Landscape Architecture

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Diversity-Buffered Allergenic Leverage Analysis of Subtropical Public Gardens in Funchal

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Abstract

In urban gardens, shade, culture, recreation, biodiversity and many other positive attributes are provided; yet, in addition to providing these positive traits, plants found in gardens could contribute towards increasing allergies through the release of allergenic pollen. The current paper uses DBALM in the assessment of two urban public gardens located in Funchal, Madeira: Municipal Garden and Santa Catarina Park. In particular, a direct analysis of the Index of Urban Green Zone Allergenicity (IUGZA), along with the use of threshold position, Shannon-evenness buffering, green-surface normalisation, latent biological activation, contribution concentration and replacement leverage is used. In the first place, IUGZA is 0.39 for Municipal Garden and 0.16 for Santa Catarina Park, implying that only the former exceeds the concern threshold of 0.30. In addition, the use of diversity buffering helped preserve this differentiation, since DBP is 0.257 and 0.070, correspondingly. This differentiation could not be explained through the comparison of the gardens' areas and numbers of plant species, yet differences in trees' evenness, contribution concentration and pressure in planted surfaces were evident. There are four plants that account for 72.54% of contribution signal, namely *Ginkgo biloba*, *Cinnamomum camphora*, *Celtis australis* and *Araucaria columnaris*. Their functional replacement would lead to decreasing IUGZA from 0.39 to 0.107, while their partial replacement would decrease this value to 0.249. Overall, Santa Catarina Park shows less realised pressure, although it has higher latent biological activation, indicating surveillance needs there, rather than broad interventions.

Keywords: allergenic plants; urban green spaces; IUGZA; pollen exposure; Shannon diversity; Madeira; urban forestry; public-health planning

1. Introduction

Urban green spaces are increasingly expected to provide climate adaptation, biodiversity, stormwater regulation, recreational activity and aesthetic appeal in the same finite urban space. Vegetation can cool urban areas, intercept pollutants, foster identity and facilitate social use, but vegetation can also be a source of ecosystem disservices in terms of pollen allergies, volatile organic compounds, obstructed ventilation or dominance of certain plant species, all of which increase the pressure for sensitive individuals [11, 12, 18]. Thus, the design task becomes one of compositionality in which appropriate selection, distribution and management of vegetation should preserve the desirable effects of green spaces while mitigating unnecessary allergenic pressure.

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Allergenic plants and their role in urban health have recently gained increased relevance since airborne pollen has significant effects on allergic rhinitis, asthma and other respiratory conditions that can be aggravated by air pollution, warm temperatures, extended flowering seasons and high concentrations of human presence within public spaces [2, 10, 20, 26]. Changes in pollen seasonality due to climate sensitivity are particularly relevant for public gardens located within mild subtropical or Mediterranean-influenced climates, which tend to feature elongated flowering periods thus prolonging the exposure to localised pollen-emitting taxa within gardens. Thus, although a public garden can be aesthetically pleasant, biodiverse and culturally significant, it can contain pollen emitting taxa that create health risks for the visitors.

Allergy-sensitive plant selection and design have been studied extensively, and it has been noted that, because of ornamental preferences, urban landscapes rely heavily on taxa selected for other traits such as shape, shade-giving capacity, fast growth or low maintenance requirements [5, 8]. The Index of Urban Green Zone Allergenicity (IUGZA) was proposed to estimate the allergenicity of an urban green space by quantifying the allergenic potential, pollination strategy, pollination period, occupied surface and plant height into one numerical value per garden [6]. Several case studies proved the potential of IUGZA and similar indices as tools for improving the allergenic potential of urban green zones in different climatic conditions [7, 13, 17, 22–24]. Such case studies showed that botanical inventories can be used to derive valuable insight for management practices.

However, an index value by itself cannot provide sufficient guidance for the action plan. For example, gardens with equal IUGZA indices can require entirely different strategies if the high value is produced by a few high-contributing taxa, whereas others have many small-contributing taxa. Similarly, the high value can result not from the biological potential of the garden but from the surface area occupied by the contributing species or the lack of distribution and diversity that could buffer against the high potential. Therefore, a high allergenic potential of a garden means little about management if the garden has high plant diversity but low evenness in the distribution of the contributing plants. Furthermore, the effect of biodiverse gardens can be diluted by high allergenicity of just a few species present in a limited portion of the garden.

Thus, the question remains what factors contribute the most to the high allergenic potential of urban gardens and what measures need to be implemented to address the issue. The current study addresses these questions in a subtropical context with multiple biogeographical influences, using Funchal public gardens and the botanical data derived from Camacho et al. [4]. Specifically, the two gardens with the highest and lowest IUGZA indices were chosen and examined for their biological opportunity, plant diversity, contribution dominance and surface area. As in previous studies, the IUGZA value remained the primary measure, with the concepts of biological potential, evenness-based pressure reduction and contribution dominance being additionally investigated.

2. Materials and Methods

2.1. Study sites and floristic inventory

The floristic inventory followed the protocol used in Camacho et al. [4]. Thus, the Municipal Garden features an approximate total area of 8,300 m^2, 50.94% green-surface share, 173 recorded species and 63 plant families. Santa Catarina Park, on the other hand, features an approximate total area of 35,200 m^2, 36.45% green-surface share, 210 species and 68 families. This provided sufficient botanical data to compare a compact historic garden and a larger open public park.

The difference between the two gardens in terms of morphology and layout is illustrated in Figure 1. It is clear that the Municipal Garden occupies a significantly smaller area yet has higher planted concentration, while Santa Catarina Park has larger surface area yet a distributed park structure. This is a significant factor for the analysis because the exposed surface area plays an important role in the exposure of individuals to pollen within a garden.

Figure 1. Site profile.

2.2. IUGZA classification and threshold position

The observed IUGZA value was retained as the primary expression of site-level allergenic potential. The 0.30 reference value was used as the threshold separating lower concern from conditions in which allergenic plants are sufficiently influential to warrant closer planning attention [7, 8]. For each garden g, the threshold-exceedance factor was calculated as

$$\mathrm{TEF}_g = \frac{\mathrm{IUGZA}_g}{0.30}. \tag{1}$$

This ratio does not change the original index. It states how far the observed value is from the planning reference. Values above one indicate exceedance, whereas values below one indicate that the garden remains under the threshold. Interpreting the index as a ratio is useful for managers because it distinguishes a marginal exceedance from a clear exceedance without adding a separate risk classification system.

2.3. Diversity buffering of allergenic pressure

The diversity-buffer component evaluates whether tree and shrub diversity attenuate realised allergenic pressure. Trees were weighted through Shannon diversity and evenness because tree height, canopy spread and pollen release can dominate the local exposure environment. Shrubs were included because they shape the visitor-level vegetation layer and contribute to ornamental density. The buffer score was calculated as

$$B_g = \frac{1}{2}\left(H'_{T,g}E_{T,g} + H'_{S,g}E_{S,g}\right), \tag{2}$$

where $H'_{T,g}$ and $E_{T,g}$ denote tree Shannon diversity and tree evenness, and $H'_{S,g}$ and $E_{S,g}$ denote shrub Shannon diversity and shrub evenness. The adjusted pressure was calculated as

$$\mathrm{DBP}_g = \mathrm{IUGZA}_g \exp(-0.25B_g). \tag{3}$$

The attenuation coefficient is deliberately conservative. It allows a high-diversity garden to receive a lower adjusted value, but it does not eliminate the influence of allergenic potential, plant height, occupied surface or pollination traits. The buffer therefore acts as an interpretive modifier. It asks whether the observed allergenic pressure is embedded in an even vegetation structure or in a dominance-prone assemblage.

2.4. Green-surface normalisation and latent biological activation

The two gardens differ in total area and green-surface proportion. To compare the intensity of the allergenic signal within the planted portion of each site, green-surface normalised pressure was calculated as

$$\mathrm{GSNP}_g = \frac{\mathrm{IUGZA}_g}{S_g}, \tag{4}$$

where S_g is the proportion of the garden classified as green surface. The result is not a substitute for IUGZA. It is a supporting indicator that helps identify whether the allergenic signal is concentrated within the planted fraction of a site.

Latent biological activation was used to separate realised index contribution from the pool of species that could become more important under altered maintenance, invasion, maturation or phenological change. It was calculated as

$$\mathrm{LBA}_g = p(AP \geq 2)_g \times p(POL \neq E)_g \times p(DPP = 3)_g, \tag{5}$$

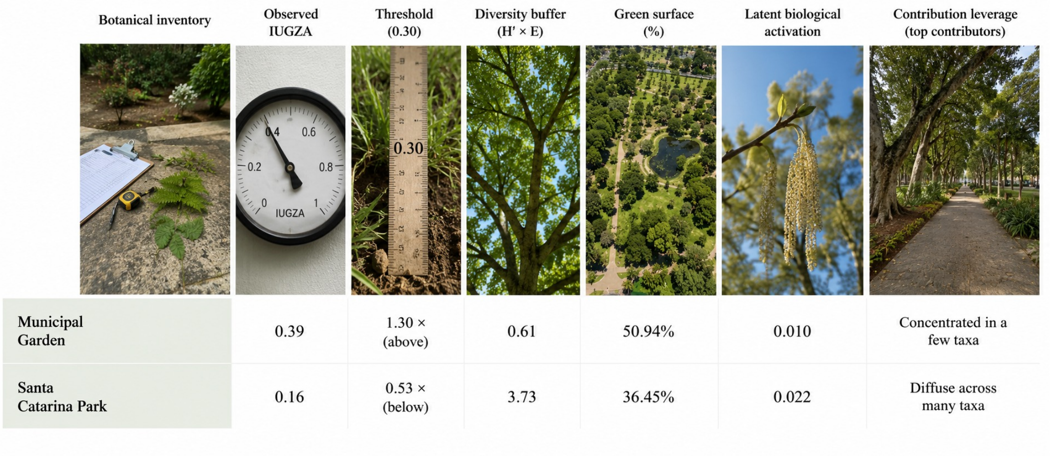
where $p(AP \geq 2)_g$ is the proportion of species with moderate or higher allergenic potential, $p(POL \neq E)_g$ is the proportion of amphiphilous or anemophilous species, and $p(DPP = 3)_g$ is the proportion of species with a long pollination period. The value captures biological opportunity rather than current contribution. This distinction is essential when a garden has many potentially relevant species but only a low observed index.

2.5. Contribution concentration and replacement effect

Species and family contribution shares were used to identify whether allergenic pressure is diffuse or concentrated. The contribution leverage of the top k species was calculated as

$$\mathrm{CL}_{g,k} = \mathrm{IUGZA}_g \sum_{i=1}^{k} c_{i,g}, \tag{6}$$

where $c_{i,g}$ is the proportional contribution of the ranked species. Two replacement outcomes were retained from the applied analysis. The full replacement case estimates the value after the dominant contribution set is removed or functionally replaced by taxa with negligible contribution. The partial case estimates the value after a 50% reduction in that contribution through phased replacement, reduced future planting, sex-specific replacement, pruning, local access modification or comparable management.



Botanical inventory	Observed IUGZA	Threshold (0.30)	Diversity buffer (H′ × E)	Green surface (%)	Latent biological activation	Contribution leverage (top contributors)
Municipal Garden	0.39	1.30 × (above)	0.61	50.94%	0.010	Concentrated in a few taxa
Santa Catarina Park	0.16	0.53 × (below)	3.73	36.45%	0.022	Diffuse across many taxa

Figure 2. DBALM sequence.

The analytical sequence in Figure 2 shows how the existing IUGZA assessment was interpreted. The sequence starts with the floristic inventory and progresses through threshold relation, diversity buffering, green-surface intensity, biological activation and contribution leverage. Its purpose is to organise the same botanical data into management decisions without adding a separate field protocol.

3. Results

3.1. Garden scale, green surface and threshold position

The two gardens differ in a way that immediately challenges a simple area-based interpretation. Santa Catarina Park is more than four times larger and contains more recorded species and families, yet the Municipal Garden has the higher observed allergenicity index. The garden-level variables in Table 1 show that the Municipal Garden combines a smaller total area with a higher green-surface share and a higher index value.

Table 1. Garden descriptors and threshold status.

Variable	Municipal Garden	Santa Catarina Park
Total garden area (m^2)	8,300	35,200
Green-surface share (%)	50.94	36.45
Approximate green surface (m^2)	4,228	12,830
Recorded plant species	173	210
Recorded plant families	63	68
Observed IUGZA	0.39	0.16
Threshold-exceedance factor	1.30	0.53
Green-surface normalised pressure	0.766	0.439

The values in Table 1 indicate that the Municipal Garden exceeds the threshold by 30%, whereas Santa Catarina Park reaches only 53% of the reference value. The approximate green surface is larger in Santa Catarina Park, but the allergenic pressure per unit of planted fraction is higher in the Municipal Garden. This result rules out an interpretation based only on the quantity of vegetation. The key difference lies in how vegetation is composed and how strongly particular taxa contribute to the site-level index.

The threshold-buffer comparison in Figure 3 adds a second reading of the same contrast. The Municipal Garden remains the higher-pressure site after diversity adjustment, while Santa Catarina Park becomes very low after the diversity-evenness buffer is applied. The figure therefore confirms that the observed threshold exceedance is not an isolated artefact of the raw index; it persists after structural moderation.

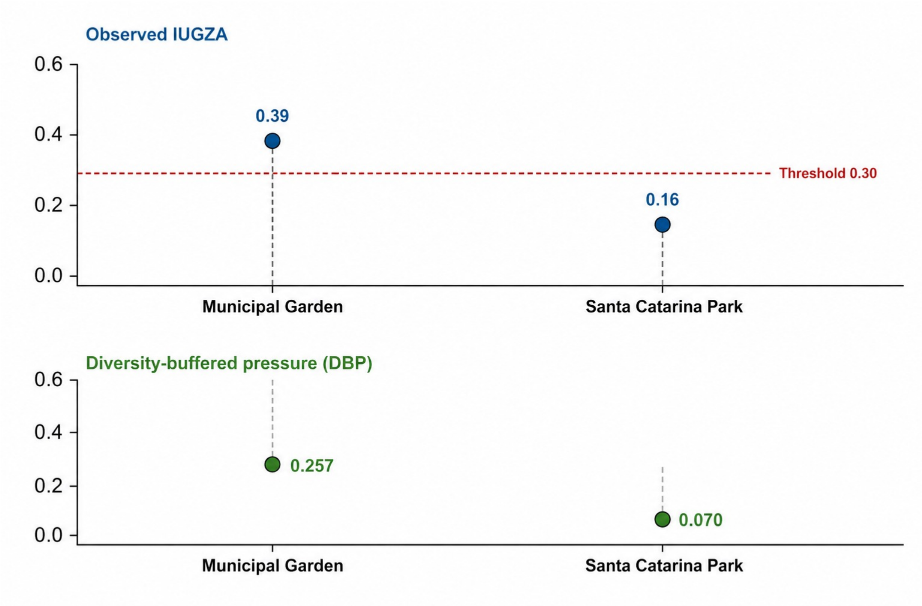


Figure 3. Observed and buffered pressure.

3.2. Diversity structure and buffered allergenic pressure

Tree diversity and evenness were the most important structural differences between the gardens. The Municipal Garden had tree Shannon diversity of $H' = 1.56$ and tree evenness of $E = 0.39$, whereas Santa Catarina Park had tree diversity of $H' = 4.01$ and tree evenness of $E = 0.93$. Shrub values were much closer between the two sites: the Municipal Garden had shrub diversity of $H' = 3.25$ and Santa Catarina Park had $H' = 3.42$, with identical shrub evenness of $E = 0.84$. These values are summarised in Table 2.

Table 2. Diversity buffering and adjusted pressure.

Garden	H'_T	E_T	H'_S	E_S	B_g	DBP_g
Municipal Garden	1.56	0.39	3.25	0.84	1.669	0.257
Santa Catarina Park	4.01	0.93	3.42	0.84	3.301	0.070

The buffer score for Santa Catarina Park was almost double that of the Municipal Garden. After the buffer was applied, the Municipal Garden retained a DBP of 0.257, while Santa Catarina Park declined to 0.070. The adjusted ratio between the two gardens is approximately 3.67, meaning that the Municipal Garden remains nearly four times more pressured after accounting for diversity-evenness structure. The decisive contrast is therefore in the tree layer. Shrubs contribute to the ornamental profile, but they do not explain the difference in adjusted pressure because shrub evenness is the same in both gardens.

The canopy interpretation in Figure 4 clarifies this result. The Municipal Garden is more vulnerable to dominance by a smaller number of influential trees, whereas Santa Catarina Park has a more even tree assemblage. A counterfactual reading is informative: if the Municipal Garden retained IUGZA = 0.39 but had the Santa Catarina Park buffer value, its adjusted pressure would be approximately 0.171. Such a value would still not erase the need for intervention, but it would represent a substantial reduction in structural vulnerability.

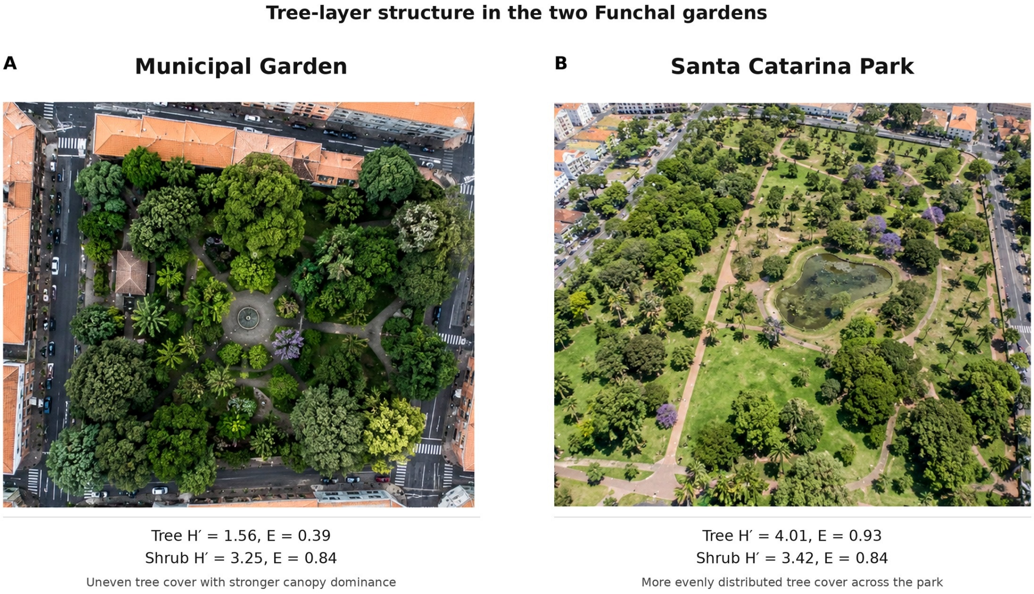


Figure 4. Tree and shrub structure.

3.3. Biological traits and seasonal persistence

The biological parameter distributions show a different dimension of risk. Santa Catarina Park had more species with moderate or higher allergenic potential, a slightly larger proportion of amphiphilous or anemophilous species, and a higher latent biological activation score. The Municipal Garden had the higher realised pressure, but Santa

Catarina Park had a larger pool of species that could become important if their surface occupation, abundance or flowering persistence increased. Table 3 summarises these values.

Table 3. Biological traits and latent activation.

Variable	Municipal Garden	Santa Catarina Park
Species with allergenic potential $AP = 0$	126 (72.41%)	135 (64.29%)
Species with allergenic potential $AP = 1$	36 (20.69%)	46 (21.90%)
Species with allergenic potential $AP \geq 2$	12 (6.90%)	29 (13.81%)
Entomophilous species	143 (82.18%)	168 (80.00%)
Amphiphilous or anemophilous species	30 (17.24%)	41 (19.52%)
Long pollination-period species	149 (85.63%)	173 (82.38%)
Latent biological activation LBA	0.010	0.022
Long-season vulnerability IUGZA × $p(DPP = 3)$	0.334	0.132

The higher latent biological activation value in Santa Catarina Park does not contradict its lower IUGZA value. It means that biological opportunity and realised pressure are different. Santa Catarina Park contains a larger proportion of species with traits that can support allergenic exposure, but those species do not currently dominate the observed index. The Municipal Garden has fewer moderate-or-higher allergenic species but a stronger realised signal because influential contributors occupy more important structural positions.

The realised-latent contrast is shown in Figure 5. The Municipal Garden has the higher diversity-buffered pressure, while Santa Catarina Park has the higher latent activation. This separation is useful for management because it assigns different time horizons. The Municipal Garden requires immediate attention to current contributors. Santa Catarina Park requires surveillance of species that could become more important if their abundance or occupied surface increases.

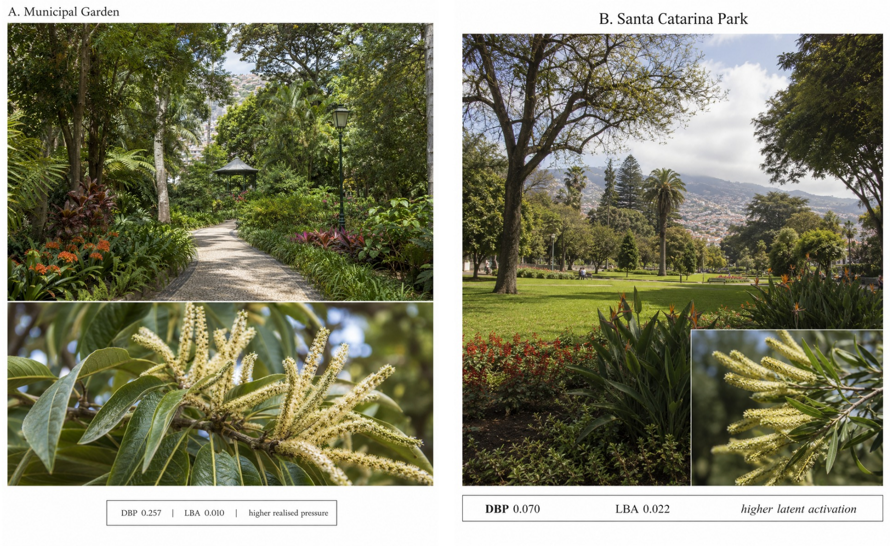


Figure 5. Realised and latent pressure.

Seasonal persistence changes the interpretation again. The Municipal Garden has a long pollination-period species share of 85.63% and a long-season vulnerability value of 0.334. Santa Catarina Park has a slightly lower long pollination-period share of 82.38% and a lower long-season vulnerability value of 0.132. The difference is driven by the combination of high observed IUGZA and long-pollination prevalence in the Municipal Garden.

The seasonal profile in Figure 6 indicates that the Municipal Garden's problem is not only index magnitude, but also persistence. A site with both elevated IUGZA and high long-season species prevalence can expose visitors across a longer portion of the year. This is especially relevant under warming conditions, because earlier onset and longer pollen seasons have been reported in several pollen-monitoring records [2, 14, 26]. The result supports phenological monitoring as part of routine maintenance rather than a one-time species list.

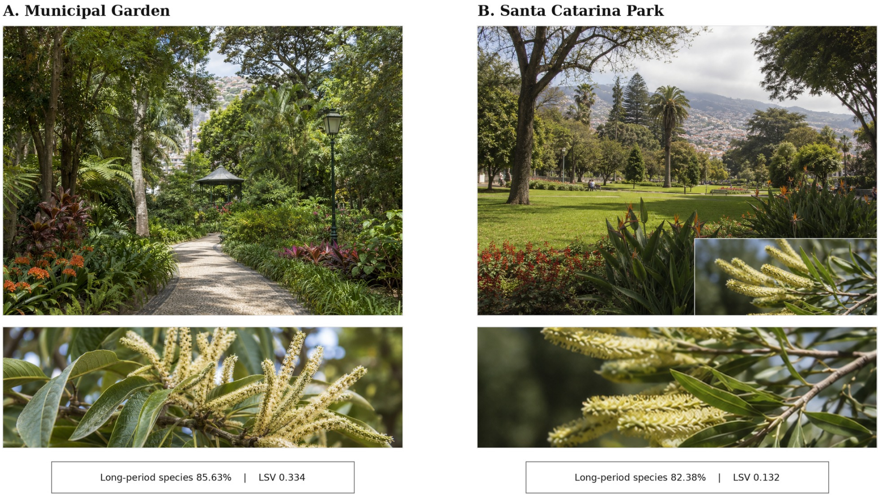


Figure 6. Long-season persistence.

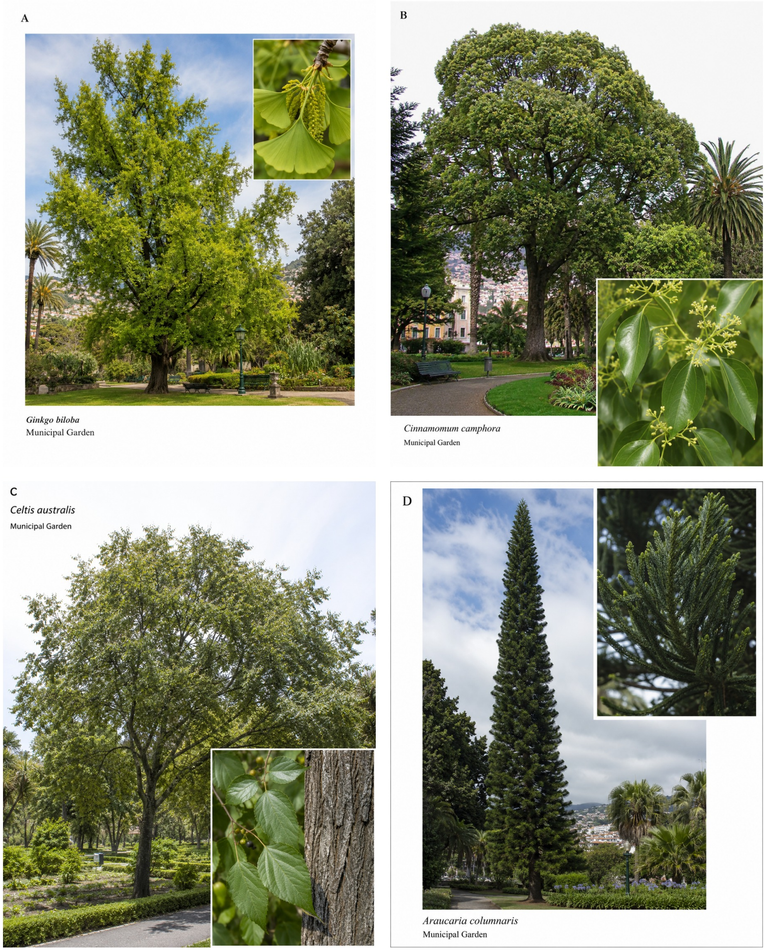


Figure 7. Municipal leverage taxa.

3.4. Species leverage and family contribution

Contribution concentration was the strongest management discriminator. In the Municipal Garden, three families accounted for 64.88% of the total index contribution: Gingkoaceae contributed 33.72%, Lauraceae 22.99% and Ulmaceae 8.17%. At species level, *Ginkgo biloba*, *Cinnamomum camphora*, *Celtis australis* and *Araucaria columnaris* together accounted for 72.54% of the allergenic signal. Santa Catarina Park had a flatter profile: Lauraceae, Araucariaceae and Oleaceae together accounted for 22.12%, and the top-four species set accounted for 20.54%.

The dominant Municipal Garden taxa in Figure 7 should be interpreted as a leverage set rather than as a removal list. Their combined contribution shows why targeted management can be more efficient than broad action across the whole garden. The largest single contributor, *Ginkgo biloba*, accounted for 33.72% of the Municipal Garden signal, which is higher than the combined top-three family share in Santa Catarina Park.

The family-level profile in Figure 8 reinforces the same conclusion from a broader taxonomic scale. The Municipal Garden shows a steep contribution structure, while Santa Catarina Park shows a flatter distribution. This difference explains why the same type of intervention would have very different returns. Selective action is highly meaningful in the Municipal Garden because a small group carries much of the index. In Santa Catarina Park, diffuse contributions mean that large structural intervention would offer limited index reduction and could damage the diversity buffer.

Figure 8. Family contribution profiles.

3.5. Replacement effect in the Municipal Garden

The replacement calculations quantify the effect of acting on the dominant contribution set. Table 4 shows that the top-four Municipal Garden species have a contribution leverage of 0.283, compared with only 0.033 for the top-four set in Santa Catarina Park. This difference is the numerical basis for the different management recommendations.

The values in Table 4 show that a full functional replacement of the Municipal Garden leverage set would reduce the observed value from 0.39 to 0.107. A 50% reduction in the same contribution set would reduce the value to 0.249, bringing the garden below the 0.30 threshold. In Santa Catarina Park, equivalent action would have only a small effect because the contribution signal is already diffuse. Full top-four replacement would lower the value from 0.16 to 0.127, and 50% mitigation would lower it to 0.144. The same numerical operation therefore supports intervention in one garden and restraint in the other.

The replacement sequence in Figure 9 communicates the practical meaning of the Municipal Garden result. The important finding is the 50% pathway, not only the theoretical full replacement value. Partial mitigation can move the index below the concern threshold without implying wholesale removal of mature vegetation. This is particularly relevant in historic public gardens where tree replacement must respect heritage value, shade provision, visual identity and visitor experience.

Table 4. Contribution leverage and replacement effects.

Indicator	Municipal Garden	Santa Catarina Park
Largest single contributor	*Ginkgo biloba* (33.72%)	*Cinnamomum camphora* (11.12%)
Top three family contribution	64.88%	22.12%
Top four species contribution	72.54%	20.54%
Contribution leverage CL for top four species	0.283	0.033
Expected IUGZA after full top-four replacement	0.107	0.127
Expected IUGZA after 50% top-four mitigation	0.249	0.144
Green-surface normalised pressure GSNP	0.766	0.439

Figure 9. Municipal replacement effect.

4. Discussion

4.1. Dominance behind the Municipal Garden index

This is confirmed by the evidence presented above, which reveals that the Municipal Garden has a higher index than Santa Catarina Park not because it is bigger, species rich or more diverse. Actually, the first garden has a lower number of species and a smaller area, and the two features are combined with greater contribution structure and reduced contribution evenness, producing a high IUGZA value of 0.39. In other words, Municipal Garden is not generally problematic; it is a compact garden that includes several influential taxa exerting excessive pressure.

In this regard, the findings are consistent with the general experience of IUGZA application, according to which high allergenic potential can emerge in case of numerous, tall, concentrated or enclosed allergenic individuals [6, 7, 23, 24]. They also confirm that the urban forests' ecosystems can provide both services and disservices since mature trees can offer shade, identity and cooling, but produce pollen [11, 12, 18]. Therefore, management needs to act at the level of the specific contributors, not making general pro or contra decisions about vegetation.

4.2. Tree evenness as an allergenicity buffer

The evidence provided above clearly indicates that the allergenic pressure experienced by Santa Catarina Park is significantly lower than in the other study object due to its greater tree diversity and higher evenness. These attributes generate a powerful diversity-buffer, and the low DBP value confirms the fact that the park's tree layer is not dominated by a limited number of high-contribution taxa.

It does not imply that Santa Catarina Park does not have any allergenic species; the garden's contribution leverage suggests the reverse situation. However, the taxa with high PAV are not dominant there, and the garden is protected against potential allergenic problems by the diversity structure.

The Municipal Garden represents the opposite scenario, in which tree diversity is relatively low, and tree evenness is also reduced. As the size of tree and the ability to form canopy contribute to the calculation, the low evenness enables some species to exert higher leverage. Therefore, diversity can be considered a tool complementing, not replacing the management, which should act on contribution.

Gradual replacement of the high-contribution plants with low-allergen taxa would help to achieve higher evenness in the future, thus making the garden less vulnerable to domination in the future. However, it would not resolve the problem right now.

4.3. Biological activation and seasonal management

While the difference between the DBP value makes the analysis easier and prevents potential misinterpretations, a comparison of LBA indicates that Santa Catarina Park needs surveillance, and it cannot be regarded as a redundant step. Although allergenic pressure in the garden is currently minimal, its LBA of 0.326 indicates the presence of many allergenic taxa with high PAVs and long pollen seasons. Therefore, regular monitoring can be recommended as a preventive measure in the garden.

The presence of many long-season species is also an important feature characteristic of the Municipal Garden ($LS = 0.334$). Since climate change leads to warming and pollen-season lengthening, it is important to note that urban microclimate and long-flowering taxa are likely to play an increasing role [2, 14, 20, 26]. This fact implies that the Municipal Garden has to be managed seasonally.

Therefore, management should record the flowering windows for the dominant taxa, avoid practices that can trigger pollen emission during high-visitor periods, and inform people of high-exposure windows whenever possible.

Finally, two sentinel species need to be identified: *Parietaria judaica*, which is of clinical importance as a Mediterranean allergenic, and *Cortaderia selloana*, which was reported as an invasive allergenic plant. Although the former species is not necessary the current dominant contributor in the Funchal garden, it can be problematic from a long-term perspective, since it tends to persist in walls, edges and disturbed habitats [9, 10].

Similarly, *Cortaderia selloana* was described as a public health risk, and although the latter species does not seem to be the current dominant contributor in the garden, it can quickly become one under changed maintenance conditions [21].

Periodic checks of wall vegetation and unmanaged margins, as well as identification of grass-dominated patches, are more appropriate for allergenic management than repeated counting of ornamental taxa over time.

4.4. Management implications for each garden

The management implications for each garden follow the calculations presented in Figures 9 and 10. Santa Catarina Park is characterized by high tree evenness, low allergenic pressure and diversity-buffer effect, which implies the absence of the need for extensive measures.

Although it is better to avoid future dominance of high-PAV species, monitor sentinel plants and maintain an even canopy, management of Santa Catarina Park can be preventive rather than remedial.

In turn, the Municipal Garden needs specific action aimed at reducing the contribution structure and improving tree evenness. This garden has already lost its natural buffer and has to cope with excessive dominance of a small number of taxa exerting excessive pressure, which requires immediate action.

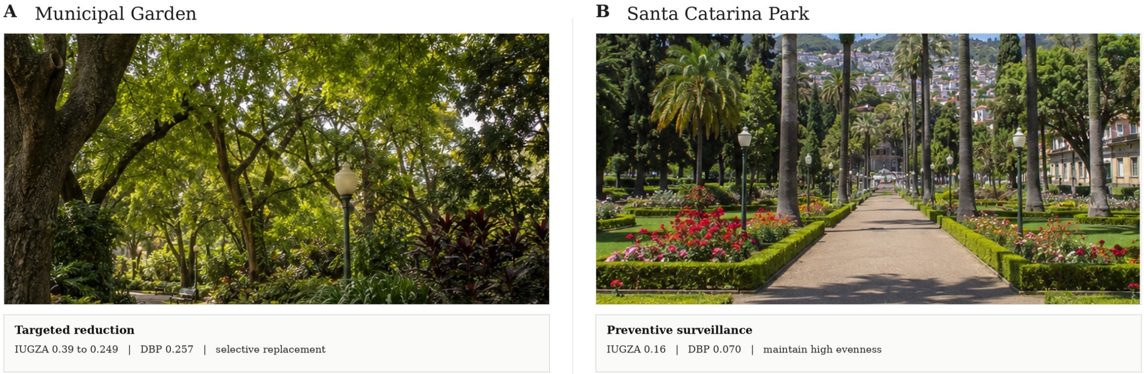


Figure 10. Garden management response.

However, the measures suggested above do not have to be extreme. Pruning the excessive growth of male *Ginkgo* trees, selective replanting of the dominant taxa with low-allergen species and careful management of visitor exposure to dominant contributors would help to decrease pressure without destroying the garden structure.

4.5. Model applicability and limitations

It should be noted that the proposed model can be applied to other sites, since all variables included in it are already common in most studies using the IUGZA method. Once the species identity, PAV, pollination strategy, pollination period, occupied surfaces, plant height, evenness, diversity and other values are collected, it is enough to use ordinary spreadsheet calculations. The resulting parameters are easily interpreted by landscape planners and public health specialists.

The only limitation is that the estimated values are based on the potential exposure; actual exposure depends on climatic factors, pollen production rates, visitors' movements and relative locations of allergens and people, and they also depend on the exact moment. For example, rainy days do not contribute to allergen transmission, but the diversity buffer is interpreted as a conservative value, which can be calibrated using local pollen data.

Additionally, the calculated reduction estimates assume that the replacement is proportional, which can be incorrect in real-life situations, since the cutting of excessive parts of plants can affect flowering and growth. Finally, replacing a tree takes certain time, and it can also influence air circulation.

These factors need to be addressed in field studies in Funchal.

5. Conclusions

To summarize the findings, it was necessary to determine why there is a difference in allergenic potential between the Municipal Garden and Santa Catarina Park of Funchal, what are the management responses for each garden. It became clear that Municipal Garden poses the greatest risk because it contains a greater contribution structure in combination with greater evenness. On the contrary, the second garden has more diversity, a greater likelihood of biological activation, but also lower contribution.

Thus, Municipal Garden is characterized by an excess of pressure, indicated by an IUGZA of 0.39 and a reduced DBP of 0.257, in which four taxa produce 72.54% of the total pressure. In this case, the garden can be improved by decreasing the contribution structure and increasing evenness. Replacing the entire high-contribution group of species with other ornamental taxa would reduce pressure down to 0.107, and reducing their contribution by half would also decrease pressure down to 0.249.

Therefore, the main recommendation for management is to act selectively on high-contribution taxa, leaving the garden structure largely intact.

On the contrary, Santa Catarina Park has minimal pressure, a very low DBP of 0.070, low contribution leverage of 0.234, and a significant probability of latent biological activation, since its LBA value equals 0.326. Consequently, Santa Catarina Park does not need extensive measures, since it has sufficient diversity to protect itself from dominance. Management should concentrate on monitoring sentinel species and preventing the formation of new dominance in the future.

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