SUMMARY

Key words: *urban trees, models, predictabilities, aesthetic benefits, ecosystem benefits/disservices*

Woody vegetation is the main natural element of the urban landscape, representing the green skeleton of landscaping. Trees develop their own way of adapting to urban site conditions and to design constraints due to urban infrastructure. The process is conditioned by the interaction of *species-specific* (species specificity) and *site-specific* (site specificity).

The development of the cities in the 20th-2st centuries was made in such a way so that in the cityscape the report mineral / vegetable would favor the mineral. Urbanism normative and country planning proved to be effective in the middle years of the twentieth century, but the growth and development of vegetation in urban conditions showed its "limits" to the late twentieth century, which led to the need to develop the *framework* concept *green / blue infrastructure* as environmental policy for all the countries of the Community. After 2005-2010, the new concept, that of *ethical management of resources*, defined by the sustainability process, changes the paradigm *human - spotlight* and places the *habitat, the ecosystem* in the central plan, with the human as part of them. The new environmental policy defines the overall principles of sustainable development of urban sites as part of a global whole, linked by means of the *green corridors* - landscaping subject to conservation, restoration and preservation to become *ecosystems*.

Landscaping solutions, according to the doctrine of *green liberalism* (Stephens, 2001) are that by means of which "*the negative impact of urbanization*" of the urban landscape is "*neutralized*" (Elewa, 2014). By using the principles and elements of *green and blue infrastructure* originality and daring approaches are promoted, both creatively and constructively.

Ornamental tree species are the main plant component of urban *green infrastructure*, and for this reason, the estimation *of the aesthetic and ecosystem benefits (services) and disservices* is an important indicator of "*our economic and social well-being*" (European Commission, 2010b). The estimation aims at both existing green areas and at those projected, both analyses being of paramount importance in order to implement *optimized landscaping solutions* within

green and blue infrastructure as "*sustainable and intelligent infrastructures*" (Courtney *et al.*, 2013).

The doctoral thesis is structured following a work scheme according to an own design (fig. 1.). By analyzing six ornamental tree species, mainly used in green areas in Iasi (Sandu, *et al.*, 2012), the entire study developed and presented in detail in the doctoral thesis proposes a methodology – *the flowchart diagram of the evaluation path* - by means of which the selection of the *landscaping solution* for different types of sites, identified as a method of landscaping intervention, is made based on an analytical structure.

Each chapter presented in the thesis covers segments of *input* data required for the processing stream of analytical scheme for each species. Also, each chapter and sub-chapter addresses a specific area of interest concretely analyzed, at the end of which *observations* are presented.

The range of regression functions and models obtained by the processing of data-sets, annexed to the thesis (direct measurement, calculation and software processing) offers in a phased way, *analytical-numerical values*, either we refer to the structural parameters of trees (sizes, shapes or volumes) with reference to its aesthetic appearance and evaluation, or the analysys referred to the estimation of the detailed *ecosystem benefit* (issuance of O_2 and VOCs, retention of the categories of pollutants or the hydrological intake, by avoiding runoff). These *analytical-numerical values* were subjected to comparative analysis, on species, obtaining actual and ponderal values, presented at the end of each chapter.

But pursuing the framework concept of *green infrastructure*, that through which rigid approaches from landscape design should be avoided, the landscaping design being, above all, an exercise of art those results were considered as *a database*. Since each parameter modeling was performed by reference to the same dependent variable, trunk diameter measured at the height of 1.4 m above the ground (*equivalent diameter at breast height - DBH eq.*), the entire set of graphical and analytical-numerical data obtained show *homogeneity and interconnection, a* necessary and sufficient condition so that the data panel can be integrated in *the flowchart diagram of the evaluation path* of the proposed or existing landscaping projects, in order to identify the *landscaping solution*, through *optimization*.

The entire approach structured on specific areas - *aesthetic and environmental* - was developed in order to deliver results that constitute, for each species, data sets which can be integrated in *the flowchart diagram of the evaluation path*, eliminating subjective implications.

Direct *input data-sets* from the flow of *the flowchart diagram of the evaluation path*, and the intermediate (additional) *output-input* ones aim at the tree as *element* and the full realization of the database introduced for the *optimization of the landscaping solution* can be done *per each*

item and as a whole (through multiplication or as an amount of each item parameters). For this reason, the end result – *landscaping solution* chosen - based on the issue of *predictability* converging to create a *scenario* materialized spatially and temporally, has a high degree of accuracy, typical fot *deterministic simulation systems*, where the process and relationships are known (known set of *inputs* that lead to a single set of *outputs)* (Mehta and Johnson, 2011).

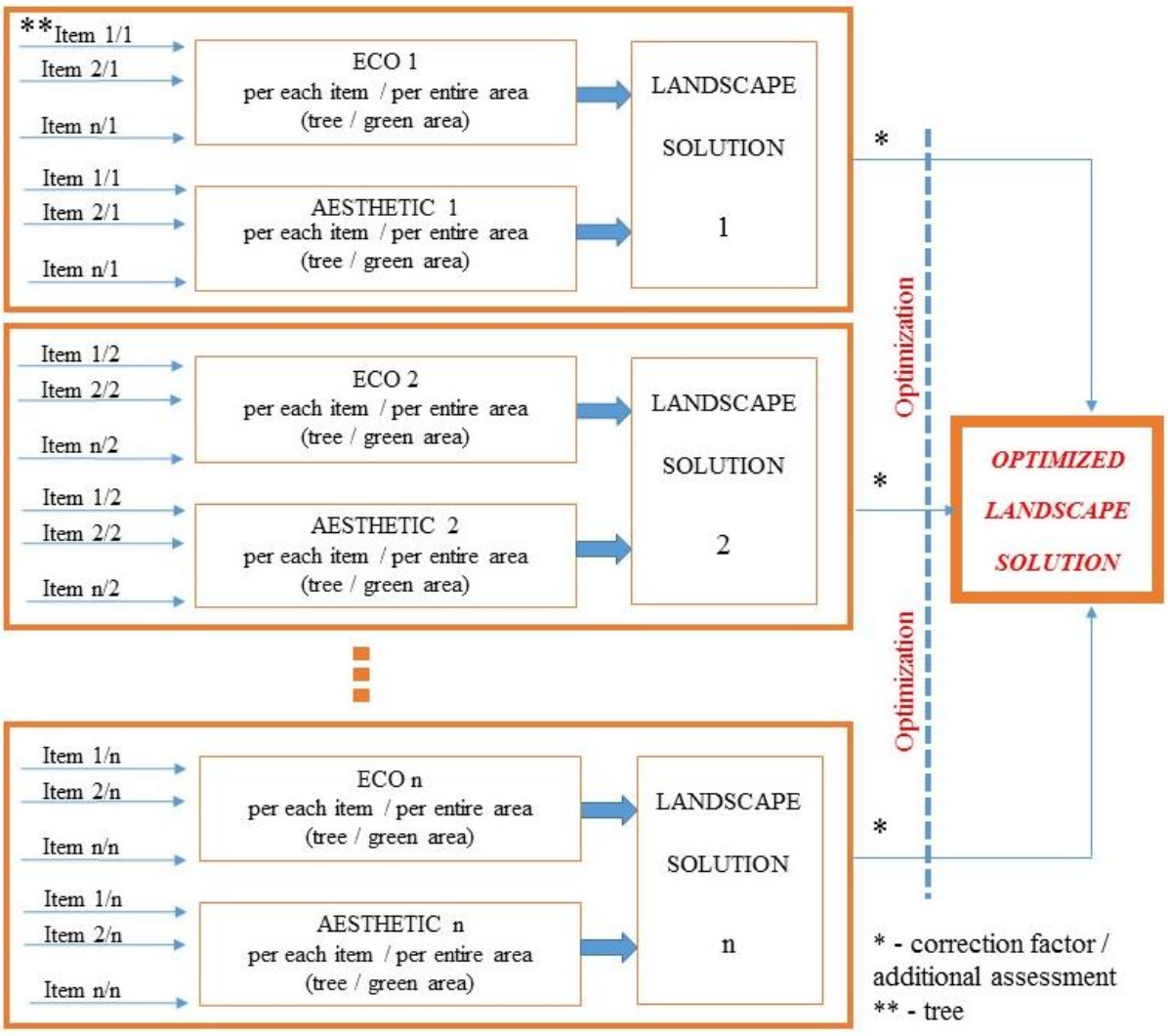

Fig. 1. The flowchart diagram of the evaluation path; landscaping optimization solutions (original)

The structure of *the flowchart diagram of the evaluation path* (fig. 1.) is made so that it can be used in all three types of green landscaping projects in which *green urban infrastructure* includes tree species: 1. *landscaping projects made by fully using existing ornamental woody vegetation for which only maintenance works are provided - conservation and/or landscape restoration* project; 2. *landscaping projects made by partly, using the existing ornamental woody vegetation, requiring design for landscaping rehabilitation and/or restoration*; 3. *landscaping*

projects made for empty surfaces, without ornamental woody vegetation, and for which a totally new project of landscape planning is suggested.

The type of research addressed in the doctoral thesis is that of the processing of data obtained in a limited time - "*short-term studies and performance evaluation*" (McPherson and Peper, 2012).

Doctor's degree thesis entitled **"RESEARCH ON USING ORNAMENTAL HORTICULTURAL SPECIES IN THE PRESERVATION AND RESTORATION OF THE LANDSCAPE"** is structured in two sections and contains eight chapters. The structuring of chapters focused to obtain all the necessary data (in graphical and analytical-numerical form) which are established as *input data* in *the flowchart diagram of the evaluation path* flow (fig. 1.) for six tree species (Norway maple (*Acer platanoides L.*), Horse chestnut (*Aesculus hippocastanum L.*), Linden (*Tilia* sp. *M.*), Cherry plum (*Prunus cerasifera* Ehrh.), Catalpa (*Catalpa bignonioides* Walt.) and Norway spruce (*Picea abies* Karst.)).

In the first part, Chapter I - GENERAL CONSIDERATIONS - are developed the concepts underlying the structure based on which the doctoral thesis was elaborated, and aims at defining both the terms and the theories and concepts that justify the necessity and usefulness of the research topics. In the thesis were defined the notions of *landscape, urban landscape, natural and manmade structures*, the range of rules based on which they were designed, as well as the current and future vision on the policies of *green liberalism* doctrine. Also, this chapter presents the current state of research on *the growth and development of ornamental horticulture species in urban site conditions* and their role in *the preservation and restoration of the urban landscape* in the implementation of the *green infrastructure* concept. Following the latest research in the field of mathematical modeling and simulation, of drawing environmental, planning and landscaping *predictabilities and scenarios*, which are based on computer applications, in the end of Chapter I the concepts are presented on the development of *urban green spaces management* and *landscape optimization solutions* in terms of the contribution of ornamental horticultural species – an important part of *green, sustainable and intelligent infrastructure*.

In Chapter II – PRESENT STATE OF KNOWLEDGE – are shown the concepts that describe the theories and models which represent the theoretical and experimental support of the research topic of the doctoral thesis, aiming at two levels of study: *benefits to urban landscape brought by ornamental horticultural species by aesthetic and ecological attributes.*

In the second part of the thesis, in Chapter III - PURPOSE, OBJECTIVES, MATERIAL AND METHOD OF RESEARCH – are presented in detail *the need and purpose of research*. They are embodied in the form of an original *flowchart diagram of the evaluation path* of own

conception. The *research material and method* include *the organizational structure of the experiment*, description of the urban *sites* where measurements were conducted, and respectively, *vegetal material* presentation, the six ornamental tree species, with important weight in the study area. Research techniques use specific tools in which *data processing, mathematical modeling, graphical representation and statistical analysis* was performed on advanced *IT software* support.

In Chapter IV - DESCRIPTION OF THE STUDY AREA. URBAN SITE CONDITIONS - are described *orographic, hydrographic, soil, climate, air quality conditions* and *type of vegetation and fauna*, respectively. The informations are presented in detail, and for the climate and air quality conditions it was made the trend analysis for the period 2004-2013, as this is part of the support *input* for the data processing software procedure (*i-Tree Eco Applications*) as *site specificities*.

Chapter V - RESULTS OBTAINED BY FIELD MEASUREMENTS, SOFTWARE APPLICATIONS AND CALCULATIONS – presents in detail the *methodology for obtaining the parameters necessary for mathematical models, terminology and notations* used and the parameters obtained by *direct measurement, software* and *computing technique* which form at their turn the data-sets required to develop models and charts - *input data* for the structure of *the flowchart diagram of the evaluation path* of landscaping project, covering the informations about the six ornamental tree species.

Chapter VI - RESULTS: TOWNSCAPE AESTHETIC BENEFITS PROVIDED BY ORNAMENTAL TREES - analyzes the benefits brought to urban landscape by the aesthetic aspect of trees, through the morphological and biometric characteristics reported to landscape theory elements with practical applicability in facilities created by the principles of landscaping design, as a means of artistic expression. In the first part of the chapter are analyzed and determined the assumptions related to the standards of the landscape design technique, so to have the same basic results reporting (mature size) in the processing and interpretation of all mathematical models (uniformity and data interconnection). Aesthetic attributes and the range of landscaping solutions they generate are analyzed sequentially, aiming at an own presentation structure. Interpretation and evaluation was performed both a centralized level and in a phased manner for each sub-chapter and presented at the end, as *comments*.

Chapter VII - RESULTS: TOWNSCAPE ECOSYSTEM BENEFITS (SERVICES) AND DISSERVICES PROVIDED BY ORNAMENTAL TREES - presents in detail the results concerning the *atmospheric pollution removal, hydrological implications* and potential *disservices* caused to the environment by using these six ornamental tree species. Interpretation

and evaluation of results was made in a phased manner for each sub-chapter and presented at the end, as *comments.*

The results obtained (Chapters VI and VII) come from the processing of data-sets resulting from measurements, software calculation and processing (Chapter V) by means of mathematical (analytical-numerical) and graphical procedures with statistical assurance. Their processing was performed up to form in which they can be interpreted on the one hand by direct analysis, and on the other hand integrated into a *flow of relationships*, at the end of which the *landscaping solution* resulted is the optimal solution regarding the contribution of tree species on the *urban landscape* defined as "*part of the territory subject to the action of natural and / or human factors and their interrelations"* (European Landscape Convention Florence, 2000). The results obtained through the research conducted refer to the most important types of *benefits (services) and disservices* obtained by the urban landscape by using tree species (McPherson and Geiger, 2005). By default, the manner of optimization of the *landscaping solution* by the flow of information processed through the *analysis scheme* is one with consistent support of data structured in *static and dynamic-deterministic* interrelated systems (Mehta and Johnson, 2011).

Chapter VIII - DISCUSSIONS, CONCLUSIONS AND RECOMMENDATIONS - relates to the presentation of *the way to follow* for automatic integration (without excluding their use in a manual way) of the results obtained. They become useful only if *optimization of landscaping solutions* is pursued (urban planning with *tree vegetation*) by implementing data (*analytical-numeric values* or *regression functions*) into the information flow of *the flowchart diagram of the evaluation path*. The conclusions present in a condensed manner the contribution of each species, spread over analysis segments, in a *descending ordering* manner according to the averages obtained by generating mathematical functions (*best fit*) relative to "mature size" of DBH *eq*. Recommendations aim at both the practical applicability of research, and the opening of a new horizon of research.

The globalization of information and studies in recent years, though scattered and with a private character (site and species specificity), are and will be part of a whole set of useful data and absolutely necessary that *landscaping scenarios*, products of *models and of the predictability* developed in a concert way, will be able to be analyzed in a computerized manner (IT software) even from the design stage.

The whole course of analyses from the doctoral thesis is developed in order to represent a *best practice guide* (model) useful in developing *integrated management of urban green spaces*.

The doctoral thesis ends with the BIBLIOGRAPHY, which includes titles at home and abroad, with reference to the topic explored.