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IMPORTANCE AND EVALUATION OF THE GREEN FRAMEWORK OF THE SAIDA AGGLOMERATION (WESTERN ALGERIA) USING A NEW APPROACH

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Abstract

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The aim of this study is to evaluate phytodiversity in urban environments. The new approach proposed in this work is based on the Saida conurbation. In order to assess the urban phytodiversity of the latter, the inventory and phytoecological diagnosis concerned 10 habitats (43 sites), for which we calculated an index (the Floristic Interest Index, FII), integrating information on the floristic richness index, naturalness (indigeneity) index, typicity index and rarity index of taxa. This new index identifies and classifies sites (sectors) and habitats of great interest for conservation and above all restoration, according to their degree of ecological importance. The results show that one suburban forest environment (fenced and more at the month monitored) had the habitat with high floristic interest index and two urban forest environments (open environment) had a medium floristic interest index. This is explained by the degree of impact of anthropic action and the presence of watercourses (riparian vegetation) for the first habitat.

Key words: evaluate, approach, FII index, anthropic, Saida.

Introduction

Biodiversity lies at the heart of nature in the city and cuts across the various services it provides; its preservation is fundamental at all scales (gene, species, habitat, landscape) (Clergeau, 2008; Aouadj, 2021) and is of concern, well beyond the circle of specialists, to government representatives and urban policy players (Pickett et al., 1997; Reygrobellet, 2007; Aouadj et al., 2020a-g).

Demographic growth and polluting industrial development are factors that accentuate the risks of altering our environment. In the absence of nature preservation, green spaces are becoming a necessity and a priority in view of the multiple functions they perform in urban spaces (Benmohamed, 2008).

The interest in preserving nature in the city is justified by the ecosystem services it provides. The Millennium Ecosystem Assessment (2005) recognises three main functions: provisioning (multiplicity of usable species), cultural services (education, aesthetics) and environmental regulation (pollination, biological control).

Initial inventories and analysis of the resulting typologies have shown that almost 50% of mobile species (birds, bats, flying insects, certain plants) are now found in cities. As a result, cities can no longer be regarded as unnatural spaces and their steady geographical expansion is increasingly raising the question of the responsibility of urban planning in biodiversity conservation (Clergeau, 2008). This preservation also involves the creation of green networks to link parks and green spaces, thus creating green grids. The development of green grids within towns and between town and country could become a new element structuring future land-use planning (Ahern, 2007).

In the absence of a clearly defined policy for promoting nature in general and green spaces in particular, there is currently no exhaustive assessment of the situation of green spaces in Algeria, nor any guidelines in this area.

All the master plans for urban development carried out across all the communes show a lack of management of spaces reserved for greenery. The absence of mandatory standards

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Fig. 1. Geographical location of the wilaya of Saida.

and the institutions responsible for enforcing them are the main causes of this appalling situation.

These observations lead us to recommend the introduction of a comprehensive policy for the development and management of green spaces in urban areas, which should help to empower the various players in charge of this task. This policy must be supported by effective structures (knowledge, management, financing .....) and translated into concrete projects.

In the city of Saïda, the state of green spaces is worrying, revealing a lack of policy strategy for their preservation and development.

The creation and expansion of cities and urban agglomerations, including the erection of high-rise buildings, create physical barriers that hinder pollination and plant seed dispersal, isolating communities demographically and genetically from one another (Pickett et al., 2004). This affects the dynamics of plant populations and has led to the total destruction of previously existing environments, making regeneration of the original ecosystem impossible (Kinzig, Grove, 2001; Wilcox, Murphy, 1985; Miller, Hobbs, 2002; McKinney, 2002, 2006; Boucher, Fontaine, 2010).

In addition, climate change (by increasing the frequency and intensity of extreme events) (Boucher, Fontaine, 2010) leads to the spread of invasive or disease-carrying species (Siron, 2010; Ferland, 2015; Clergeau, 2019; Aouadj et al., 2026) and pollution (Alberti, 2005) to the detriment of native vegetation (Boucher, Fontaine, 2010; Clergeau, Desire, 1999; Barnosky et al., 2011).

For this reason, we need to give serious thought to the problems faced by green spaces, which are reflected in the constraints that need to be identified and resolved.

An analysis focused on assessing the behaviour of all the forest species across the different types of green spaces in the city of Saïda will thus be an important part of improving the situation.

This ground-breaking study is a contribution to the understanding of plant diversity on the scale of a highly urbanised conurbation, with the aim of assessing the areas with the richest floristic diversity. To this end, the Floristic Interest Index (IFI) was calculated, combining the richness, indigeneity, typicality and rarity of the species present on a site (Muratet, 2006), thereby classifying habitats according to the importance of their contribution to the plant biodiversity of the Algerian conurbation.

Material and methods

Study area

The study area (Tellian Atlas of Saida) is located in the northwestern Algeria and occupies mountains and hills, representing a small part of a whole forest of the Saida mountains. It extends for about 20 km to the west of the city of Saida. The study area is located according to the longitude/latitude projection (WGS84) between 34.9674 degrees North, 34.8068 degrees South, 0.149499 degrees East and -0.1120236 degrees West (Aouadj et al., 2022).

The study was conducted over approximately 20000 ha of forest in Djefal, Makhnez, Guetna, and Ain El Hadjer. According to the Digital Terrain Model (DTM), the study area has a heterogeneous relief, mainly rocky, covering a total area of approximately 5624 ha, with an altitude between 580 and 1203 m above sea level and an average altitude of 950 m. The western sub-zone is characterised by a low altitude between 580 and 900 m (these are generally the valley bottoms and foothills), while the high altitude distinguishes the eastern sub-zone between 800 and 1203 m. Over 40% of the area is dominated by gentle slopes (0–5%), which characterise all the valley bottoms (land on the plains and the areas where the wadis spread out) and the lower foothills. Twenty-five per cent of the area has average slopes (5–15%) and characterises the low piedmont of hills (djebels and hilly areas). The remaining area (25%) has steep slopes (>20%), particularly towards the east, which causes soil erosion characteristic of the high foothills and summits of mountain ranges (Aouadj et al., 2023a-c).

In general, the study area is exposed in all directions. East and south-facing areas receive a significant amount of sunshine. The northern part, on the other hand, receives considerable moisture. These two factors are among the parameters that can explain the type of vegetation and land use in the study area.

The main soil and lithological units that characterise the soils in the study area are (i) Lithosols: These are fairly widespread and occur on almost all bare slopes. They are thin (generally less than 20 cm) and very fragmented. (ii) Brown-red soils: These include brown-red soils with a humus-rich horizon and light-textured Mediterranean brown-red soils.: These include brown-red soils with a humus-rich horizon and light-textured Mediterranean brown-red soils. These soils are found on the hills. They are formed on limestone or dolomite. They are rich in iron and silica. They are ancient soils that developed under the deciduous forest in cooler, wetter conditions. Their rubefaction corresponds to a warmer phase with sclerophyllous vegetation and gave rise to red fersialitic soils or terra rossa.

From a bioclimatic perspective, the area lies within a semi-arid climate zone with the presence of humid microclimates with a long dry spell lasting between 6 and 8 months, from the beginning of May to the end of October (the current dry spell is a month and a half longer than the previous one).

The thermal regime of the region is characterised by very high temperatures in summer and low temperatures in winter.

Table 1. The 10 habitats identified in the city of Saida.

Type of urban environment	Habitats	Nature of the environment
Semi-natural environment	Forest	Closed
	Rivers and wadis	Opened
Intermediate environment	Forest border	Intermediate
	Communication paths	Opened
	Railroad tracks	Opened
	Lawns (Pelousses)	Opened
	Urban wood	Closed
Urban environment	Wall and bitumen cracks	Opened
	Tree bases	Closed
	Residential	Opened

The highest temperatures are recorded in July and August, when they reach an average maximum of 36 °C for the new period and 34 °C for the old period, which corresponds to high evaporation. The lowest temperatures occur in February, with an average temperature of 9 °C for the new period and 8 °C for the old period and an average minimum temperature of 2.8 °C for the new period and 2.5 °C for the old period. The Emberger rainfall temperature index classifies the area as upper semi-arid (Q 2 =39), with a cool climate (Aouadj, 2021). The climate analysis of the study area reveals that annual average rainfall is irregular, with the study station receiving an annual average of 250–300 mm of rainfall (Metrological station, 2024) (Fig. 1).

Floristic interest index (FII)

According to Muratet (2006) and Muratet et al. (2007), the IFI is an average of four indices: species richness, indigeneity or naturalness, rarity and typicity:

- The floristic richness index corresponds to the number of taxa inventoried in a habitat divided by the total number of taxa observed in a habitat.
  According to Blondel (1979), Frontier (1983) and Ramade (2003), specific wealth (S): S = sp1+ sp2+ ..+ spn
- The native index is the proportion of taxa native to a site or habitat out of the total number of native taxa observed in the habitat (Muratet, 2006).
- The rarity index is the average rarity of each taxon sampled at a site or habitat, divided by the average rarity of all taxa (Muratet et al., 2007).
- The typicity index is the number of typical (characteristic) species of a habitat out of the total number of typical species (Muratet, 2006; Muratet et al., 2007).
- The overall index PII varies between 0 and 1, with habitats approaching 1 being of very high floristic interest (Muratet, 2006; Muratet et al., 2007).

PPI= ¼ (Rich/Rich max +Ind/Ind max + Rar/Rarmax+ Typic/Typic max).

Floristic inventory

The spring and autumn surveys took place during 2017 to 2024. One hundred and fifty floristic surveys were carried out in the habitat types covering our entire study area (Gehu, Rivaz-Martinez, 1981).

The number of floristic surveys carried out in each homogeneous habitat depends on the diversity of topo-ecological descriptors (Aafi et al., 1997).

Table 2. Summary of forest species inventory.

List of species by family		Numbers	Percentage (%)
Aceraceae:	*Acer negundo*	60	1 ,85
Anacardiaceae	*Schinus molle* *Pistacia lentiscus*	119	3,68
Caesalpiniaceae	*Ceratonia siliqua* *Gleditschia triacanthos*	318	9,85
Casuarinaceae	*Casuarina équisetifolia*	729	22 ,58
Cupressaceae	*Cupressus sempervirens*	422	13,07
Fabaceae	*Sophora japonica*	31	0,96
Meliaceae	*Melia azédarach*	03	0,09
Mimosaceae	*Acacia cyanophylla* *Acacia dealbata* *Acacia retinoides*	40	1,23
Myrtaceae	*Eucalyptus camaldilensis*	319	9,88
Oleaceae	*Fraxinus excelsior* *Olea europea* *Ligustrum japonicum*	47	1,45
Papilionaceae	*Robinia pseudacacia*	22	0,68
Pinaceae	*Pinus halepensis*	435	13,47
Platanaceae	*Platanus acerifolia*	227	7,03
Salicaceae	*Populus alba* *Populus nigra*	62	1,92
Simaroubaceae	*Ailanthus altissima*	125	3,87
Sterculiaceae	*Brachychiton populneum*	96	2,97
Ulmaceae	*Celtis australis* *Ulmus campestris*	129	3,99
Tamricaceae	*Tamarix galica*	02	0.8
Total	*Total*	**3286**	**~ 100 %**

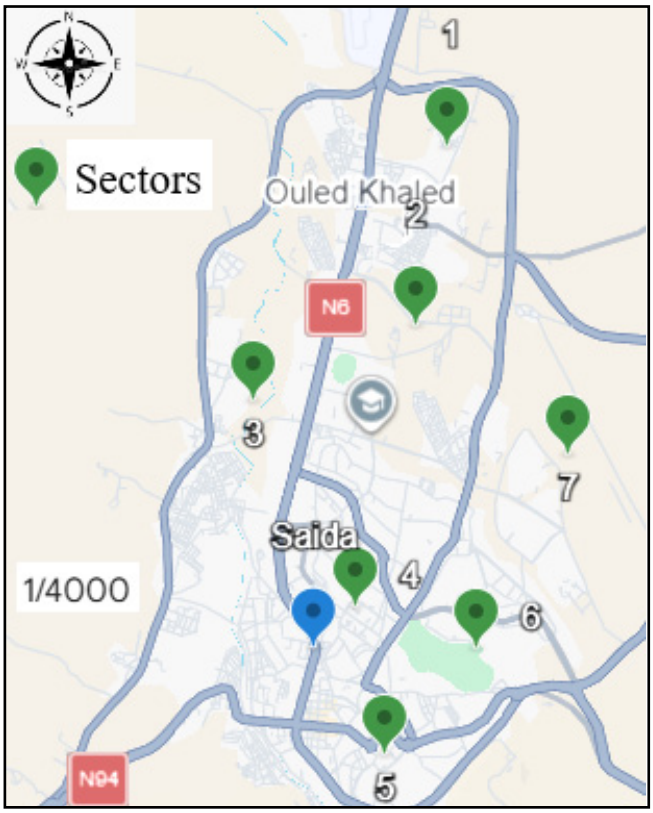


Fig. 2. Map of the distribution of sectors in the city of Saida.

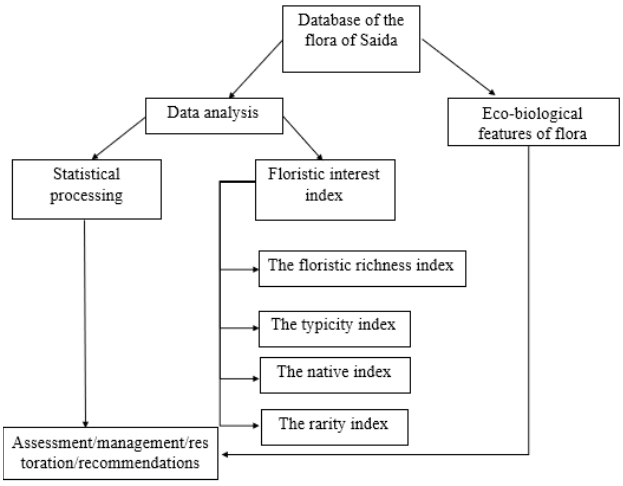


Fig. 3. Working principle.

Table 3. The 43 sites according to the total number of species inventoried.

Semi-natural environment		
Sites	**Richness (n° of taxa)**	**n° of species Naturalized**
El Ogbane forest	153	04
Mekimen forest	82	
Ilreme forest	97	
Saida river	80	
El halouf river	65	
Intermediate environment		
Forest border of El Ogbane forest	50	16
Forest border of Mekimen forest	31	
Forest border of Ilreme forest	39	
Railroad line of industrial zone	27	
Railroad line of Gare zone	21	
Railroad line of Elmejdoub zone	33	
Highway of Dar elbaida	24	
Highway of Saida	19	
Highway of Castor	28	
Wasteland boukhors	33	
Urban lawn Ryadh	27	
Urban lawn 5/7	17	
Urban lawn 20/8	29	
Urban lawn Amrous	33	
Urban environment		
Garden Ryadh	23	11
Garden 5/7	24	
Garden 20/8	26	
Garden Amrous	27	
Residential Nasr	14	
Residential Riad	19	
Residential Badr	12	
Residential 5/7	11	
Residential Dar baydha	15	
Residential Boukhors	22	
Residential Zitoune	20	
Residential Amrous	10	
Residential Castors	14	
Residential Sidi Cheikh	11	
Residential Graba	25	
Residential Sidi Gacem	28	
Residential Elmejdoub	30	
Residential gare	14	
Residential city center	19	
Residential AADL	18	
Residential 11/12	10	
Tree bases	19	
Walls and bitumen cracks	13	

Habitat sampling and identification

Target sites were selected based of field surveys distributed over (Table 1):

- Semi-natural environment: urban forest, suburban forest and riparian vegetation.
- Intermediate environment: freeways, railways and alignments.
- Urban environment: gardens, squares, traffic circles, villas, etc.

Green space ratio

The ratio generally used to assess the importance of the plant component within urban space is that of m^2 of green space per inhabitant:

Ratio= surface area of green spaces/capita. (1)

For the quantitative assessment of green spaces in the city of Saida, we used the Master Plan for Urban Planning and Development (Plan Directeur d'Aménagement et d'Urbanisme) map at a scale of 1:10,000, prepared by a consultancy firm, to first locate and then assess the importance of green spaces in the study area.

In the absence of any preliminary work to identify reliable urban sectors, the urban area was divided into seven sectors to facilitate our study (Figs 2, 3). This division was essentially based on the following parameters:

- housing typology,
- city districts.

Once the surface areas of the sectors had been calculated, it was possible to roughly calculate (since the work was carried out on a 1:10,000 plan) the ratio of green spaces per inhabitant in square meters. This is a vital benchmark for developing a sustainable green space management strategy for each sector of the city of Saida.

Results and discussion

The floristic inventory

The floristic inventory of the city of Saida has identified 75 families (the Asteraceae family is the most represented with 57 species, followed by the Fabaceae family with 52 species and the Poaceae family with 34 species) out of 420 species.

The studies conducted identified 367 native species (87.3%) compared with 53 naturalised species (12.6%), according to the floras of Dobgnard and Cahtelin (2010–2013) and Quezel and Santa (1962–1963). The number of species per site varies from 106 in more or less preserved areas to 5 in urbanised areas. The suburban forest contains the highest number of species with 183 (50% of the total), while the habitat (cracks in walls and asphalt) is home to only 7.6% of the species (Tables 2, 3).

According to the classification of Raunkier (1934), the therophytes dominate with 60%, the phanerophytes with 17%, the hemicryptophytes with 15%, followed by the geophytes (5%) and finally the chamaephytes with a low percentage of 3%.

Biogeographically, Mediterranean species dominate, followed by cosmopolitan, Eurasian, western Mediterranean, palaeotemperate, sub-cosmopolitan and Euro-Mediterranean, while endemic type, Eurasian-Mediterranean, Asian Mediterranean, Atlantic Mediterranean, Iranian-Turanian Mediterranean are represented at lower levels.

Dendrogram of the hierarchical ascending classification

Applying an ascending dendrogram (Fig. 4) to these surveys revealed three main groups among 150 surveys:

- Preserved sub-natural environments.
- Intermediate environments, more or less preserved.
- Heavily anthropised urban environments.

Using the information collected in the field, these are analysed from an ecological and floristic point of view. Based on the table of eigenvalues, only the first four axes were retained, with an inertia rate of 40%. The inertia of the other axes is low and

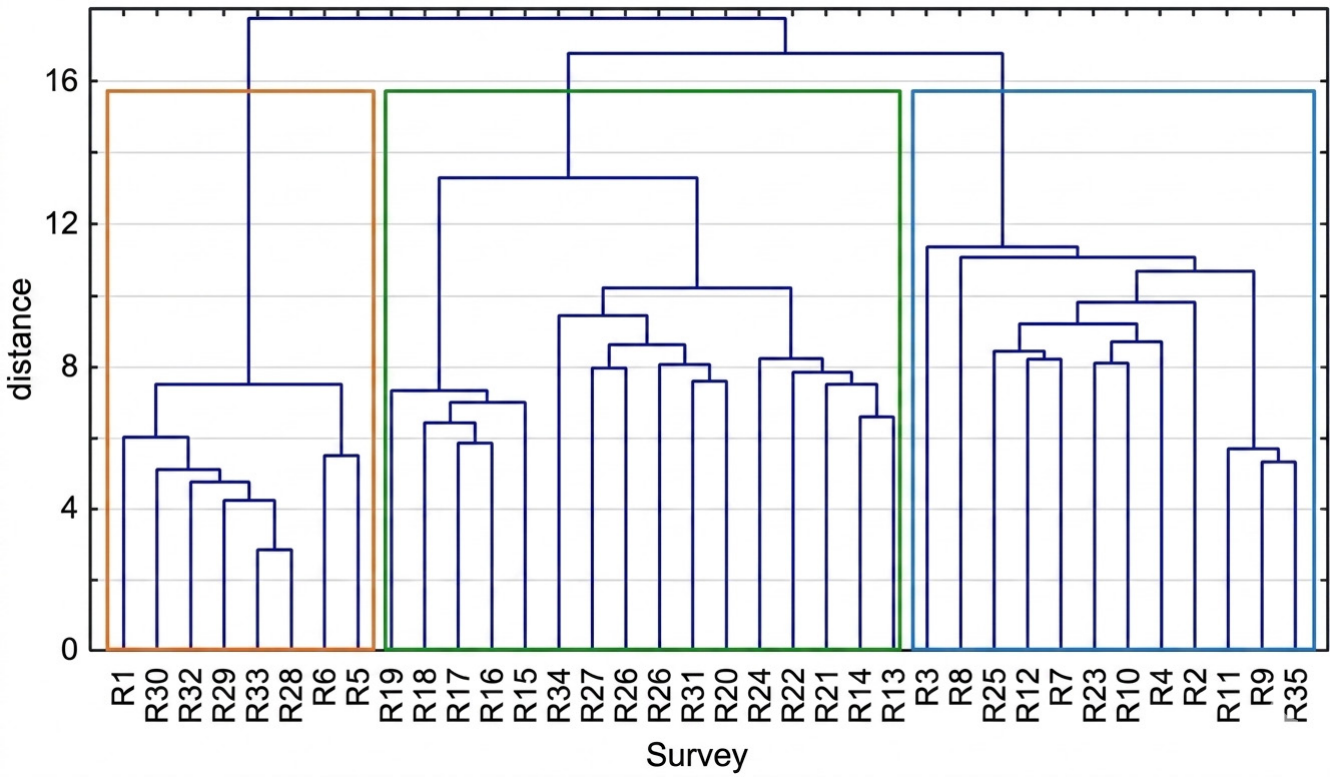


Fig. 4. Dendrogram of the hierarchical ascending classification.

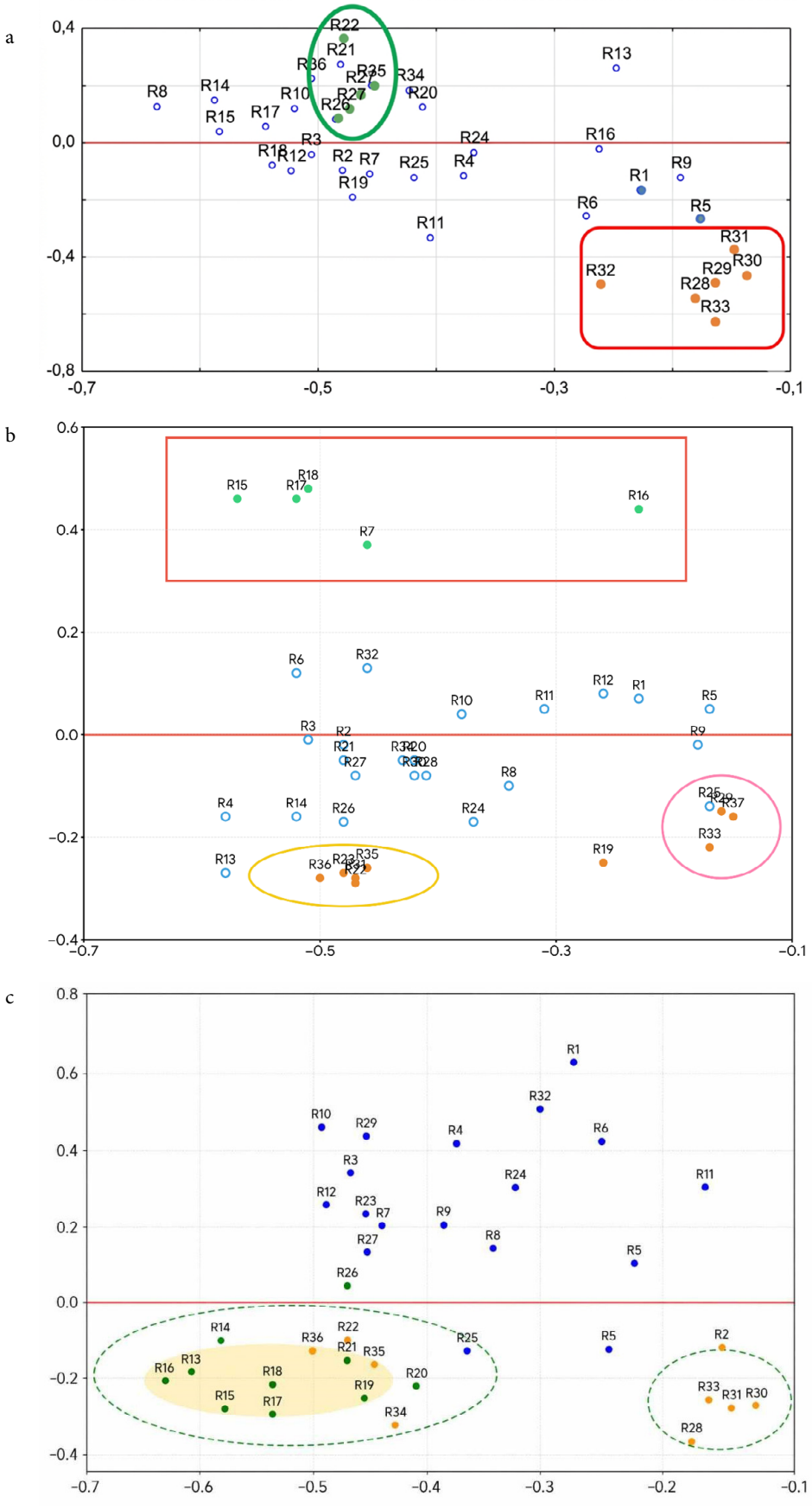


Fig. 5. Correspondence Factor Analysis (CFA). a: Axis 1; b: Axis 2; c: Axis 3

decreases rapidly (Table 4). Therefore, there is no obvious dominant and discriminating ecological factor in the urban environment; ecological factors and human activities act simultaneously. The factorial design of axes 1 and 2 of the CFA explains 28% of the total variance. This value, which can be interpreted as follows, is slightly less than one third of the total information (Fig.5):

- Group I is made up of five railway surveys forming a cloud of survey points grouped in the extreme negative part of axis 1.
- Group II: consists of 10 records. This group forms a cloud of points distributed along the negative part of axis 2.

It is made up of 1 subgroup: Surban woodland and housing.

It is composed of one subgroup: suburban woodland and housing.

Analysing the factorial level (1–2) and disaggregating the surveys into two groups, a gradient emerges: open environment (railway station), intermediate environment (derelict land proper) and closed environment (urban woodland).

Axis 3 shows the gradient of urbanisation from the town centre (avenues and roads).

The factorial design 1–4 has an inertia of 37% and is composed of the following:

- Group I is represented by the railways which are located in the positive part of the axis 4.
- Group II: is made up of the surveys located in the negative part of axis 4.

It consists of three 1 subgroup: dwellings. Axis 4 highlights the presence of a gradient of pollution that runs from the residential areas to the roads. The presence of ruderal species is characteristic of polluted and open environments.

Floristic Interest Index

By ecological habitat

Species richness varies from habitat to habitat. Forests are the richest ecosystems (sub-natural) with a species richness index of 0.46, natural and intermediate) with an index of 0.35 (Fig. 6 and Table 5).

The high proportion of native species was found in forests, which are rich in native plant species. Housing represents a highly anthropised environment. However, the Indigenousness Index is 0.28 and this high proportion of native species can be explained by the lack of maintenance of green areas, which favours the colonisation of the environment by native species. The rarity of a species corresponds to the rarity of the habitat.

The rarity of a species corresponds to the proportion of the habitat in which the species has not been observed. It varies between 0.99 and 0.24. The rarity index for the 10 habitats ranged from 0.99 to 0.80.

The sub-natural and intermediate habitats are home to a large number of typical species, which can be explained by the fact that they are more or less well preserved. In this case, the index of typicality varies from 0.2 for the habitat of the forest to 0.05 for the habitat of roads and trees.

The calculation of the floristic interest index for all habitats shows a variation from the subnatural environment to the urban environment. The habitat with the highest floristic interest corresponds to the forests, where the index is 0.49, followed by the wadis with an index of 0.40. In the intermediate environment, the index varies between 0.38 and 0.25 for wasteland and urban lawns.

Table 4. Eigenvalues and inertia percentages of the first factorial axes.

Axes	Valeurs propres	% d'inertie	% d'inertie cumulée
1	7.10	18.07	18.54
2	4.6	9.02	27.22
3	3.1	7.11	34.10
4	2.05	6.2	39.17

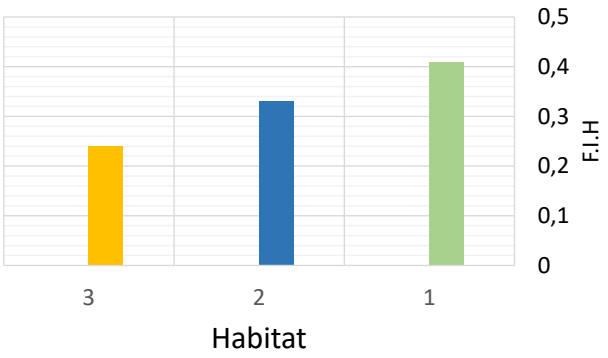


Fig. 6. Floristic interest by habitat (1 – semi-natural environment; 2 – intermediate environment; 3 – urban environment).

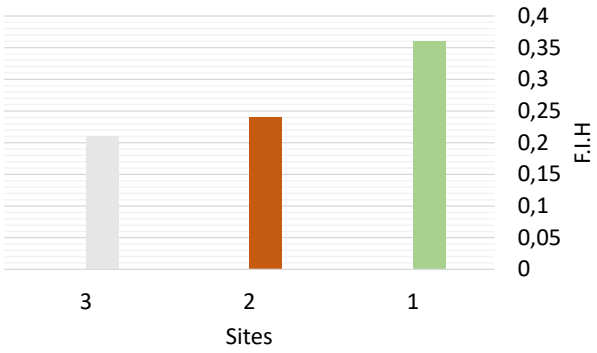


Fig. 7. Floristic interest by sites (1 – semi-natural environment; 2 – intermediate environment; 3 – urban environment).

Index of floristic interest by site

Sites with a high level of floristic richness were found in the sub-natural and intermediate environments, while the urban environment contains a smaller number of species and is therefore less rich. The most floristically rich site is site 5, with a richness index of 0.24, followed by sites 4 and 7, which are considered conserved. Taking into account that these sites are located in **an urban environment**, sites 31, 33 and 35 also have a relatively high floristic richness. This richness is explained by the high number of naturalised species, which represent 20% of the vegetation on these

Table 5. The richness of species, the indigénat, rarity and typicity by habitat.

Semi-natural environment				
Sites	**Richness**	**indigenat**	**rarity**	**typicity**
El Ogbane forest	0.38	0.43	0.87	0.21
Mekimen forest	0.31	0.33	0.88	0.19
Ilreme forest	0.3	0.32	0.84	0.18
Saida river	0.42	0.45	0.85	0.19
El halouf river	0.39	0.41	0.92	0.17
Intermediate environment				
Forest border of El Ogbane forest	0.29	0.27	0.81	0.14
Forest border of Mekimen forest	0.28	0.27	0.84	0.15
Forest border of Ilreme forest	0.28	0.29	0.8	0.14
Railroad line of industrial zone	0.24	0.26	0.8	0.04
Railroad line of Gare zone	0.26	0.25	0.81	0.05
Railroad line of Elmejdoub zone	0.24	0.24	0.8	0.06
Highway of Dar elbaida	0.25	0.24	0.8	0.14
Highway of Saida	0.22	0.21	0.8	0.15
Highway of Castor	0.2	0.21	0.81	0.16
Wasteland boukhors	0.2	0.22	0.82	0.15
Urban lawn Ryadh	0.26	0.25	0.81	0.14
Urban lawn 5/7	0.25	0.24	0.83	0.18
Urban lawn 20/8	0.25	0.24	0.81	0.19
Urban lawn Amrous	0.2	0.25	0.82	0.19
Urban environment				
Garden Ryadh	0.18	0.16	0.91	0.09
Garden 5/7	0.20	0.18	0.9	0.08
Garden 20/8	0.22	0.19	0.9	0.1
Garden Amrous	0.21	0.15	0.92	0.09
Residential Nasr	0.23	0.21	0.89	0.14
Residential Riad	0.22	0.22	0.89	0.15
Residential Badr	0.21	0.20	0.9	0.17
Residential 5/7	0.23	0.23	0.9	0.18
Residential Dar baydha	0.23	0.22	0.92	0.18
Residential Boukhors	0.25	0.23	0.91	0.18
Residential Zitoune	0.26	0.24	0.92	0.18
Residential Amrous	0.24	0.22	0.9	0.16
Residential Castors	0.23	0.2	0.9	0.17
Residential Sidi Cheikh	0.2	0.2	0.88	0.14
Residential Graba	0.24	0.21	0.87	0.15
Residential Sidi Gacem	0.25	0.23	0.88	0.14
Residential Elmejdoub	0.26	0.24	0.89	0.14
Residential gare	0.21	0.19	0.88	0.15
Residential city center	0.17	0.19	0.88	0.14
Residential AADL	0.19	0.17	0.9	0.15
Residential 11/12	0.2	0.18	0.88	0.14
Tree bases	0.12	0.11	0.80	0.15
Walls and bitumen cracks	0.15	0.13	0.81	0.15

sites.

The indigenous index calculated for site 6 (sub-natural environment) and site 38 (urban environment) varies between 0.27 and 0.005. The result for the latter can be explained by the high rate of naturalised species (30%) and the low species richness (0.04).

When analysing rareness by site, this index varied from 0.98 for site 40 (semi-natural) to 0.69 for site 37 (urban).

The sub-natural and intermediate environments are home to many typical species compared to the urban environment where there is no typicality. The Floristic Interest Index plot shows the IFI value across the 32 sampled sites. The sub-natural and intermediate environments appear to be the most floristically interesting sites, with an IFI of 0.35 for site 9 (sub-natural environment), which corresponds to the most floristically rich site. This is followed by sites 3 and 7.

An examination of the species richness index for the different habitats reveals high richness in woodlands, the latter being intermediate between natural habitats (woodlands) and heavily

Table 6. The richness of species, the indigénat, rarity and typicity by site.

Semi-natural environment				
Sites	**Richness**	**indigenat**	**rarity**	**typicity**
El Ogbane forest	0.31	0.26	0.93	0.07
Mekimen forest	0.3	0.27	0.93	0.08
Ilreme forest	0.3	0.08	0.91	0.06
Saida river	0.25	0.27	0.95	0.04
El halouf river	0.3	0.28	0.92	0.05
Intermediate environment				
Forest border of El Ogbane forest	0.22	0.16	0.81	0.04
Forest border of Mekimen forest	0.21	0.16	0.84	0.05
Forest border of Ilreme forest	0.22	0.12	0.8	0.04
Railroad line of industrial zone	0.21	0.14	0.8	0.04
Railroad line of Gare zone	0.2	0.14	0.81	0.05
Railroad line of Elmejdoub zone	0.2	0.09	0.8	0.06
Highway of Dar elbaida	0.22	0.1	0.8	0.04
Highway of Saida	0.22	0.1	0.8	0.05
Highway of Castor	0.19	0.07	0.81	0.06
Wasteland boukhors	0.18	0.08	0.82	0.05
Urban lawn Ryadh	0.24	0.11	0.81	0.04
Urban lawn 5/7	0.25	0.09	0.83	0.08
Urban lawn 20/8	0.25	0.08	0.81	0.09
Urban lawn Amrous	0.06	0.08	0.82	0.09
Urban environment				
Garden Ryadh	0.04	0.02	0.91	0.02
Garden 5/7	0.0.5	0.01	0.9	0.03
Garden 20/8	0.05	0.03	0.9	0.02
Garden Amrous	0.03	0.04	0.92	0.02
Residential Nasr	0.16	0.15	0.89	0.04
Residential Riad	0.2	0.17	0.89	0.05
Residential Badr	0.18	0.14	0.9	0.07
Residential 5/7	0.2	0.16	0.9	0.08
Residential Dar baydha	0.13	0.11	0.92	0.08
Residential Boukhors	0.13	0.14	0.91	0.08
Residential Zitoune	0.16	0.12	0.92	0.08
Residential Amrous	0.15	0.13	0.9	0.06
Residential Castors	0.14	0.14	0.9	0.07
Residential Sidi Cheikh	0.12	0.16	0.88	0.04
Residential Graba	0.15	0.15	0.87	0.05
Residential Sidi Gacem	0.15	0.15	0.88	0.04
Residential Elmejdoub	0.16	0.16	0.89	0.04
Residential gare	0.14	0.16	0.88	0.05
Residential city center	0.17	0.15	0.88	0.04
Residential AADL	0.19	0.17	0.9	0.05
Residential 11/12	0.2	0.11	0.88	0.04
Tree bases	0.12	0.1	0.80	0.02
Walls and bitumen cracks	0.15	0.1	0.81	0.03

urbanised habitats (residential).

Regarding indigenous species, a high proportion of indigenous species is found in forests. However, a relatively high indigenous index is observed in the vicinity of housing, which seems to be related to a lack of maintenance. Overall, the rarity index does not vary between habitats. Subnatural environments (forests) are home to a considerable number of typical species. In fact, the typicality index varies from 0.02 to 0.005 when we move along the roads from the forests to the wadis (Table 6, Fig. 7). The floristic interest index is higher in the forest environment, at around 0.5. It varies between 0.3 and 0.4 for the other habitats.

In general, the city of Saida was found to have 9% of naturalised species, which is relatively average. This value can be compared to a similar study conducted in Algiers (13%); Hauts-de-Seine (France), where 16.6% of naturalised species were found (Muratet et al., 2008); and Brussels, where 19.8% of vascular plants were reported as naturalised (Godefroid, 2001). The greater proportion of invasive species in urban areas is a general trend (Kowarik,

Table 7. The characteristics of each neighbourhood and estimation of the population of Saida.

Neighborhood	Population	Number of dwellings	Number of families	Surface area of green spaces
Nasr	3623	1920	575	7845 ha
108 logts	31	108	5	
45mai	148	72	23	
Lot sonaik	43	23	6	
Azhar	3219	638	511	
El fath	2614	595	415	
Badre	12325	508	1956	
208 logts	1910	208	303	
Lot badre	716	30	113	
Riadh	5203	566	825	
5.7	3133	652	497	
Lot maternité	967	126	153	
250 logts	1195	384	189	
400 logts	848	236	134	
Aoufi Miloud	1158	210	183	
Meghit Sayah	891	67	141	
Cite Soummam	3281	1000	520	
Cite amrous	2018	197	320	
Khater Abdelkader	1366	186	216	
Ali Boumendjel	1082	253	171	
Attig djeloul	869	134	138	
Lot Boukadda	2362	402	375	
Kerfouf Boudjlel		37		
Chahrouri		100		
Cite heureuse		220		
Cite com mdjdoub	7027	503	1115	
Sidi gacem		212		
Daoudi moussa	8493	1690	1348	
Bordj I et II	1950	477	309	
500 logts	Empty	-	-	
Sid chikh	2491	512	395	
Bokhors+1000 logts	30233	1090+2696	4835	
Centre ville	13431	9342	2132	
Castors	2052	1021	325	
Amir Abdelkader	1066	78	169	
Hay sallem	1628	243	258	
Yahi Abdeloihab		100		
Abdellah Ahmed		50		
Frères sadek	6088	765	966	
Saadaoiu kadda	5183	1115	822	
Zone industriel	583	Units	92	
Beau marche	488	143	77	
Lots sid chikh	7362	900	1176	
TOTAL	145710	29818	17436	

1995; Pyšek, 1998; Godefroid, 2001), explained by the presence of a complex network of roads, railroads, rivers and airports. These contribute to species dispersal and colonisation.

Exotic plants introduced for ornamental or other purposes include *Ficus* sp., *Eucalyptus* sp. and *Elaeagnus angustifolia* L.

The IFI, which combines objective quantitative and qualitative information on floristic diversity, can be used by managers of green spaces to make decisions on the preservation of natural biodiversity in urban areas within the framework of green networks and the maintenance of connectivity.

The IFI integrates four equally weighted variables (species richness, typicality, indigenousness and rarity).

The IFI provides information on both the number and 'quality' of the species present, unlike most approaches where the floristic interest of the site is generally estimated on the basis of species richness alone. The quality variables were chosen not only because of their relevance to conservation (Godefroid, Koedam, 2003) but also because they can be measured easily and objectively. IFI is a

simple, objective and repeatable index, which is easy and inexpensive to use in many cities that already have botanic data. As such, this index can be a useful tool for assessing the biodiversity of sites and habitats and for identifying priority areas for conservation.

Green space ratio

To calculate the ratio (sup green space/inhabitant), it is necessary to know the number of families per neighbourhood. Table 7 represents the characteristics of each neighbourhood and estimation of the population of Saida.

After the calculation, we obtain the following results (Table 8). The total surface area of the different types of green spaces in all sectors is around 67.44 ha, out of an urban fabric of 7,583 ha. This represents just 0.89% of the total urbanised surface area, a very low figure which gives an idea of the catastrophic situation of green spaces in the city of Saida.

With a total urban area of 7,600 ha and a population of around 146,000, the ratio of green space per inhabitant is just 4.60 m² at most.

It should be emphasised that this ratio represents the surface area reserved for green spaces; if we were to take the actual surface area of green spaces as a basis for calculation, the result would be an even lower ratio of around 1.5 m², one of the lowest figures in the whole country. This ratio is still a far cry from countries such as Turkey with 10 m²/capita, Paris with 18 m²/capita, Vienna with 25 m²/capita and Copenhagen with 43 m²/capita (Samuel, 1992).

According to the diagnosis carried out in terms of the ratio of green space per inhabitant in the city of Saida, the situation is not encouraging, with major constraints that can be summarised as follows:

- Spaces set aside for greenery and leisure activities are under constant attack, and their initial vocation is being transformed into built-up areas.
- A constant reduction in the area of green spaces in favour of subdivisions and urban extensions, which are often unjustified and unacceptable.
- A lack of regulation, especially at local level, since there is a law governing green spaces.
- Rehabilitation measures underway are minimal and do not have a significant impact on the ratio.
- Lack of a local policy to preserve and extend green spaces.
- Poor choice of species and typology of green spaces.
- The city's gardens are in a very advanced state of deterioration, as a large number of plants have disappeared due to lack of maintenance and neglect. This is particularly evident as in the case of the Riadh public gardens and, above all, the Amrous garden, which is in a very advanced state of deterioration and is on the verge of collapse.
- Public squares are also abandoned and poorly maintained, with only a few very sickly and deformed plant species surviving.
- For several decades now, there has been an obvious lack of care for green spaces, for a variety of reasons, each as worrying as the next, as evidenced by the state of all the green spaces.

Conclusion

The exhaustive inventory of forest areas introduced into Saida's green spaces confirms that they are quite diversified, with no single strategy in terms of choice of species and type of tree. The main observations are a mix of species that are often ill-suited and poorly trained due to ecological unsuitability and a poor choice of forest species, both aesthetically and architecturally.

Table 8. The ratio of green space per inhabitant.

Sector	surface area of green spaces	population	ratio
1	10.2	34 949	2.91
2	1.85	22 585	0.82
3	2.68	30 233	0.88
4	7.42	23 670	3.13
5	15.39	19.40	8.08
6	0.63	12 733	4.94
7	29.47	2500	0.01
Total	**67.44**	**146 000**	4.60

A qualitative and quantitative analysis of the various green spaces in Saïda also shows that the ratio of green spaces per inhabitant is only around 4.60 m², a figure still far from the 15 or 21 m² recommended by the AMM. Despite the natural potential of the area (climate and soil in particular) and the irregular distribution of green spaces within the urban fabric, some new districts have virtually no green spaces at all, confirming the total absence of preliminary studies in this area at the time of urbanisation.

The study carried out reveals an unexpected level of biodiversity in urbanised environments, particularly in the Saida conurbation, in comparison with other metropolitan areas. In many cities around the world, the introduction of exotic species has depleted the local flora. In Saida, however, the opposite is true, with a typical forest herbaceous flora enriching the city's arteries.

This can only be explained by the use of soil taken from neighbouring forests for the production of nursery plants by the department in charge of green spaces in Saida.

Sub-natural habitats, such as forests and wetlands, are of great interest from a floristic point of view and constitute the main reservoir of native biodiversity in the agglomeration.

Particular attention needs to be paid to these sites, which are characterised by a high IFI and are of potential interest and would fully justify a new paradigm for managing nature in Greater Saida.

This work represents an initial approach to urban ecology applicable to the Saida conurbation. It will involve intensifying the sampling of numerous habitats and sites, which will allow a more precise identification of floristic diversity and its conservation in the context of a sustainable city.

In order to overcome these shortcomings, it is important to know the behaviour of these species, which constitutes a starting point for setting up a strategy and managing them in an urban environment. It should also be noted that the success of any plantation depends on the right choice of forest plant species adapted to the climatic conditions of the region.

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