

Arboreal vegetation parameters and indices in urban parks explained by multivariate analysis

MARIUS SILIVĂȘAN¹, FLORIN SALA^{1,2*}

¹University of Life Sciences "King Mihai I" from Timisoara, 300645, Timișoara, Romania

²Agricultural Research and Development Station Lovrin, 307250, Lovrin, Romania

Abstract: The arboreal vegetation in the Cathedral Park in Arad Municipality was considered in the analysis. Thirty-five deciduous and coniferous tree specimens were recorded. Various morphological parameters and specific indices were evaluated: metric factor (MF), Age (years), circumference (Circ, cm), growth factor (GF), trunk diameter (TD, cm), plant height (PH, m), crown diameter (CD, m), density index (DI), crown height (CH, m), crown volume (CV, m³), crown projection (CP, m²), ecological value (EV), and global value (GV). Multivariate analysis explained the relationship of parameters and indices in relation to the Principal Components and quantified the mode and intensity of action of each. Nine parameters and indices were loaded in PC1, with positive action and variable intensity, from $r = 0.786$ (Age parameter), to $r = 0.917$ (CD parameter). Two parameters were loaded in PC2, with negative action, of very strong intensity ($r = -0.918$, MF parameter; $r = -0.917$, GF parameter). In PC3, the DI index was loaded, with positive action, of strong intensity ($r = 0.776$).

• Introduction

Urban parks are structural and functional elements of urban ecosystems, with multiple functionalities and benefits for people [13], [16], [4], [6]. The integration of trees into urban ecosystems (e.g. parks) has been studied in relation to climatic conditions, the level of urbanization, the degree of adaptation of plants, visitor preferences, and the benefits provided to the population [12], [9], [11]. Monitoring and evaluating trees based on dimensional parameters is important for describing the functionality of urban ecosystems [10]. Tree crown dimensions (e.g. crown widths) in urban areas represent an important indicator for assessing tree health, leaf area and ecosystem functions [14].

• Material and method

The study used multivariate analysis and correlation methods to explain parameters and indices of arboreal vegetation as a component of a park in the urban ecosystem. For this study, data resulting from the vegetation assessment of the Cathedral Park, Arad Municipality were used. Plant specimens from the park area were noted, by plant species, and data related to specific parameters and indices were recorded: metric factor (MF), age (years), circumference (Circ, cm), growth factor (GF), trunk diameter (TD, cm), plant height (PH, m), crown diameter (CD, m), density index (DI), crown projection (CP, m²), crown height (CH, m), crown volume (CV, m³), ecological value (EV), global value (GV). The recorded data were analyzed mathematically and statistically, in relation to the purpose of the study. PAST software v 4.14 [7] was used for data analysis and figure generation.

• Results and discussions

Based on the values of the coefficient of variation (CV), low variability was assessed for the DI parameter (CV = 10.66), moderate variability for the MF parameter (CV = 22.04) and the GF parameter (CV = 22.09) and high variability for the other parameters and indices. The multivariate analysis generated the loading of the parameters and indices in relation to the Principal Components and quantified the mode and intensity of action of each, under conditions of statistical safety ($p < 0.001$). In PC1, nine parameters and indices were loaded, with positive action and variable intensity, from $r = 0.786$ (Age parameter), to $r = 0.917$ (CD parameter), Table 3, Fig. 2. In PC2, two parameters were loaded, with negative action, of very strong intensity ($r = -0.918$, MF parameter; $r = -0.917$, GF parameter). In PC3, the DI index was loaded, with positive action, of strong intensity ($r = 0.776$). The Circumference parameter (Circ) occupied the uniqueness position. Correspondence Analysis (CA) was used to evaluate the relationships between categorical variables (specimens, parameters) and generated the multivariate ranking, with the Eugenvalue values in Table 6 and the Scatter plot diagram in Figure 4. The correlation analysis indicated the interdependence between the parameters considered in the description of the vegetation in the Cathedral Park, Arad Municipality, based on the values of the correlation coefficient, Fig. 7. Positive and negative correlations of different intensity levels between the considered parameters were recorded. The results of the present study described the variability of the parameters and indices considered in the vegetation description and the study area, explained the relationship of the parameters with the principal components, the association of the parameters with the plant specimens, and described the interdependence relationship between the parameters in the vegetation description.

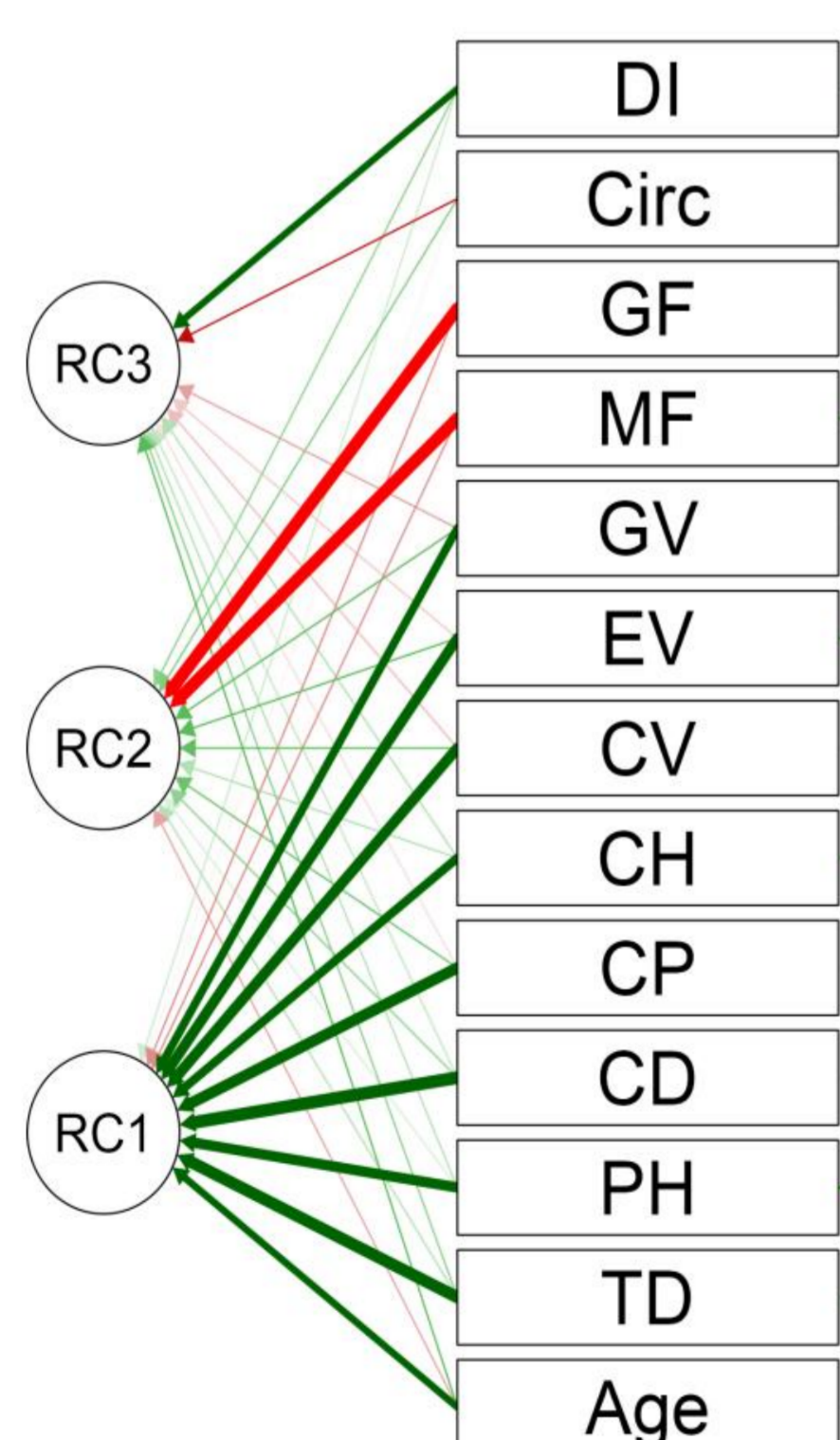


Figure 2. Expression of the relationship of parameters (components) in principal components

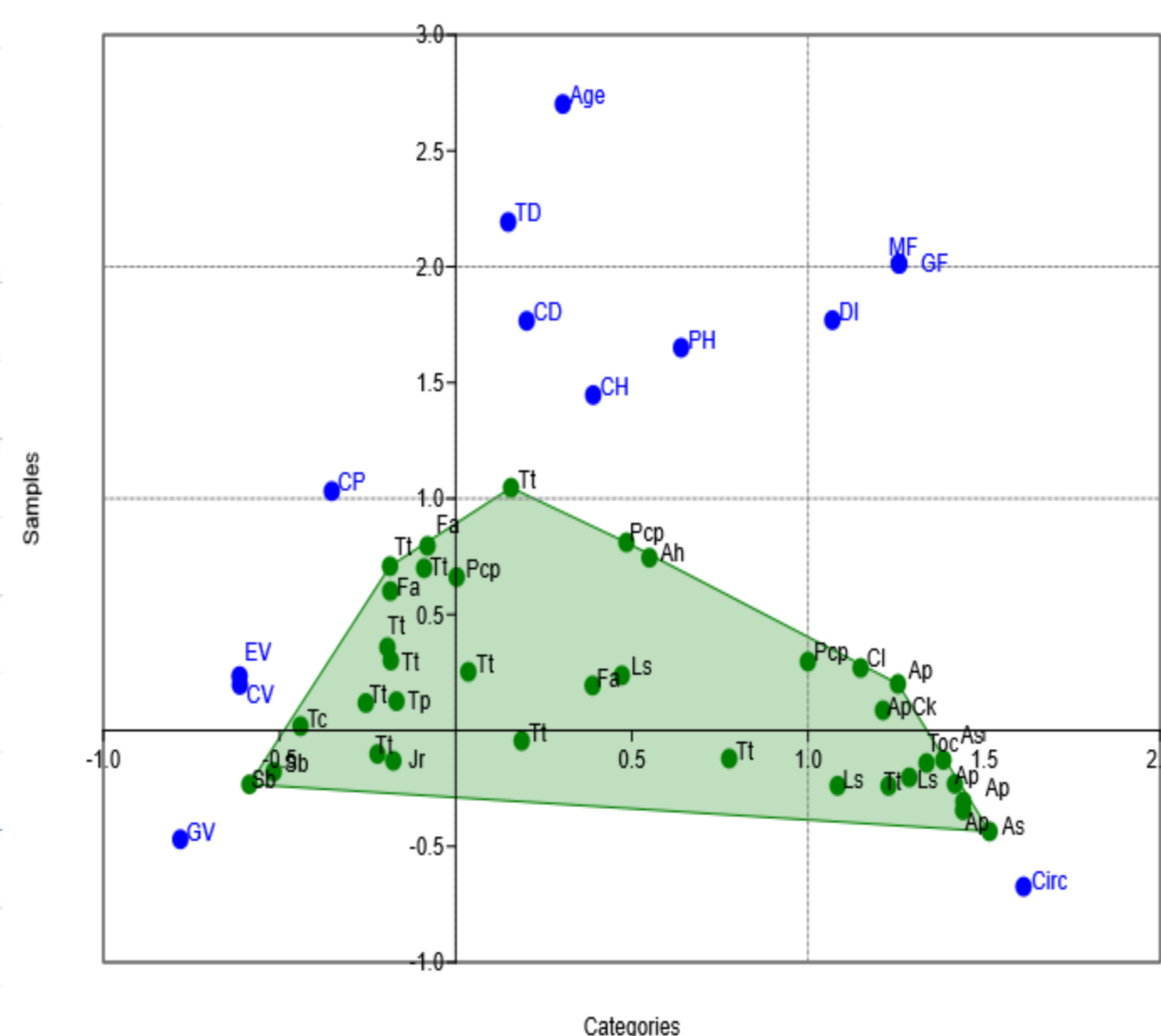


Figure 4. Correspondence analysis scatter plot; green dots - rows (specimens), blue dots - columns (parameters)

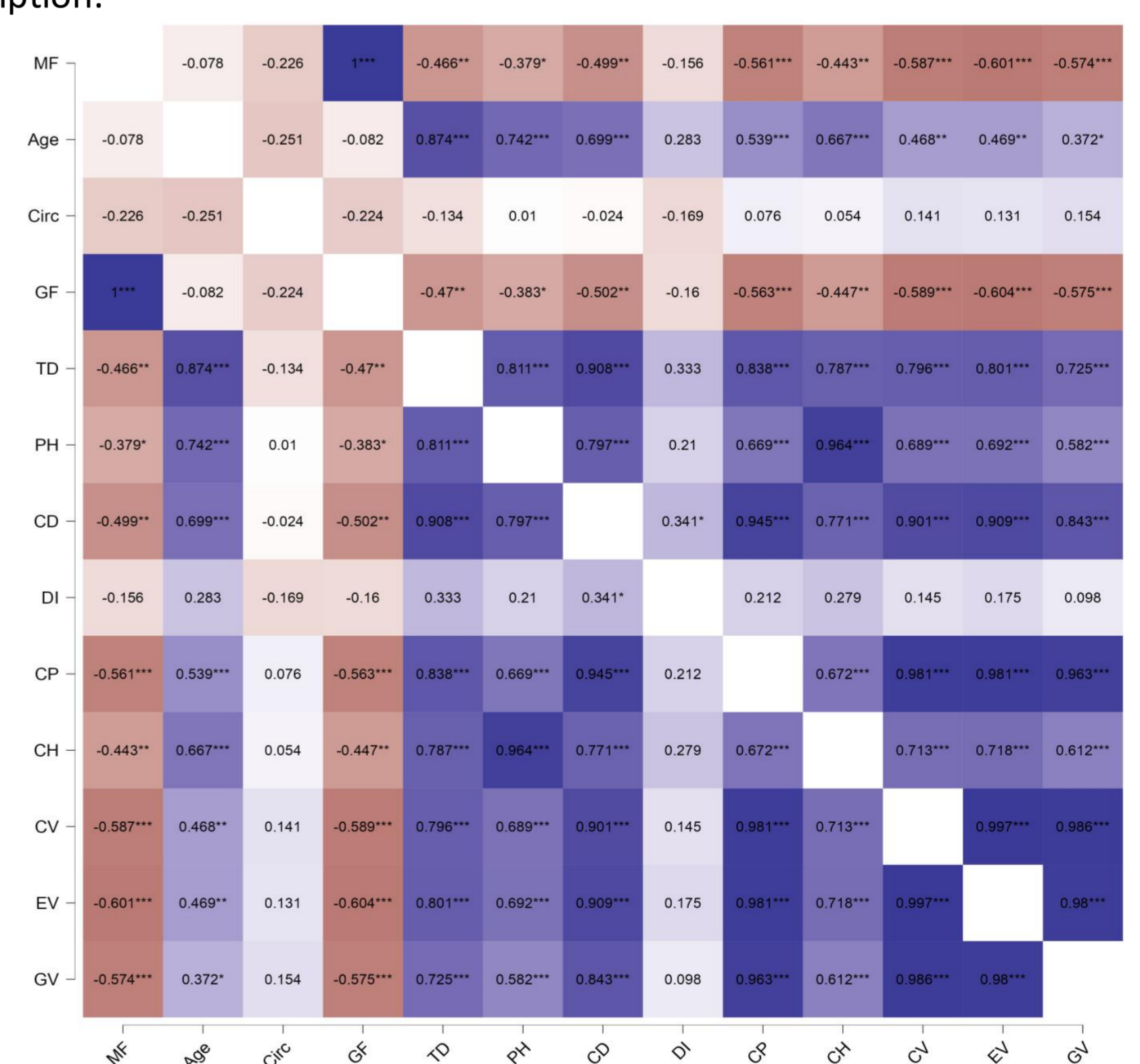


Figure 7. Correlation matrix between vegetation description parameters

• Conclusions

The data series, represented by 35 records for each parameter and index of the arboreal vegetation studied in the Cathedral Park, Arad Municipality, presented a normal distribution, under conditions of statistical safety. Low variability was recorded for the DI parameter (CV = 10.66), moderate variability for the MF parameter (CV = 22.04) and the GF parameter (CV = 22.09), and high variability for the other parameters and indices. Differential association of specimens with characterization parameters and indices was recorded. The KMO (Kaiser-Meyer-Olkin) test indicated the adequacy of the sampling, a strong data structure, with values ranging from 0.725 (Circ parameter) to 0.856 (GV parameter). The results are important for the study of plant samples in urban ecosystems, and can be considered in certain analyses for the identification of plants, considered as "key species" and the generation of response models in relation to environmental factors, especially stress factors, or in relation to ecosystem services.

Acknowledgement:

Publishing of this journal is supported by the Institute for Plant Biotechnology of the University of Life Sciences "King Mihai I" from Timisoara.