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How the Joint Impact of Land Use and Climate Influences Airborne Pollen Spectrum?

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Short Communication

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ABSTRACT

Airborne pollen concentration depends on flowering intensity of wind-pollinated species. The pollen spectrum, and the variations in its composition and concentrations has been traditionally studied in correlation with weather features. But, what is the role of recent land use changes on atmospheric pollen load? The joint influence of climate and land use changes in South Spain indicates different behaviour for arboreal, herbaceous, agronomical and ruderal species pollen linked with climate but also with new agronomic practices and changes in urban planning strategies with a higher building pressure.

Changes in land use and land cover are major components of global dynamic, directly prompting alterations in habitat composition, biodiversity and the functioning of the ecosystem [1,2]. Since airborne pollen come from local plant cover, one consequence of the recent changes in urban and sub-urban landscape can be the alteration of airborne pollen.

Very few aerobiological studies include land use as a descriptive variable [3]. Pollen variations are usually attributed to weather-related factors. In a recent study carried out in the city of Córdoba, we analyzed the joint impact of land use changes and climate on airborne pollen load [4]. The present short communication reports the main advances of that research in a more resumed way. The studied locality (37°53'0"N 4°46'0"W) is placed at southern Europe, in the Mediterranean region, area with a special interest in this sort of studies because it has a lower degree of landscape persistence and a higher anthropization rate than the temperate region areas. Therefore it is highly vulnerable to the impact of land cover changes on the plant species [5]. Plant phenology response, including flowering and pollination, is modulated by climate. Over recent years, southern Europe has witnessed an increase both in temperature and in rainfall intensity, especially in the Mediterranean climate area [6]. Although pollen production per flower is genetically determined in each species, atmospheric pollen concentrations of the different taxa are obviously governed by the amount of flowers and the plant response to climate variables, but also by local land uses which determine the number of individuals of each species in a given area.

The main objectives of our work were to investigate the role played by biogeography in regional and urban variations in pollen composition. Also we analyzed the possible influence of these variables and their implications for other fields such as allergy to pollen, ecology and agronomy. Our research, recently published, has demonstrated that biogeography in regional and urban variations in pollen composition can potentially provide insights into how pollen production and dispersal respond to changes in climate and urban and peri-urban land use.

Pollen Load Variations: Influence of Land Use and Climate Changes

Annual airborne pollen data from 15 taxa were analyzed in the southern Spanish city of Córdoba (37°53'0"N 4°46'0"W) during the period 1996-2010 corresponding to the available land use data years in the region. The seasonal trend analysis showed that by far the highest increase was recorded for Olea (olive tree) pollen, followed by Quercus (oaks) one. Both pollens are from tree species located outside the city. Among herbaceous taxa, high pollen counts were observed for Poaceae (grasses) in comparison with other cities of the region [7]. Nevertheless a decrease of pollen from ruderal weed species has been detected; the Urticaceae family (nettles), Amaranthaceae (goosefoots), Rumex (docks and sorrels) or Plantago (fleaworts).

Changes in land use and land cover around the city analyzed for different radius levels from the trap in order to detect the variations at different distances from the city: 5000, 10000, 25000, and 50000 m from MUCVA project (1999; 2007) developed in base to CORINEL and Cover project (Coordination of Information on the Environment) [8]. In the area has been an increase in the urbanized land area at the expense of forest areas, natural pastures or natural wetlands. Cropland has become more homogeneous: a greater area is being devoted to olives, whereas arable crops surface (mostly cereals and sunflowers) has diminished.

Apart from the impact of changes in land use around the city the correlation of climate factors and pollen concentrations was analysed with a view to obtaining an overview of all the main factors shaping airborne pollen concentrations over the long term. Significant correlations were observed for several taxa. Positive influence between rainfall during the months prior to flowering and pollen concentrations for Olea, and more particularly for herbaceous taxa such as Poaceae, Plantago, Rumex and Asteraceae (daisies, sunflowers), all of them causing allergy. Temperature displayed a less marked impact, though there is still a significant negative correlation with Olea and Urticaceae pollen concentrations. It should be noted that the earliest and latest years of the study were the wettest in their respective north Atlantic oscillation (NAO)-linked micro-climatic cycles [9]. This fact influences on flowering intensity as we demonstrated in a recent previous research in the Iberian Peninsula, where NAO has been reported as a significant factor for guiding long term trends in pollen series [10].

Analysis of pollen trends in conjunction with weather variations and changes in land use yielded various striking results. A significant rising trend in Olea pollen concentrations was observed. This pollen type includes pollen from both cultivated and natural olives, although the presence of these last ones is so scarce, so our results could be attributable both to the increasing area given over to olive-growing in recent years but also to changes in temperature and rainfall prior to olive flowering. By contrast, the significant declining trend observed for airborne pollen from ruderal species and other taxa associated with marked anthropogenic activity, such as Amaranthaceae, Rumex, Plantago and Urticaceae, may be linked to recent changes in urban planning strategies, involving an increase in the surface area of urbanized land and a reduction of urban wastelands in the last years of the study. Poaceae pollen concentrations detected in the trap mostly come from natural areas, ant they have displayed a rising trend favored by increased rainfall prior to the flowering season which influenced on the increase of the number of days with high grass pollen counts and therefore the extension of the pollen-season length [11]. Finally rising trends were observed for pollen concentrations of urban ornamental species such as Platanus, Cupressaceae, Myrtus or Morus, linked to an increase in the amount of urbanized land in the vicinity of the pollen trap, which could be prompted the increase of pollen allergy incidence in the area.

Changing land use may well influence both the severity and timing of the airborne pollen seasons that are due to the pollination of wind-pollinated species (the percentage of pollen from entomophilous plants liberated to the atmosphere is insignificant). Moreover, atmospheric pollen analysis could be a good complement to modern sediment pollen samples as invaluable research tools improving investigation of the relationship between pollen production and the environmental parameters such as vegetation, land-use, and climate that the pollen proxy represents [12]. The expansion of urbanized areas in Mediterranean countries has prompted a sharp increase in the incidence of pollen allergies, particularly in densely-populated cities. Moreover, the increase in certain kinds of croplands and the abandoning of others due to specific economic policies also influences plant biodiversity and pollen emission [13].

In our study we analysis how the effect of climate on plant phenological response can be strengthened or mitigated by the impact of human activity on plant distribution through changes in land use [4]. This interaction is likely to affect public health (pollen allergy), agriculture and even the functioning of the ecosystem. It can be concluded that pollen spectrum variations, traditionally attributed to climate features, may be also influenced by land use and by changes in land cover, even that some high allergenic pollen as Olea, Poaceae, Cupressaceae or Platanus are highly increasing in the Mediterranean area reflecting fluctuations in land cover and climate, which can be influence on the sharp increase of pollen allergy in Mediterranean population.

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