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Roberto BARBUTI, Stefano CHESSA, Roberto FRESCO, Paolo MILAZZO

PREFACE

The technological innovation in biology and agriculture often leveraging on innovation in computer science and engineering, pushed forward the process of integration among these disciplines. In particular, information technology (IT) provides common methodologies and tools for the automatic acquisition and analysis of the data that concern the management and optimization of the natural and territorial resources.

In agriculture, applications of IT enable the integration of interventions concerning its sustainability and productivity, by offering methods and tools to monitor, control, analyse and optimize the production while keeping it respectful of the environment. Similarly, the best practices for bio sustainability, for the management of bio-diversity and for the bioremediation of the environment (including soil, water etc…) are also progressively adopting IT, which enable more focused (and thus more effective) applications.

In this context, the conference "Technologies and innovation for sustainable management of Agriculture, Environment and Biodiversity" (TI4AAB), was held in July 2016 at the Natural History Museum of the University of Pisa located in the Calci Charterhouse (Calci, province of Pisa) in order to encourage the sharing of emerging knowledge about the above topics.

In fact, the conference was dedicated to fostering innovative cross-disciplinary research and applications and to stimulating the exchange of strategies and experiences, among academic and company experts from different disciplines (agriculture, biology, computer science and engineering and environmental decision making), in order to encourage a common, interdisciplinary discussion about the adoption and perspectives of IT in modern agriculture, environmental management, biodiversity and bio-sustainability in general.

The conference was held under the auspices of the municipality of Calci, the University of Pisa and of the "Ordine dei Dottori Agronomi e Dottori Forestali". It was also attended and supported by some leading national and worlwide industries, like CAEN RFID, OSRAM, STMicroelectronics, EBV Elektronik, Qprel Srl, AEDIT Srl, EMipiace Srl, and Zefiro Ricerca & Innovazione Srl, and by the Italian National Forestry Authority.

This volume constitutes a selection of the contributions presented at the conference and cover the aspects of innovation in agriculture, biology, and applied information technology. In particular, concerning innovation in agriculture, the paper by Nin et al. studies new soilless cultivation systems for wild strawberry growing in the Tuscan Appennine mountains. The paper by Prisa describes experimental research concerning the use of zeolites in combination with effective microorganisms, in order to improve the quality of olive trees. Finally, the paper by Lombardo et al. describes collaborative approaches to innovation in agriculture (co-generation of technology).

Concerning innovation in biology, the paper by Baldacci et al. describes the results of the preliminary phases of the AIS-LIFE project, which aims at developing aerobiological information systems in order to improve pollen-related allergic respiratory disease management. Still concerning the AIS-LIFE project, the paper by Natali et al. aims to describe the strategy used in AIS-LIFE project, to evaluate daily pollen concentration in the atmosphere produced by many allergic plant species. The use of data and GIS system are shown as an approach to assess allergy risk maps.

Concerning innovation in computer science applied to agriculture and biology, two contributions focus on modeling approaches, and two contributions provide a survey of information technology applied to agriculture and biology. Specifically, the paper by Bodei et al. describes the application of the IOT-LYSA formal modelling framework to a possible scenario of grape cultivation, in order to assess water consumption, and the paper by Barbuti et al. proposes a mathematical model of artificial reefs, in order to study the dynamics of algal coverage and of populations of fish in some Italian artificial reefs. Finally, the paper by Fresco et. al. explores the current challenges and IT solutions in order to realize a digital agriculture framework, intended as an evolution from Precision Farming to connected knowledge-based farm production systems, and the paper by Pucci et al. provides a survey on biologging methodologies for the collection of knowledge about animals' behaviour, making a review of some related common data analysis techniques.

All papers have been carefully reviewed by experts in the specific fields. Here is the list of the reviewers, that we thank for the collaboration.

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AIS LIFE PROJECT: POLLEN ALLERGY RISK MAPS IN TUSCANY

Abstract: F. Natali, M. Napoli, A. Dalla Marta, G. Argenti, L. Cecchi, S. Orlandini, S. Baldacci, S. Maio, A. Angino, P. Silvi, S. La Grutta, G. Viegi, F. Ruggiero, G. Bedini, U. Berger, M. Prentovic, I. Annesi Maesano, A. Moustafa, M. Thibaudon, S. Monnier, *AIS LIFE project: pollen allergy risk maps in Tuscany.*

The arrival of spring marks the beginning of a new yearly allergy cycle; the new season is the return on time pollen cause annoying and often debilitating problems, especially respiratory. In the last year, the allergic population has increased in Tuscany Region too. In the AIS LIFE project a case study about the monitoring of allergic pollen from arboreal species has developed in Tuscany. Six botanic families have been taken into consideration. Pollen allergy risk maps have elaborated and diffused on the web. The beneficiaries could involve the following stakeholders and users: allergic population, Pharmacies and Health Agencies, General practitioner and allergy specialists.

Keywords: Allergy, Health, Quality of life

Riassunto: F. Natali, M. Napoli, A. Dalla Marta, G. Argenti, L. Cecchi, S. Orlandini, S. Baldacci, S. Maio, A. Angino, P. Silvi, S. La Grutta, G. Viegi, F. Ruggiero, G. Bedini, U. Berger, M. Prentovic, I. Annesi Maesano, A. Moustafa, M. Thibaudon, S. Monnier, *Progetto AIS LIFE: mappe di rischio allergico in Toscana.*

L'arrivo della primavera demarca l'inizio di un nuovo ciclo allergico annuale; la nuova stagione corrisponde alla ricomparsa di pollini che causano fastidi e, spesso, problemi debilitanti, specialmente di carattere respiratorio. Nell'ultimo anno si è constatato un incremento della popolazione allergica, anche nel territorio della regione Toscana. Nell'ambito progetto AIS LIFE come caso di studio è stato effettuato un monitoraggio dei pollini da specie arboree in Toscana considerando sei famiglie botaniche. Sono state elaborate e diffuse sul web, mappe di rischio allergico da pollini. I beneficiari di tale attività includono i seguenti portatori di interessi e utenti: la popolazione allergica, agenzie farmaceutiche e della salute, professionisti e specialisti in allergie.

Parole chiave: Allergia, Salute, Qualità della vita

INTRODUCTION

The most important biological component of ambient air is pollen, as its allergens are the driver of airborne allergic diseases. Reasons for increases in susceptibility to develop allergy in response to exposure to pollen allergens remain elusive, but environmental and lifestyle factors appear to drive increases. Pollen allergy has a remarkable clinical impact over Europe. A body of evidence suggests that prevalence of pollen-related allergic respiratory diseases, e.g. asthma and rhinitis, has increased in past decades.

Allergic rhinitis and asthma have a significant economic impact on the patient, the patient's family and the society as a whole. The growing prevalence of allergy also has major economic consequences for society by absence from education or work or by impaired performance, thereby placing a greater burden on healthcare resources and increasing medication costs. For example, economic costs due to ragweed-related allergy in Germany amount to € 32 million per year (von Gunten *et al.*, 2012)

The symptoms of uncomplicated seasonal rhinitis may significantly reduce the capacity of the individual's ability to study and work. Nasal congestion associated with late phase reaction is an important factor contributing impairment of performance, because it disturbs sleep and results in daytime fatigue Parikh & Scadding, 1997; Blaiss, 2003). Furthermore, allergic rhinitis is associated with, and may bring about, complications that may increase the likelihood

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of problems when studying and working. Complications include recurrent middle ear infections, eustachian tube dysfunction, allergic conjunctivitis, sinusitis, conductive hearing loss, sleep disorders, frequent respiratory infections, chronic cough and asthma (Blaiss, 2003).

In Italy the prevalence of allergic rhinitis has reached 25.8% of the population (c.15 million people affected) (De Marco R *et al.*, 2012) and its annual direct cost is 1000 euro for patient (www.federasma. org). It has also estimated that 7-8% of the Italian population presents clinical manifestation of pollinosis (GINA-Italia, 2003).

At least ten / fifteen percent of the Tuscany population suffers from allergic reactions and suffer from this annoying disorder that could affect people at any age and without sex differences. The arrival of spring marks the beginning of a new yearly allergy cycle; the new season is the return on time pollen cause annoying and often debilitating problems, especially respiratory.

But there are not only pollen to complicate the lives of thousands of citizens: dust, mites, weather, environmental pollution, chemicals and cosmetics inadequate, are equally "at risk" for allergy pollen population (Cecchi and D'Amato, 2008).

In 2014 the AIS LIFE "Aerobiological Information Systems and allergic respiratory disease management" project has started.; the AIS project proposes some objectives to be achieved within its proposed time frame and means which work towards to overall project aim: to develop the information base for policy on environment and health, in terms of improved management of pollen-related allergic respiratory diseases. Among the actions of the project a case study in Tuscany has been developed. About 50% of Tuscan territory is covered by forests (Tuscany Region website); and about 40% of its territory is covered by allergy species. The study has considered the tree most common species with the highest allergy incidence.

The aim of the case study is to improve the quality of life of the people suffering from allergies through the production of risk maps based on the concentration of pollen present in the atmosphere.

METHODS

Aerobiological and meteorological monitoring

The aerobiological and meteorological data collection has been necessary for the realization of the pollen allergy risk maps in Tuscany.

The aerobiological data have been produced by the Tuscany Regional Environmental Agency (ARPAT); in Tuscany five aerobiological stations are active: Lido di Camaiore, Pistoia, Montecatini Terme, Florence and Grosseto. Thank to the LIFE funds a new stationis also available in Tuscany; this new station is in Pisa and it is managed by the Department of Biology of Pisa University; the station has been installed in the AIS LIFE project activities (see Fig. 1).

Airborne pollens were collected by a particular type of volumetric sampler: Lanzoni VPPS 2000 (http://www.lanzoni.it/vpps-2000.html) that applies the principle initially

Fig. 1 - Tuscany aerobiological stations.

proposed by Hirst (Hirst 1952). These instruments were located at 15-20 m of height above ground level far away from walls and protection. Daily data obtained from the sampler were read following the standard method (UNI11108:2004) recommended by the AIA (Italian Association of Aerobiology).

The method used for counting pollen was in accordance with the guidelines described by National Council of Research Institute of Atmospheric and Ocean Science (Mandrioli 1990).

Data have provided by ARPAT for Florence, Arezzo and Grosseto stations and by Department of Biology, University of Pisa, for Pisa station. All data were expressed as mean daily concentration of pollen grains in the atmosphere in cubic meter of air (p/m3).

LaMMA Consortium - Environmental Modelling and Monitoring Laboratory for Sustainable Development, provides a meteorological forecast for the successive weeks containing indication about temperature, humidity, rainfall and wind tendency.

Land Cover monitoring

All regional territory has been taken into consideration and the analysis of land use has been conducted using the Corine Land Cover Software. This database was created through satellite observations and it was used to analyse the use of soil.

The "Inventario Forestale della Toscana", a regional database containing information on forest tree species (IFR) was used for selecting tree families producing allergenic pollen in Tuscany. Families considered had been: Oleaceae (Olea spp and Fraxinus spp), Fagaceae (Quercus spp, Fagus sylvatica. and Castanea sativa), Corylaceae (Corylus avel-

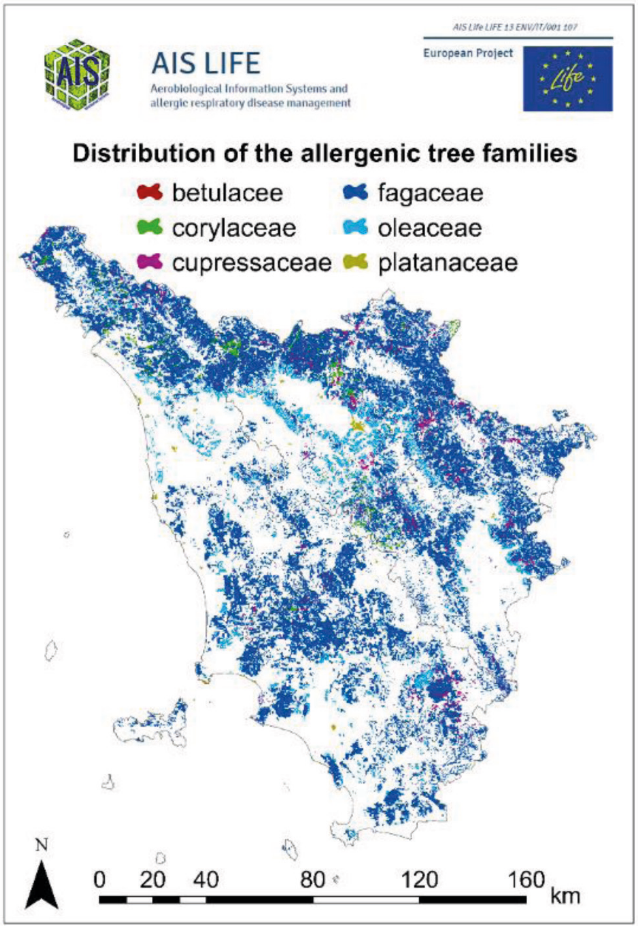


Fig. 2 - Distribution of all allergy species in Tuscany.

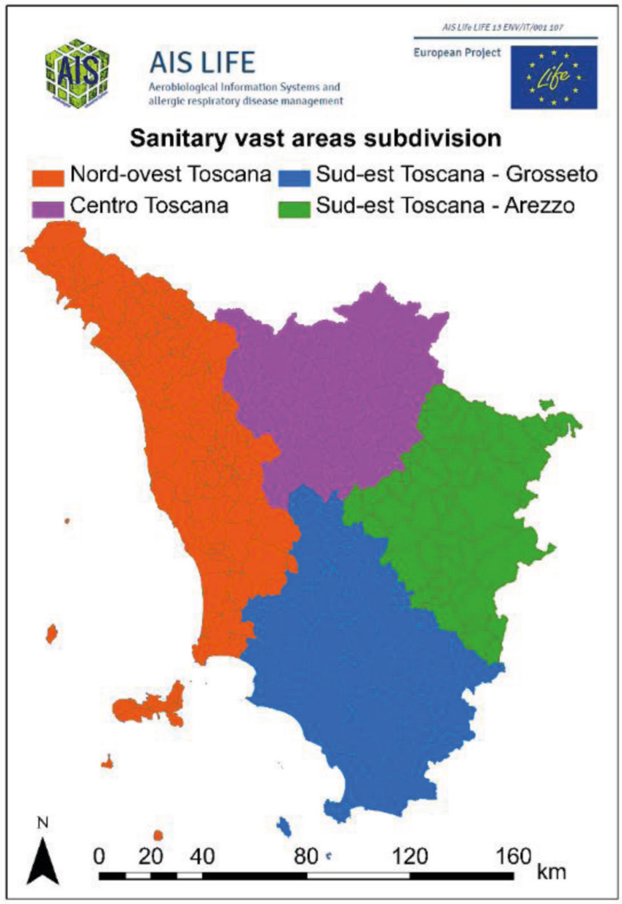


Fig. 3 - Sanitary vast area division of Tuscany.

lana, Carpinis betulus and Ostrya carpinifolia), Betulaceae (Alnus spp. and Betula spp.), Cupressaceae (Cupressus spp.), Platanaceae (Platanus spp) (Fig. 2).

The Municipalities of Tuscany have grouped in four vast regions corresponding to the Regional Sanitary Districts of Pisa, Firenze, Arezzo and Grosseto (See Fig. 3). Four aerobiological stations have been selected for aerobiological data collection, one for each Sanitary District where it represents the aerobiological reference station.

Pollen Risk Maps elaboration

The acquisition of data from aerobiological and meteorological station permits to elaborate a map of pollen concentration, classified in high, medium, low or absent, for individual tree family in each area of study. For each allergic family the tendency of concentration trends (increasing, decreasing or stationary) to the successive week was provided, according to the meteorological forecast.

Density of pollen sources was elaborated for each input cell location using the values of each botanical family. A spatial analysis by the GIS software ESRI ArcGIS Focal Statistics (version 9.3) toolbox was performed setting up a radius of 5 km.

Data were interpolated to a 250 × 250 m grid restricted to the area of Tuscany, at daily time step by means of the regularized spline with tension (Napoli *et al.*, 2014). For each grid cell and for each family, the aerobiological data were interpolated with "Inventario Forestale della Toscana" to define the source of pollen particle.

Two buffers around those plant sources with a diameter of 5 km and 10 km were established.

The buffers represent areas with 5 or 10 km of radius from the pollen source, applying a range of colors (color ramps) according to the concentration of pollen source.

For each allergic species, the tendency of concentration trends (increasing, decreasing or steady) for the successive week was also provided.

RESULTS

Weekly maps have elaborated and disseminated. Figg. 4-5 represent some examples of output (pollen risk maps).

The maps described the trend of pollen concentration for arboreal species.

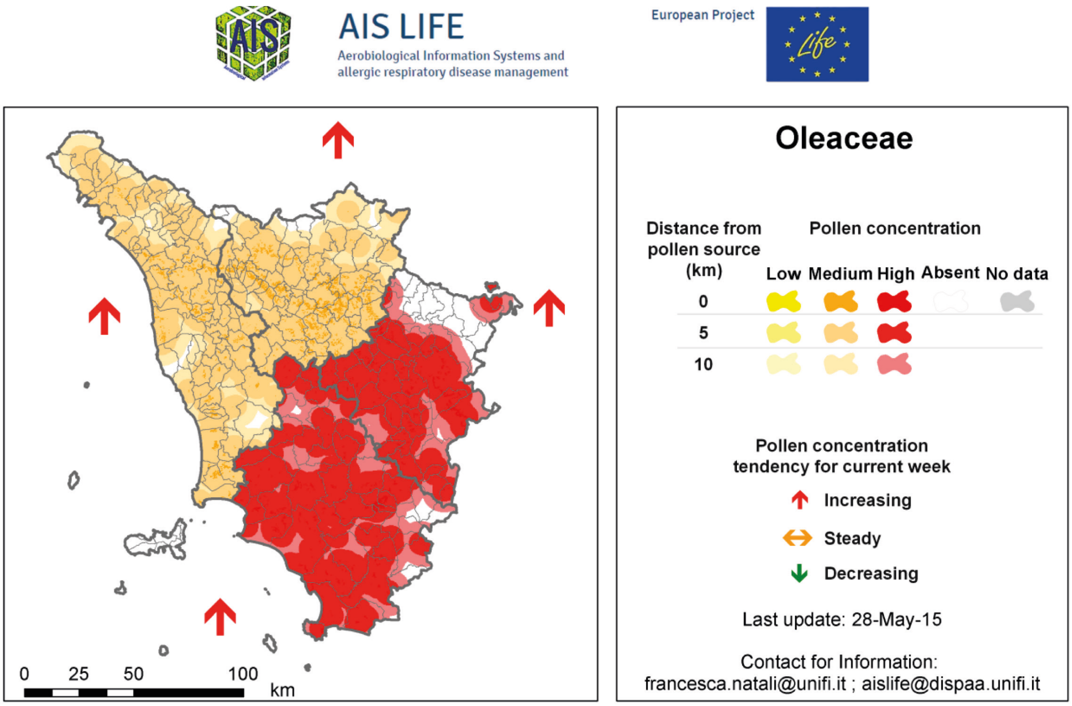


Fig. 4 - Oleaceae pollen concentration.

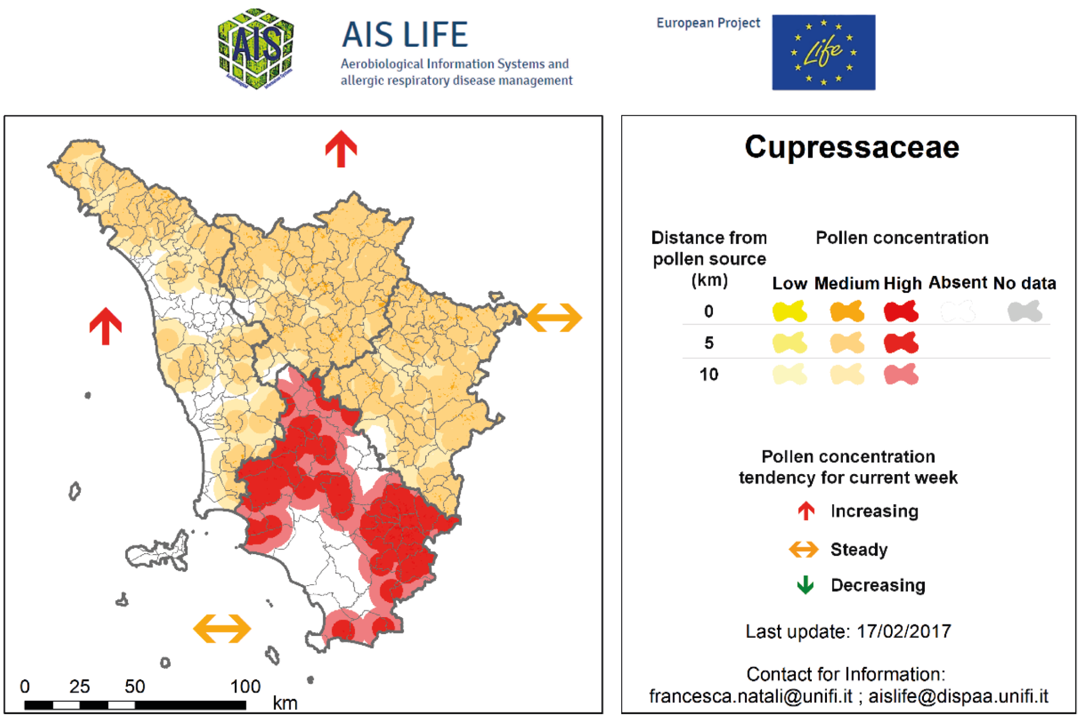
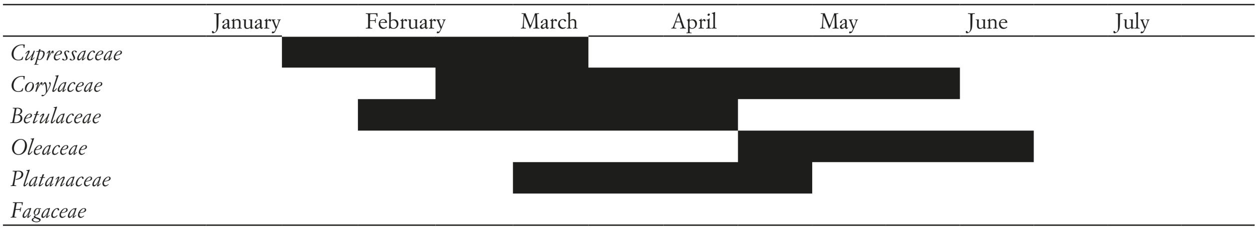


Fig. 5 - Cupressacee pollen concentration.

For allergic population the critical period, corresponding to the presence of pollen in atmosphere, begins in January and it finishes in July according to the calendar reported in Table 1.

In the same botanic families, different species have flowered in different period: for example in the Corylacea family, Corylus avellana usually starts the flowering at the end of February, following by Ostrya Carpinifolia and Carpinus Betulus, at the end of March. Moreover, the flowering of the same species could have a shift of two week if we consider a place near the coast or in internal area.

Table 1 - Presence in atmosphere of pollen allergic tree.



The maps were uploaded on the project web sites www.ais-life.eu, on www.biometeo.it and on AIS LIFE Facebook account.

DISCUSSION AND CONCLUSIONS

The beneficiaries of the pollen risk maps could involve the following stakeholders and users.

Allergic population: the distribution of pollen concentration maps provide useful information about the level of risk to patients depending on the geographic area and the species considered.

Pharmacies and Health Agencies: they are interested in receiving weekly maps forecasting about the pollen concentrations of main allergic tree species. This information is seen as added value to the service that they provide to citizens.

General practitioners and allergy specialists are responsible for safeguarding people's health and prevent health risks. The maps should support them in providing accurate medical indications, and in improving diagnosis and to support patient cure as well. Knowledge of pollen season trends could allow allergy doctors to modify dosages and duration of therapies and avoid excessive medication.

Some additional tools (e.g. questionnaires) could be useful to evaluate the real efficacy and use of the maps. These aspects will be investigated in the final phases of AIS LIFE project.

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