Climate change and pollen allergy: cities and municipalities should take people suffering from pollen allergy into account when planting in public spaces

Karl-Christian Bergmann[1], Torsten Zuberbier[2], Jobst Augustin[3], Hans-Guido Mücke[4], Wolfgang Straff[4]

[1]German Pollen Information Service Foundation, Berlin; [2]European Center for Allergy Research Foundation, Berlin; [3]Central Research Institute of Ambulatory Health Care, Berlin; [4]Federal Environment Agency, Dessau-Roßlau (all Germany)

Summary

Climate change leads to changes in pollen flight. The pollen of hazelnut, alder and birch in particular tend to appear earlier and in higher concentrations. This trend is promoted by the planting of birch trees in town.

Until now, there have been no recommendations in Germany regarding the new planting of trees in public spaces that takes the needs of people suffering from pollen allergy into account. In order to prevent the further increase of allergenic tree pollen in cities, a proposal listing tree species that municipalities should avoid planting is presented. Also attached is a list of allergologically safe trees that are suitable for cultivation.

Zusammenfassung

Der Klimawandel führt zu Veränderungen im Pollenflug. Besonders betroffen sind davon die Pollen von Haselnuss, Erle und Birke, die früher und tendenziell in höheren Konzentrationen auftreten. Dieser Trend wird durch die Neuanpflanzung von Birken in Städten gefördert.

Bisher gibt es in Deutschland keine Empfehlung zur Neupflanzung von Bäumen im öffentlichen Raum, die Rücksicht auf die Belange von Pollenallergikern nimmt. Vorgelegt wird ein Vorschlag, welche Baumsorten bei Anpflanzungen in Städten zu vermeiden sind, um einer weiteren Erhöhung der Menge an Baumpollen vorzubeugen. Beigefügt ist auch eine Auflistung allergologisch unbedenklicher Baumsorten, die zur Anpflanzung geeignet sind.

Klimawandel und Pollenallergie: Städte und Kommunen sollten bei der Bepflanzung des öffentlichen Raums Rücksicht auf Pollenallergiker nehmen

Key words
Climate change – plantation – cities – pollen allergy – prevention

Schlüsselwörter
Klimawandel – Bepflanzung – Städte – Pollenallergie – Prävention

Submitted/Eingang
5. Mai 2011
Accepted/Annahme
20. November 2011

Background

Climate change can, among others things, endanger the health of the population by altering the distribution of pollen-producing plants with allergenic potential [2].

The distribution of plants is directly influenced by climate change but people can also frequently introduce plants , as was the case with Ambrosia artemisiifolia (common ragweed) by the transport of building rubble and the distribution of seed in contaminated bird food. Nonetheless, when landscaping private and especially public spaces plants are also consciously selected because they may offer advantages from the viewpoint of city climate, but may be problematic from an allergological perspective. Birch serves as a good example: As it has little demands on its habitat and is visually attractive, it is quite suitable as a city tree and has been and still is being planted in large numbers in Germany. At present more than one-third (38 %) of patients consulting allergy outpatient services [6] and already 10 % of all children are sensitized to birch pollen [14].

It is notable in this respect, that a relatively small number of plant species are responsible for about 90 % of pollen-induced allergies [18]. This fact clearly shows the relevance of human activities with respect to dealing with the respective plant species.

The number of children, adolescents and adults with allergies to pollen in Germany has further increased in recent years. Statistically, about 20 % of the German population develops a pollen allergy during the course of their lives, i.e. about 15 million people [14].

Typical clinical manifestations are hay fever, conjunctivitis and asthma. The oral allergy syndrome, where consumption of certain foods – especially stone fruit or pomes as well as vegetables – triggers allergic reactions of the oral mucosa and gastrointestinal tract, also creates problems for many people with pollen allergies. Every second adult hay fever patient is affected by this [11].

Climate change and allergies: a special problem for cities and municipalities

Due to the high number of people with pollen allergies in cities, and the expected climate alterations within the framework of climate change, the authorities in charge of new planting in cities and municipalities should be aware of their responsibility. Most trees in cities are planted in a planned manner; not paying attention to health aspects can lead to a further aggravation of the allergy problem. On the one hand, already known and widespread sources of allergy-inducing pollen (e.g. birch trees) should not be increased, while on the other hand new risks for people with pollen allergies (e.g. planting olive trees) should be avoided or actively combated (e.g. the control of Ambrosia plants).

Due to air pollution, increased problems with allergy are particularly to be expected in cities: Firstly, the release of allergens and immune mediators from pollen is dependent on exposure to air pollutants [16]. On the other hand, certain air pollutants promote both the sensitization and the effector phase of an allergic process [16]. Furthermore, higher temperatures favor allergen release from pollen [7]. As cities are already considered “islands of heat”, urban areas experience a further increase in temperature already altered by climate change, which together with contemporaneous increases in CO2 concentrations results in increased growth and pollen production of allergy-inducing plants [19].

Under the assumption that in Berlin about 15 to 18 % of the population suffers from a pollen allergy, 500,000 to 615,000 people would be affected just in this city alone. Besides private costs for medication and costs for the health care system, the learning and work capabilities of children and adults with symptomatic pollen allergy would be limited by about 30 % [5] resulting in an economic loss to the cities.

Knowledge and consideration of allergenic plant species is of particular importance for cities and municipalities adapting to climate change. Therefore, plant species, in as far as they have an allergenic potential, should no longer be planted in the future. In addition, the present population of allergenic plants should gradually be reduced in the coming years by follow-up planting of species without allergenic potential.

Such a task cannot be managed within one or two years. It is a long-term project that might take the needs and conditions of individuals and society into consideration.

In many cases, it will also depend on awakening understanding and sympathy for the plan by comprehensive information for the population. To this end, it is necessary to win the cooperation of, or include in the project the relevant organizations (German Allergy and Asthma Association, Society of German Allergologists, European Center for Allergy Research Foundation, etc), institutions (plant protection offices, garden and parks departments, schools, etc) and the media. The problems of this topic have already been pointed out in a study of the allergic potential of pollen from plants in cities and municipalities and on possible strategies for reduction [17].

Risk evaluation

To evaluate the allergenic potential the number, quality and type of pollen are of importance.

On the number of pollen

In sensitized persons even low pollen concentrations of some species can already lead to allergic symptoms. For *Ambrosia artemisiifolia* a threshold value of only 10 to 15 pollen to trigger nasal symptoms was determined [3].

Unfortunately, it has not yet been possible to determine definitely the number of pollen that led to a sensitization or to allergic symptoms of the nose, eye or bronchial tract in the individual or in population groups (threshold value). Only by combination of registered symptoms and their severity with the actual exposure to the individual pollen type it will be possible to calculate the threshold values for both individuals as well as the population of people with pollen allergy in a region.

As pollen can travel great distances due to the low weight, complete avoidance of exposure will not be possible. Nevertheless, it is sensible to consider the pollen that occurs in large amounts in the immediate vicinity of the population and reduce it if possible when health is endangered, as the severity of symptoms depends on the actual pollen burden of outdoor air [10].

On the quality of pollen

Aggravation of allergic problems is expected in cities due to air pollutants such as NO2, ozone as well as fine dust,. On the one hand, air pollutants act as adjuvants both at the level of the sensitization phase as well as the effector phase of an allergic process [16]. On the other hand, the release of allergens as well as immunomodulators from pollen is related with the exposure to air pollutants Floating dust caused by traffic can increase allergen release as well as the formation of aerosols containing allergens. Pollen-associated lipid mediators (PALM) that have proinflammatory and immunomodulatory action are also involved [12]. Furthermore, allergenic pollen proteins can also attach to other particles suspended in air.

On the type of pollen

Among pollen-producing plants only those that are relevant for triggering pollen allergies induce sensitizations and diseases. These are especially pollen of the tree species hazel, alder and birch, pollen of sweet grass and rye as well as the herbs mugwort and ragweed that are therefore systematically registered by the German Pollen Information Service Foundation and named in the daily pollen reports (www.pollenstiftung.de).

Sensitization is understood as the appearance of antibodies towards the corresponding allergens in the skin, mucous membranes or in the blood, detectable by a positive skin test or detection of allergen-specific immunoglobulin E (IgE) antibodies in the blood. Previous sensitization is the prerequisite for the induction of the symptoms of allergy in the nose and eyes in the form of hay fever or conjunctivitis, or in the bronchial tract in the form of asthmatic cough. Without treatment, chronic allergic asthma can result. Detection of a sensitization cannot, nonetheless, be equated with an allergic disease. In other words, the sole detection of a sensitization does not allow for a statement on the presence of an allergic disease.

To date, it has not been possible to determine the actual cause of induction of allergen-specific IgE antibodies, or to discover the reason(s) why pollen of certain plant species cause sensitizations and allergic diseases, while pollen of other plant species do not.

Frequency of sensitizations

The current and most comprehensive overview of the Europe-wide distribution of clinically relevant sensitization rates to pollen allergens has been published by the Global Asthma and Allergy European Network (GA²LEN) in 2009 [6]. Due to the large database compiled by this network (about 3,000 patients from 14 European states were tested with respect to the frequency of a current clinically relevant sensitization) [4, 8] as well as due to the standardized approach [9], for the first time conclusions could be drawn on the frequency of clinically relevant sensitizations and thus arrive at a rating of pollen-producing plants with respect to the allergy risk in Europe.

As expected, differing frequencies of sensitizations (S) and their clinical relevance (cR), i.e. the induction of a disease such as hay fever or allergic asthma, were found for Germany (**Table 1**). In the assessment of the data in **Table 1** it must be remembered that these are results in adults who have consulted a physician due to their complaints. It does not represent frequencies in the total population.

These pollen are currently relevant for Germany, their seasonal occurrence, the methods of their determination

Table 1

Frequency of sensitizations to the allergen mixture of the pollen (S) and the clinical relevance (cR) of the respective sensitization in adults with allergic rhinitis and allergic bronchial asthma in Germany at the start of the 21st century (selection from [6]; see there for detailed data)

Plant	S (%)	cR (%)
Ambrosia*	14.4	64.6
Mugwort	22.5	84.9
Birch	37.6	90.7
Alder	34.8	91.1
Grasses	37.9	90.0
Hazel	35.9	90.3
Plane	5.3	43.4
Cypress	2.8	28.6
Parietaria	6.9	3.9

** Sensitizations to major and minor antigens of Ambrosia artemisiifolia*

Table 2

Classification of the allergy potential of trees and shrubs in public spaces, with the city of Berlin as example

Latin name	Common name	Category
Betula	Birch	1
Betula pendula	Silver birch	1
Carpinus betulus	European hornbeam	2
Carpinus betulus „Fastigiata"	Upright European hornbeam	2
Corylus colurna	Turkish hazel	1
Fraxinus	Ash	2
Fraxinus excelsior	Common ash	2
Fraxinus excelsior „Atlas"	European ash	2
Platanus × acerifolia	Maple leaf sycamore	2
Platanus × hispanica	London plane	2
Quercus	Oak	2
Quercus petraea	Sessile oak	2
Quercus robur	English oak	2
Quercus robur „Fastigiata"	Columnar English oak	2
Quercus rubra	Northern red oak	2
Salix	Willow	2
Salix alba	White willow	2

Table 3

Trees and shrubs native to Berlin suitable for new planting from an allergological perspective

Latin name	Common name
Acer	Maple
Acer campestre	Field maple
Acer negundo	Ash-leaf maple, boxelder maple
Acer platanoides	Norway maple
Acer platanoides „Columnare“	Columnar Norway maple
Acer pseudoplatanus	Eurasian maple
Acer rubrum	Red maple
Acer saccharinum	Silver maple
Aesculus	Horse chestnut
Aesculus hippocastanum	Common horse chestnut
Aesculus x carnea	Red horse chestnut
Ailanthus altissima	Tree-of-heaven
Crataegus	Hawthorn
Crataegus laevigata „Paulii“	English hawthorn, filled blooms
Crataegus laevigata „Paul's Scarlet“	Genuine English hawthorn
Crataegus lavallei	Lavalle hawthorn
Crataegus monogyna	Single-seed hawthorn
Gleditsia triacanthos	Honey locust
Magnolia kobus	Kobushi magnolia
Malus	Apple
Picea	Spruce
Populus	Poplar, American cottonwood tree
Populus x canadensis	Canadian poplar
Populus nigra	Black poplar
Populus simonii	Simon's poplar
Populus trichocarpa	Western balsam poplar
Prunus	Cherry, plum
Prunus avium	Wild cherry, sweet cherry
Prunus padus	Bird cherry
Prunus padus „Schloss Tiefurt“	Bird cherry „Schloss Tiefurt
Prunus padus „Watereri“	Bird cherry „Watereri“
Prunus serrulata „Amanogawa“	Japanese flowering cherry
Prunus serrulata „Kanzan“	Japanese flowering cherry "Kanzan"
Pyrus	Pear
Pyrus calleryana „Chanticleer“	Ornamental pear, Chanticleer callery pear
Pyrus communis	Common pear
Robinia pseudoacacia	False acacia, black locust
Sorbus	Mountain ash/Whitebeam/Wild service tree
Sorbus aria	Whitebeam
Sorbus aucuparia	European mountain ash
Sorbus intermedia	Swedish withebeam
Sorbus torminalis	Wild service beam
Tilia	Linden
Tilia americana	American linden
Tilia cordata	Little-leaf linden
Tilia cordata „Greenspire“	Greenspire linden
Tilia europaea	European linden
Tilia europaea „Pallida“	Kaiser linden
Tilia platyphyllos	Large-leaved linden
Tilia tomentosa	Silver linden
Tilia x euchlora	Caucasian linden
Ulmus	Elm
Ulmus laevis	European white elm, fluttering elm

and their allergological significance are reported in the Pollen Determination Book of the German Pollen Information Service Foundation [18]. This is an important prerequisite for warnings in the daily pollen reports.

From this and the results of other European countries the following conclusion may be drawn: the more frequent a sensitization to an allergen mixture is in a population (e.g. induced by a frequently occurring allergen, that is through high exposure) and the higher the percentage of disease in the presence of this sensitization, the higher the risk of allergy induction by this plant in the affected population. From this, recommendations can be made for cities and municipalities on measures for allergy prevention in the population. This particularly concerns new planting in cities.

There is a great need for research on the effects of climate change on health in general and the distribution of allergies in particular. The Federal Environment Agency together with the European Center for Allergy Research Foundation strives to inform on the relationship between climate change and health and to recommend measures.

Conclusions

The burden of pollen in cities is of particular significance to health. The quantity, quality and type of pollen are variable. The pollen of trees (hazel, alder and birch) often result in diseases, just as grass and herb pollen do. To prevent the further spread of *Ambrosia artemisiifolia* (ragweed) plants, they are in Berlin for example, the plants need to be systematically registered and destroyed (Berlin Action Program against Ambrosia of the Free University of Berlin: http://ambrosia.met.fu-berlin.de/ambrosia/index.php).

In order to prevent a further increase in tree pollen allergies, new planting of trees and plant species with allergenic potential in public spaces should be avoided (**Table 2**). The Working Group City Trees of the Conference of Parks Departments Chairpersons supports this view when it states that landscaping measures cannot achieve total freedom from pollen, but that the selection of trees to be planted in cities should take allergological aspects into consideration [1]. Birch is planted with pleasure for aesthetic reasons, and Schenk [15] therefore searched for a hypoallergenic variety among 22 birch species – without success. No hypoallergenic subspecies could be found.

Classification of the allergy potential of trees and shrubs in public spaces in the city of Berlin, as an example

Table 2 categorizes plants that play an important role in Berlin[1] and are listed in the tree register [13] in two categories denoted by 1 and 2.

[1]At least 50 specimens of that species had to be cataloged in order to be included in the table in terms of relevance.

- Category 1: *Urgently do not plant new.*
From an allergological viewpoint these plants should urgently not be planted new, as they have a high allergy potential. Their number should be reduced if possible.
- Category 2: *As far as possible do not plant new.*
As far as possible these plants should not be planted new. They do in fact have a low, but still existing allergy potential.

Not listed in the Table are cypress and olive that are available commercially. Planting should be avoided, as both tree species release pollen with strong allergenic potential

Table 3 lists tree species with subspecies registered in Berlin without objection from an allergological viewpoint to new planting in the public or private spaces. Depending on the requirements of the location they represent an allergologically sensible alternative for planting.

Prof. Dr. Karl-Christian Bergmann
German Allergy Information Service Foundation
Luisenstraße 2
10117 Berlin, Germany
E-mail: karlchristianbergmann@googlemail.com

Acknowledgments
The authors thank Mr. Holger-Ulrich Schmidt (PflA AL), Director of the Plant Protection Agency Berlin, Mohriner Allee 137, 12347 Berlin, Germany, for the valuable revue of the manuscript.

Declaration on conflicts of interest
The authors declare that no conflicts of interest exist.

References
1. Arbeitskreis Stadtbäume 2008 (Hrsg): Grün zur Senkung von Pollenallergien. Positionspapier des GALK-AK Stadtbäume. In: Stadt und Grün 2008/10: 42–45; http://www.galk.de/projekte/akstb_allergie.htm
2. Bergmann KC, Jäger S. Pollenflug über Europa – Indikator des Klimawandels? In: Rundgespräche der Kommission für Ökologie, Bd. 38. „Bioaerosole und ihre Bedeutung für die Gesundheit". München: Dr. Friedrich Pfeil, 2010: 43–53
3. Bergmann KC, Werchan D, Maurer M, Zuberbier T. Threshold value for Ambrosia pollen in nasal provocation: patients characterization. Allergo J 2008; 17: 375–6
4. Bousquet PJ, Burbach G, Heinzerling LM, Edenharter G, Bachert C, Bindslev-Jensen C, Bonini S, Bousquet-Rouanet L, Demoly P, Bresciani M, Bruno A, Gjomarkaj M, Canonica GW, Darsow U, Durham S, Fokkens WJ, Giavi S, Gramiccioni C, Papadopoulos NG, Haahtela T, Kowalski ML, Magyar P, Muraközi G, Orosz M, Röhnelt C, Stingl G, Todo-Bom A, Mutius E von, Wiesner A, Wöhrl S, Bousquet J, Zuberbier T. GA-2LEN skin test study III: minimum battery of test inhalent allergens needed in epidemiological studies in patients. Allergy 2009; 64(11): 1656–62
5. Bousquet PJ, Bachert C, Canonica GW, Casale TB, Mullol J, Klossek JM, Zuberbier T, Bousquet J. Uncontrolled allergic rhinitis during treatment and its impact on quality of life: a cluster randomized trial. J Allergy Clin Immunol 2010; 126(3): 666–8
6. Burbach GJ, Heinzerling LM, Edenharter G, Bachert C, Bindslev-Jensen C, Bonini S, Bousquet J, Bousquet-Rouanet L, Bousquet PJ, Bresciani M, Bruno A, Canonica GW, Darsow U, Demoly P, Durham S, Fokkens WJ, Giavi S, Gjomarkaj M, Gramiccioni C, Haahtela T, Kowalski ML, Magyar P, Muraközi G, Orosz M, Papadopoulos NG, Röhnelt C, Stingl G, Todo-Bom A, Mutius E von, Wiesner A, Wöhrl S, Zuberbier T. GA(2)LEN skin test study II: clinical relevance of inhalant allergen sensitizations in Europe. Allergy 2009; 64(10): 1507–15
7. Buters JT, Kasche A, Weichenmeier I, Schober W, Klaus S, Traidl-Hoffmann C, Menzel A, Huss-Marp J, Kramer U, Behrendt H. Year-to-year variation in release of Bet v 1 allergen from birch pollen: evidence for geographical differences between West and South Germany. Int Arch Allergy Immunol 2008; 145(2): 122–30
8. D'Amato G, Cecchi L, Bonini S, Nunes C, Annesi-Maesano I, Behrendt H, Popov T, Cauwenberge P van. Allergenic pollen and pollen allergy in Europe. Allergy 2007; 62: 976–90
9. Heinzerling LM, Burbach GJ, Edenharter G, Bachert C, Bindslev-Jensen C, Bonini S, Bousquet J, Bousquet-Rouanet L, Bousquet PJ, Bresciani M, Bruno A, Burney P, Canonica GW, Darsow U, Demoly P, Durham S, Fokkens WJ, Giavi S, Gjomarkaj M, Gramiccioni C, Haahtela T, Kowalski ML, Magyar P, Muraközi G, Orosz M, Papadopoulos NG, Röhnelt C, Stingl G, Todo-Bom A, Mutius E von, Wiesner A, Wöhrl S, Zuberbier T. GA(2)LEN skin test study I: GA(2)LEN harmonization of skin prick testing: novel sensitization patterns for inhalant allergens in Europe. Allergy 2009; 64(10): 1498–506
10. Kurt E, Aktas A, Gulbas Z, Erginel S, Arslan S. The effects of natural pollen exposure on inflammatory cytokines and their relationship with nonspecific bronchial hyperresponsiveness in seasonal allergic rhinitis. Allergy Asthma Proc 2010; 31(2): 126–31
11. Oertmann C, Bergmann KC. Die Zunahme des pollenassoziierten oralen Allergie-Syndroms. Allergologie 1997; 20: 611–9
12. Plötz SG, Traidl-Hoffmann C, Feussner I, Kasche A, Feser A, Ring J, Jakob T, Behrendt H. Chemotaxis and activation of human peripheral blood eosinophils induced by pollen-associated lipid mediators. Allergy Clin Immunol 2004; 113(6): 1152–60
13. Reinheckel U, Ehlebracht K. Erfahrungen mit den in Berlin verwendeten Baumkatastern. www.galk.de/gis_bk/down/bk_b_0901sug.pdf, Januar 2009
14. Ring J, Bachert C, Bauer CP, Czech W (Hrsg). Weißbuch Allergie in Deutschland. 3. überarb. Aufl. München: Urban & Vogel, 2010
15. Schenk MF. Birch pollen allergy: molecular characterization and hypoallergenic products. Proefschrift von Wageningen Universiteit. Verteidigt 19. Februar 2008
16. Schober W, Behrendt H. Einfluss von Umweltfaktoren auf die Allergieentstehung. HNO 2008; 56(8): 752–8
17. Seyfang V. Studie zum wissenschaftlichen Erkenntnisstand über das Allergiepotential von Pollenflug der Gehölze im öffentlichen Grün der Städte und Gemeinden und mögliche Minderungsstrategien. Hochschule Ostwestfalen-Lippe, 2007/2008. http://www.aktionsplan-allergien.de/nn_461374/SharedDocs/Downloads/05__Draussen__Unterwegs/BLE__ForschungsprojektPollen.html
18. Winkler H, Ostrowski R, Wilhelm M. Pollenbestimmungsbuch der Stiftung Deutscher Polleninformationsdienst. Paderborn: TAKT, 2001
19. Ziska LH, Gebhard DE, Frenz DA, Faulkner S, Singer BD, Straka JG. Cities as harbingers of climate change: common ragweed, urbanization, and public health. J Allergy Clin Immunol 2003; 111(2): 290–5