultrafine particulate matter were integrated for the first time. The effects of integrated information on QoL, symptoms, objective parameters and medication use were evaluated. Overall, a new pollen/pollutants information processing and dissemination was made available and applicable to any country.

The rigorous design of the study can be applied to other types of environmental information systems aiming to reduce risks for human health.

---

**AIS Life economic and business innovation**

Although several applications for smartphone have been developed for information about environmental hazards for health in, none has been tested and validated for patients affected by allergic respiratory diseases.

Once proved effective both from a clinical and a cost-effectiveness point of view, the application will be further developed and disseminated, thus paving the way for new, permanent information systems and a continuous innovation of the model.

With limited short-term mitigation measures against pollen exposure, facilitation of behavioral adaptation and preemptive medication of sensitive population is the most-important goal.
Where to find more information on the AIS LIFE Project?

http://ais-life.website  @aislife_2014  Ais Life

Summary reports and highlights are available at the project’s website www.ais-life.website

Coordinating Beneficiary

Italy - Project Coordinator
UNIFI
www.unifi.it

Contact
simone.orlandini@unifi.it
+39 0552755702
www.ais-life.website

Università degli Studi di Firenze – Dipartimento di Scienze delle Produzioni Agrolimentari e dell’Ambiente (UNIFI)

Associated Beneficiaries

Italy
Consiglio Nazionale delle Ricerche (IFC-CNR)
www.ifc.cnr.it

Italy
Department of Biology, Pisa University (UNIPI)
www.unipi.it

Austria
Medizinische Universitaet Wien (MUV)
www.meduniwien.ac.at

France
Réseau National de Surveillance Aerobiologique, Lyon (RNSA)
www.pollens.fr

France
Université Pierre et Marie Curie
www.upmc.fr

France
France, Institut national de la santé et de la recherche médicale (INSERM)
www.inserm.fr

The AIS LIFE Collaborative Group*


The research described in this article was conducted under the grant agreement European Commission, Environment LIFE13 ENV/IT/001107