

INTRODUCTION

Objectives

- Identifying allergenic pollen events related with health problems.
- Design of a forecast system for such events that could be used for public warning. Starting with plane tree (*Platanus*) and grass pollens types. Next step: olive tree and *Cupressaceae*
- Developing collaboration between public administrations to optimize public resources.



Geographical and social background

- Madrid region is at Iberian Peninsula centre and encloses Spain's capital. Extension is 8,000 km² and population is 6 million inhabitants. Madrid city and neighbouring cities occupy only 33% of the region but concentrate about 72% of its population.
- Madrid city is extended over a plateau at 650 m ASL but it is eroded by several minor rivers. Terrain altitudes ranges from 550 to 700 m ASL.
- There is a huge number of parks and gardens providing inside Madrid or nearby adequate land to growth ornamental or wild trees and plants.

Asthma and pollen

- Asthma prevalence is 5% in Europe. 4/5 or asthma patients have a positive prick-skin.
- 60% of asthma patients are allergic to grass and 30% to plane tree pollen.
- Studies made in Madrid showed that 94% of persons sensitive to allergenic pollens react to grass (hay fever) and 56% react to plane tree pollen.
- Significant number of asthmatic crisis derived into urgency services or hospitalization

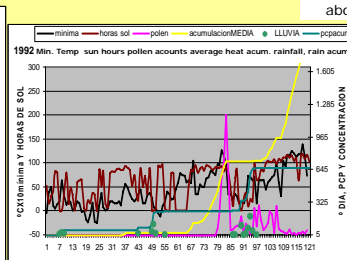
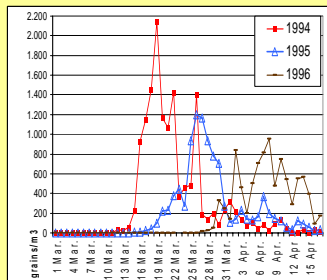
START OF PLATANUS POLLEN SEASON

Data sources

- Daily pollen amounts (grains/m³). Madrid-Salamanca Quarter) 1980-2006
- Daily pollen amounts from PALINOCAM network 1994-2007. Operated by Public Health Institute from Madrid autonomous region.
- Meteorological data from five weather stations in Madrid area: Madrid-Retiro (1980-2007), Barajas airport, Cuatro Vientos airport, Getafe AFB and Torrejon AFB (1994-2007). Operated by AEMET (Spanish Met. Agency)

Relevant meteorological factors

- Medium term inflorescences growth process in trees less dependant on atmospheric moisture than grasses or bushes.
- Cumulated rainfall not relevant in ornamental trees due to irrigation.
- Main factor is accumulated heat. Problem: Find the adequate threshold.
- Wind not significant factor.
- Abrupt changes in atmospheric moisture could lead to short term release of pollen.



Proposed forecast system

Early warning

- Cumulative heat on January-February could act as an early warning indicator.
- SPS in Madrid ranged from 6 March to 10 April with 20 March as median value.
- Four early SPS in the period 1980-2006 scored important heat accumulation in January-February.
- Combined with Medium Range Forecasts it is possible to warn on 1st March about an early SPS of plane tree in Madrid

Linear adjustments. Base for forecasts

- Data adjustment. Pollen daily amount vs accumulation degrees-day (3 days classes) 1980 to 2006 (1986 and 1987 eliminated)
 $Clasediapol = 12,22 + 0,55 * Clasediagr$
 statistically significant at the 99% confidence level, explained 69,0% of the variability in Clasediapol, correlation coefficient = 0,83
- Data adjustment. Five met. data series around Madrid. Average accumulated heat: threshold: 50 degrees. Three pollen series. Average counts: threshold: 30 grains/m³. Day +/- 2

Plane tree pollen. Medical impact. What to forecast?

Plane trees are ornamental and they are highly cultivated in cities. Generally not rainfall dependant. Prunes modulate daily and year amounts.

Low dispersion due to be heavy pollen. Long range transport not considered

Persons sensitive to this pollen are prone to suffer asthmatic crisis with relatively small amounts in the air.

Daily amounts rise quickly from zero to tens in two-four days. Target: start of pollen season by threshold amount.

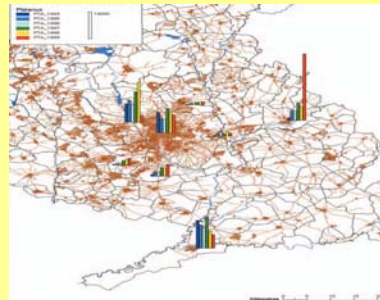
Threshold SPS

Mix of medical information and statistical behaviour: 30 grains/m³ assures allergic reaction and "no-back" Start of Pollination Season.

Examples on plane tree daily counts. Madrid (March-April). Always abrupt start. Once started pollen presence in the air, allergic symptoms remain even if emission decreased or ceased for many days.

Sampling SPS

Once fixed SPS date for Madrid-Salamanca (1980-2006), we calculated degrees day over 15 degrees for maximum daily temperatures and over 10 degrees for average daily temperatures. Cumulative degrees day for both magnitudes were calculated starting on 1st January. Better representativeness of SPS day was found for the AVERAGE of both cumulative magnitudes. Cumulative threshold value found: 50 degrees celsius.



Scores

	Method I	Method II
Prob of Detection	POD 0,63	0,64
False Alarm Ratio	FAR 0,15	0,14
Late Warning Ratio	LWR 0,22	0,21

Evolution of total year counts (plane tree pollen) from PALINOCAM network data. Madrid city and other neighbour towns are at the center of the map

CHARACTERIZATION OF GRASS SEASON

Madrid grass pollen characteristics

Grass pollens are the most important cause of pollinosis in the Madrid area. Concentrations in Madrid similar to Northern European cities (eg. London), where there is more rainfall and grasses are more abundant.

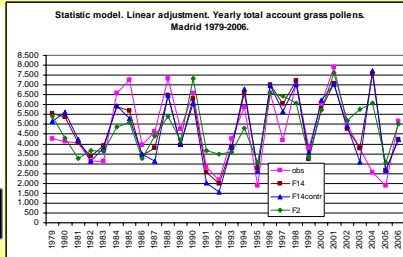
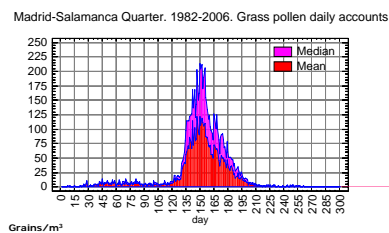
Predominance of small-grain grass pollen (diameter less than 30 μ). Medical recommended threshold: 50 grains/m³

Trisetum paniceum was the most common of the grasses that produce small-grain pollens in Madrid area

Seasonal forecasts. Total year counts

Relationship between grass total amounts and rainfall into the previous months, rainfall in May and maximum and average temperatures in May and June. Data from 1979 to 2006. Year 2004 always excluded building relations as outlier. Up to 14 relations checked. Forecast scores checked against total pollen account classes. More than 5500 grains/m³ is upper class. Indexes are relative to the ability to forecast 9 upper class events on that time period. Most successful relation is recalculated removing 7 years randomly as control.

Keys: OJR=October-January Rainfall. FR, MR and MyR=Feb, March and May Rainfall. Main photo: *Trisetum paniceum*



Represented forecasts

(F2) Tot year = 2078 + 14,3 * OJR - 22,2 * FR + 23,8 * MR
 R-squared = 57,97%. Std error of est. = 1192,4. Mean absolute error = 893,5. Durbin-Watson statistic = 1,54 (P=0,0970)

(F14) Tot year = 6851 + 14,0 * OJR + 3,4 * MyR + 1403 * MaxJun - 1967 * MaxMay + 2012 * MedMay - 1566 * MedJun
 R-squared = 78,35% Std error of est. = 917,7. Mean absolute error = 641,4. Durbin-Watson statistic = 1,04 (P=0,0031)

(F14 control) Tot year = 7599 + 12,4 * OJR + 2,4 * MyR + 1909 * MaxJun - 2751 * MaxMay + 2900 * AvgMay - 2119 * AvgJun
 R-squared = 82,52%. Std error of est. = 866,7. Mean absolute error = 622,7. Durbin-Watson statistic = 1,33 (P=0,0643)

statistically significant relationship between the variables at the 99% confidence level. High max temperatures in June and not cold temperatures in May are statistically connected with bigger total pollen amount. Also related with total estimated cereal crops?

Adjustment	F2	F14	F14cont
POD	55,56%	100%	88,89%
FAR	44,44%	33,33%	33,33%
CSI	38,46%	75,00%	66,67%

Cluster analysis (1979-2006)

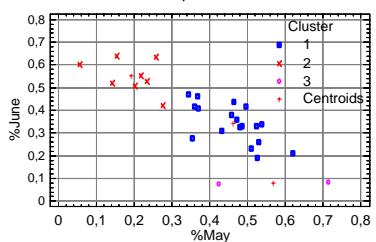
May, June, (Total year-June-May) percentage over total year and (Total May monthly total/June

Number of complete cases: 28 Clustering Method: Furthest Neighbour. Distance Metric: Squared Euclidean

Cluster	Members	%	Variables: % Total May, %Total June, % (total year-total May-total June) total May/total June
1	18	64,29	
2	8	28,57	
3	2	7,14	

Cluster	%May	%June	May/June	%Year- (May and June)
1	0,46	0,34	1,49	0,19
2	0,19	0,55	0,37	0,26
3	0,57	0,08	7,16	0,35

Cluster Scatterplot. Madrid 1979-2006



Cluster 2 are years tilted towards late pollination (June). Cluster 1 are "normal" years. Cluster 3 are years with early "end" of season. Cluster analysis provide another criteria to characterize every year added to the raw total year amount.

CONCLUSIONS

- Plane tree SPS is mainly driven by heat accumulation. SPS determining threshold has been selected from medical and statistical criteria as 30 grains/m³.
- Forecast SPS date is based on averages from several representative stations for both pollen catchments. Mean heat accumulation for the average of maximum and mean temperatures is 50 °C.
- Grass pollen is the main cause of Asthma epidemic in Madrid during spring
- There are statistical basis to make a estimation of the total grass pollen year account but it needs information from seasonal numerical models.

Early warning system on high allergenic pollen events. Estimated social benefits:

Set of medicines to prevent or mitigate asthma crisis. Estimated cost: 120-150 Eur

1 day hospital expenditure for respiratory emergencies. Estimated cost: 600 Eur (3 to 5 days: 1800 Eur - 3000 Eur).

Relationship 1 to 20 (for 4 days).

Avoiding hospitalization only in 1 to 10 persons prone to suffer asthma that system could bring benefits.

System development must be tailored by Health Authorities and checked in its results against medical data.

Coming tasks and studies

- Developing grass peaks modelization. Provide operational forecasts.
- Extending to oil trees and Cupressaceae/Taxaceae pollen type at the central plateaus of Spain.
- Extending to other autonomous regions in Spain. Developing products at national level.

Some references

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Acknowledgments

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