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Landscape information modeling (LIM)

Abstract

This paper discuss the idea of a digital platform, named Mariposa, which is structured as tool to integrate and operationalize complementary landscape projects. Therefore, it proposes, based on the Landscape Information Modeling (LIM), an integrated design platform that simulates aspects of built environments, integrating natural elements and processes. The landscape design, being an integrating dimension of the layers of intervention in the space, allows greater transparency and democratization of the decision and execution process, being able to be oriented towards meeting social, ecological, economic demands and respecting its historical particularities. A highlighted point refers to the structuring of the Mariposa, which requires the definition of a set of project parameters characterized by its diversity, adaptation and responsiveness. Hence, we argue that including parameters, it is possible to propose numerous variations for the model that allow to assess the degree of response and adaptation and, therefore, its intelligence, here understood as the system's ability to adapt to the new conditions offered by the project. Finally, this paper exposes the importance of applying the LIM process in landscape design, mainly via digital platforms.

Keywords

Landscape Project. Landscape Information Modeling. Algorithmic modeling

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MODELAGEM DA INFORMAÇÃO DA PAISAGEM – LANDSCAPE INFORMATION MODELING (LIM)

Resumo

Este artigo discute a ideia de uma plataforma digital, denominada Mariposa, que se estrutura como uma ferramenta para integrar e operacionalizar os projetos complementares de paisagem. Para tanto, propõe, a partir do conceitual de *Landscape Information Modeling* (LIM), uma plataforma integrada de projeto capaz de simular aspectos dos espaços projetados, compatibilizando elementos construídos e processos naturais. Acredita-se que o projeto da paisagem, por ser uma dimensão integradora das camadas de intervenção no espaço, permite maior transparência e democratização do processo de decisão e execução, podendo ser orientado para o atendimento das demandas sociais, ecológicas, econômicas e do respeito as suas particularidades históricas. Para estruturar a Mariposa serão definidos um conjunto de parâmetros de projeto caracterizados por sua diversidade, adaptação e responsividade. Ao incluir diferentes parâmetros, pode-se propor inúmeras variações para o modelo, de forma a objetivar diferentes soluções e avaliar seu grau de resposta e adaptação e, portanto, da sua inteligência, aqui entendida como a capacidade de adaptação do sistema às novas condições oferecidas pelo projeto. No final, este texto expõe a importância da aplicação do processo LIM nos projetos de paisagem, em especial via plataformas digitais.

Palavras-chave

Projeto da Paisagem. *Landscape Information Modeling*. Modelagem algorítmica

Introduction

This article proposes the development of a digital platform, called Mariposa, based on the concepts of landscape information modeling, generative projects and genetic decision support algorithms, with the objective of integrating and operationalizing the several stages of an urban landscape project.[1]

It is argued that this platform assists the landscape design process by providing support for the creation of alternatives, manipulating the complexity of the various areas of technical and scientific knowledge and meeting its performance variables. In this way, Mariposa acts as a means for simulating aspects of the built and natural environments of the projects to provide mechanisms so that its multiple functions are verified in its variables and evaluated to meet the environmental, social, cultural and economic needs.

With the use of the platform, the architect, urban planner and landscaper is left with a wide range of possibilities opened by the algorithms, which help him in his design activity and can express it in a more consistent and less arbitrary way. Being able to pinpoint that alternative that best suits you and the other participants in the project's decision-making process, preventing each decision from being seen as personal and personal, but as part of a co-creation that meets what all dimensions and interested agents seek.

The development of the LIM concept and the digital platform is based on a broad framework of references for urban ecosystem services (UES) and ecological concepts applied to urban and landscape planning and design. As a differential, the possibility of incorporating concepts and approaches such as nature-based solutions (NBS) and green infrastructure. The possibility of using these natural technologies is a promising field for the application of this platform, because it necessarily implies the use of a wide range of knowledge and techniques dispersed by the areas of biological, geographic and natural sciences, in addition to engineering.

As presented in this article, this is a dimension in which Mariposa has a great potential for application by generating different alternatives for generative urban water management projects based on performance data regarding the functional aspects of green infrastructures, such as efficiency, operationalization and maintenance.

This article discusses how the Mariposa Platform is a technology of interesting scope for project activity, providing answers to several technical questions when considering, for example, the gains, in terms of ecosystem services (UES) of different design solutions. Following are presented (i) the conceptual basis of the digital platform, (ii) the debate on the association of form with

[1] The development of Mariposa is carried out by the LABVERD-USP University of Architecture and Urbanism, Adriana Sandre, Juliana Alencar, Riciane Pombo, Silvio Motta and Prof. Dr. Paulo Pellegrino, with support from CAPES.

performance, to discuss in an exploratory way in the next step (iii) a practical application of the platform. In the end, this text concludes about the importance of applying the LIM process in landscape projects, especially via digital platforms.

Conceptual basis of the mariposa digital platform

The development of the Mariposa Platform will be based on the integration of Landscape Information Modeling (LIM), computational algorithmic modeling and generative design. In the last two decades, new computational processes, such as parametric, algorithmic and generative modeling, have enabled a greater range of design possibilities, helping to recognize and solve problems. The generative project uses parametric variations and transformation rules previously established through an iterative process as the main strategy for generating project alternatives (Celani, Vaz, 2012). This is done through the use of programming languages (both visual and textual) available in the modeling software (based on CAD and BIM) available for projects in the architecture, engineering and construction (AEC) markets.

It is argued that the terms "Computational algorithmic modeling" refer to the development, aided by computer aided, of mathematical models for the analysis of complex problems in several areas of knowledge - in the case of LIM to the generative project in landscape architecture.[2] To deal with complex problems associated with this framework, it is necessary to use a computational medium and a platform to acquire speed and precision in the design process.

Thus, the concept of LIM, as an iterative process, fits in the field of computational design by being aided by a digital platform linked to modeling *software* that is associated with an algorithmic system for generating design alternatives. It is about computationally modeling the complexity of Landscape information and different design alternatives.[3]

To this end, it is proposed to create the Mariposa digital platform with the objective of enabling the generation of different generative design alternatives for the provision of ecosystem services based on the integration of several variables, such as hydrological, ecological and environmental comfort, forecasting trends and assessing tendencies, restrictions and conflicts of interest (Figure 1). In an advance in relation to the design process, by including the design based on parameters and performance for the accurate modeling of information. Such integration will allow the different phases of the landscape design process, such as conception, feasibility analysis and execution to happen in a much more integrated way, as they will be based on parameters, metadata, and generative rules, which allows less rework in the entire process of project.

The LIM concept is based on an evolutionary derivation of the prerogative of BIM (Building Information Modeling), which according to Landim (2019)

[2] The term "Modeling" implies a representation process that provices the basis for simulation construction performance (modeling future behavior) and for managing construction information (Laiserin, 2016).

[3] The use of programming languages, both textual (Python, C++, *Rhinoscript*) and visual (*Grasshopper* for the Rhinoceros software) allow the creation of plugins and tools with extra functionality for these software.

allows to manage and share information between multiple agents in all cycles and phases of the project, from conception to post-occupation. Both LIM and BIM work with graphic reproduction of construction geometry (three-dimensional model) and with the concept of metadata - objects are associated with a series of attributes, as a trace on the screen is linked to the dimensions of a ladder and its properties materials and costs. In an integrated database, in which all information, properties, relationships and presentations are stored (Eastman, *et al*., 2008). For example, Revit® is associated with BIM, just like Mariposa is with LIM.

The differentiation of BIM's LIM nomenclature occurs through two defense fronts associated with the design process, in its creative and execution moments. The first concerns the design process at the time of creation. Although the design phases are not (should be) watertight given that rethinking the project is a continuous act of this process, at a time when it is necessary to materialize the object of the design, BIM systems act with primacy. Although the managerial advantages of BIM, in increasing efficiency and design precision, are significant, they do not presuppose (and do not aim at) stimulating the creation of alternatives and analysis of landscape design scenarios based on performance and capacity, for example , the provision of ecosystem services, assessing potential, restrictions and conflicts, at the heart of the Mariposa platform.

In this sense, the LIM process is inserted in the level of computational algorithmic use, according to the categorization adopted by Kotnik (2010). At this level, in addition to the manipulation of data input and output, of the parametric level, the function that executes the commands is coded, allowing greater freedom of design. In architecture, this task is the ability of the algorithm to assist in solving design problems, allowing overcoming the limitations of the user interface and designing through direct manipulation, not of form, but of code (Celani, 2017).

The second front of defense refers to the majority application and development of technologies for BIM processes and models restricted to the building, with incipient initiatives for the urban scale and, even less forceful for the landscape. Reinforcing the finding that BIM software presents a more user-friendly operational format to the building's executive design and its components (slabs, beams, masonry, frames, floors, installations, among others) (Moura *et al.,* 2018). While in BIM objects have non-geometric metadata attributes linked to the building, such as dimensions of a frame and its material properties and costs, in LIM the objects are linked to elements of the landscape, enabling the extraction of data from the three-dimensional model and the alternatives of project.

Although the exponential contributions both of BIM - in the management of buildings during the construction stages and their integration with other sciences - and of the generative project - in the generation of alternatives - the ramifications of these computational design systems for landscaping remain not theorized and not so little implanted. This finding however, does not justify the

Figure 1. Mariposa was chosen as the name for the digital platform. On January 25, 1962, Charles Darwin (1809-1882) received a box of orchids from James Bateman (1811-1897), among them was *Angraecum sesquipedale*, native to Madagascar. His fascination was such that he wrote letters to James, asking himself: "do you know its marvelous nectary 11½ inches (29.2 cm) long, with nectar only at the extremity. What a proboscis the moth that sucks it, must have! It is a very pretty case". He also says, "Good Heavens what insect can suck it", already predicting which animal could be responsible for pollination (Ardetti *et al*., 2012). Decades later, the moth *Xanthopan morganii praedicta* was discovered with its gigantic proboscis: only the longest and most specialized of languages can reach nectar and, consequently, pollinate the orchid! This is what Darwin predicts, a flower with such a long stylus would generate increasingly long proboscis, one of the main contributions to evolutionary biology: coevolution! This complex relationship illustrates our generative work, from extreme specialists - like the moth - to generalists - we all have a place in landscape, space and function (Source: Adriana Sandre and art by Julio Okabayashi brand).

inertia in maintaining the *modus operandi* in CAD for urban and ladscape design (Moura *et al*. 2018). Infrastructures and urban open spaces demand different elements of design, implementation and monitoring. This is what LIM purposes: to model information in the landscape, acting in both a scalar increase and a focus from *Building* to *Landscape* – from *built* to *free*.

Why materialize the performance associated with the form?

Although the recurrent practice of using computer systems is to generate forms and variations of the project, Mariposa focuses on performance and performance. In this sense, it fits under the Paradigm of Performance-oriented Projects in dynamic and interactive models materialized by computational tools and genetic algorithms on a platform that offers a level of control.

In seminal work *Augmenting human intellect: a conceptual framework*, Douglas C. Engelbart[4] presents the idea of an architect designing a residence in which he is not only able to conceive the architectural object, but to make previously impossible analyses, such as: the glare of cars on the highway caused by the reflection of the rising sun in the windows of the newly designed house. It is

[4] ENGELBART, Douglas C. *Augmenting human intellect: A conceptual framework.* Menlo Park, CA, 1962.

clear, therefore, how new elements come to be considered and integrated in the way of designing.

Performative concerns (such as environmental ones) imply a change from purely aesthetic issues and as such, it opens up important issues of optimization and efficiency of 'shape'. This is where we can, perhaps, begin to envision the most likely factor of change for our future cities.

The criticism here does not lie in the creative architectural morphologies focused on the emerging and adaptable qualities of the form, no longer created only by a creative act, but found based on a set of rules and algorithms (Agkathidis, 2015). Buildings with complex and curvilinear structures are intriguing and the technique that today allows us to experience them is an equally charming act, it is necessary to stimulate new and creative design solutions.

However, producing complex geometric shapes, not associated with other performance factors, does not represent a paradigm break, as it maintains the current design logic. Thus, the paradigm break for the landscape can be associated with the conception of the technical and socially functional procedural variety associated with explicit formal variations of the object. The focus is not only on the search for the dynamism of form, but also on the resignification of the process that generates a multiplicity of possible results for the landscape based on its performance.

Against the primacy of material form, we can postulate an alternative logic and make a distinction between form - as in "form because of form" - and information (Leach, 2014). While 'form' implies a concern for a static condition governed largely by aesthetic issues, 'information' implies a dynamic condition that is informed by a number of factors, many of them also including the word 'form', such as 'performance'.

The LIM conceptual process incorporates computational design, not for the development of atypical forms hostage to late capitalism, but to evolutionary systems that can be modified in real time. Parametric and algorithmic design should not depend exclusively on manipulation in a complex and visually interesting way. The future is not just based on new forms, but on new information systems, LIM's foundation, in a paradigm in which performance is related to project elements and social and environmental issues.

Materialization of performance and application possibilities of Mariposa

There are countless aspects that influence the quality of a landscape architecture project, from those related to aesthetics to ecosystem services. What the platform seeks to answer is what is the influence for the provision of ecosystem regulatory services (UES) of the modification of the design elements and variables attributed to the algorithm and which of the decision points lead to different paths. When estimating the positive effect on the project, both in terms of carbon sequestration, environmental comfort and urban drainage, depending on which tree and shrub species and elements of the Mariposa are used. In computer design, to meet these demands, at least three softwares and plugins would be needed to articulate all this specialized knowledge.[5] A major challenge that current design tools are failing to meet.

In view of this scenario, to overcome the current paradigm and have access to a performance-oriented process that optimizes quantifiable data, it is necessary to "simplify" the access of this language to projects, even though we know that we live in a universe of knowledge each time more specialized. How to articulate all this knowledge, without incurring the risk of losing the specificities of each discipline and abdicating scientific rigor?

This makes the moment favorable for the development of a digital Platform that, using a virtual environment, using the already existing means, enables the continuous and on-demand management of the various entries and specific contributions of each of the related disciplines, with their different actors, needs and times. Although the model is a simplified representation of an entity that you want to study, it can answer some questions. Allowing the insights of the partial sciences to converge using digital modeling, with information and user preferences, such as quantitative data on water quality and volume, selection and distribution of vegetation, among others that allow understanding and describing the existing conditions and allowing the design of future performances, shaping landscapes responsive to different scales, situations and functions.

Therefore, the structure of Mariposa is based on a SaaS Platform (*Software as a Service*)[6] and edge computing, which internally uses collaborative tools, software and attached plugins, to allow online three-dimensional visualization of design alternatives and the generation of different performance data for each one. In other words, it is a generative process with genetic algorithms to find an optimized solution using various technologies, such as Artificial Intelligence, based on *Machine Learning*, based on the recognition of the measured variables to feed the Platform's operation.

One of the biggest gains proposed here is the expansion of the access of algorithmic modeling in landscape projects to an immense diversity of public and private users, regardless of their knowledge of programming language and the responsiveness of their computer. Thus, on the platform, instead of specifying fixed shapes in lines and shapes, users will define the process, variables and parameters by which objects will be genetically created. It is a common, intuitive and dynamic basis for the various agents involved to dialogue and interact. To structure the generation of generative projects on the digital platform, a plugin for Mariposa will be idealized, while to measure the data, an orchestration of several plugins, described below, will be performed through an API (programming interface between software)).

It is worth mentioning that there are recent researches in Computational Design that investigate methods on how to develop specific domain platforms, such as Mariposa that connect to several back ends (output software and final visualization). Landim (2019) when analyzing some of the textual programming interfaces available for architecture, noted that the Rosetta tool (Lopes, Leitão,

[5] Examples are some of the *plugins* – LandsDesign®, Bison®, RoadCreator® and Nero® – that focus on Landscape Design and Planning. Although LandsDesign is focused on planting design specification, it does not have in its NBS library. In urban drainage, the *Storm Water Management Model (SWMM,*), stands out, a dynamic model used for urban drainage management, which simulates the quantity and quality of surface runoff, but does not focus on carrying out generative projects based on in performance. Such software can contribute to feed Mariposa, with the calculation of the input data, as well as in complex drainage analyses of the generative project generated.

[6] SaaS platforms have technological maturity in several sectors, especially related to productivity, documentation and management. The emergence of online tools for Spatial Decision Support (SDS) coupled with the research and practices of the parametric modeling application for the design of Landscape Architecture has brought new possibilities for platforms for process development. Example of SaaS tools for the design process, are companies like Ladybug Tools LCC and Procedural Aps.

2011) has one of the most interesting models for connecting a platform to different software.[7] According to the author, the study of this type of connectivity can provide a real model for Mariposa to be a robust platform that centralizes several tools in the field of landscape information modeling without worrying about coupling specific output software. Thus, it is possible to couple relevant data analysis plugins for the landscape project to the Platform.

Currently, the project is in the process of idealizing the base components for the Mariposa plugin to work, composed of the elements of the project, visualization and feedback of design alternatives. In this stage, *Rhinoceros*® 6 was chosen as the first software for its development and customization, as it is a program that allows the free development of plugins, in addition to being integrated with the visual programming language *Grasshopper*®, responsible for popularizing the use of programming for architects and designers.

An innovation point of this integration between Mariposa and Rhinoceros is the possibility of testing the link between geometry and domain metadata specific to the landscape area through the data extraction potentials of the parametric modeling methods available in the program. Currently, BIM software has metadata of construction objects referring only to AEC. Mariposa, in an innovative way, will allow exploring that metadata linked to objects of architecture and construction already existing in BIM can be expanded to metadata used in landscape, green infrastructure and urban drainage. Areas hitherto rarely explored by parametric and generative modeling of information.

In developing the plugin algorithm, it is necessary to perform a systematic extraction of logical principles, with repetitive patterns, universal principles and interchangeable modules. Of course, if we take all landscape projects, there will be no modular linearity for the provision of UES, in view of the non-similarity between their elements, both in terms of their specificities and their quantity. To idealize a platform that can be generalized and not overly simplistic or specific to a single condition, it is necessary to think about degrees of similarity between problems and distinct elements and reproducible criteria.

In this sense, modules were designed with Mariposa design elements (flower beds with combination of trees, shrubs and ground cover and NBS in different scales: retention and detention basins, rain gardens, rain beds) associated with attributes - such as programmable entities - characterized for their diversity, adaptation and responsiveness to the provision of SEs (Figure 2).[8] With the alteration of the elements and their variables, it is possible to propose numerous graphic simulations for each project, to objectify the most efficient solution for each context. Thus, when choosing an alternative, it will be possible to access a series of information, properties and relationships that would remain hidden or would be lost in traditional design processes, gathered in an integrated landscape design database. Initially, the generation of alternatives will be restricted to Mariposa's NBS, in the future, we intend to study how the user can insert his own elements.

[7] Rosetta is a programming environment that allows users to choose different programming languages (front ends) and different CAD and BIM software for the output of three-dimensional modeling (back ends), offering a certain degree of freedom for the designer to combine the best possibilities of leaving the geometric model without losing the portability of the code. This means that the same program (code) can create models in different software, without having to have the platform versioned in different programming languages for each software that is coupled (Landim, 2019).

[8] Using the solid builders of an existing modeling software will allow the plugin to focus on developing and assembling design strategies and new features for integrating its elements from different parameters.

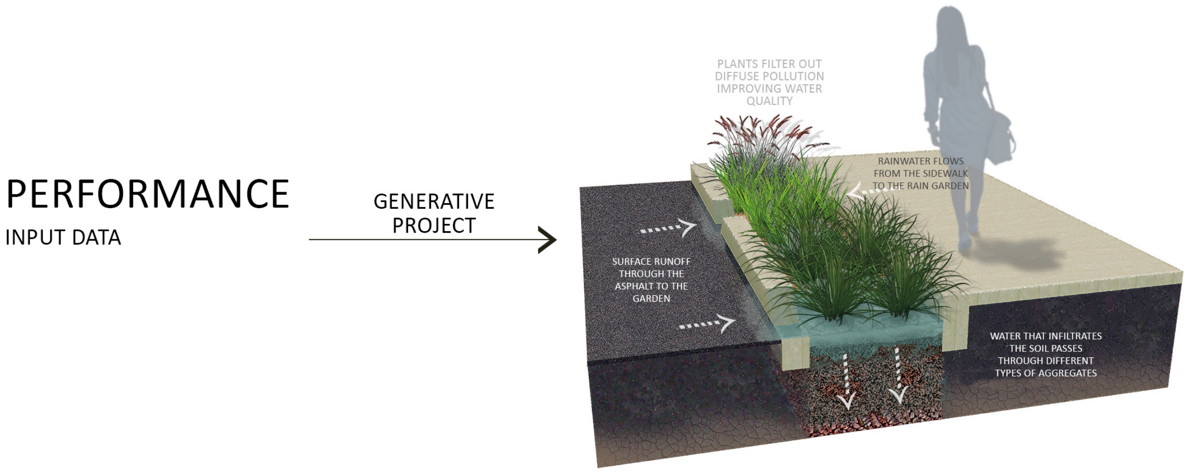

Figure 2. Generative design process of one of the elements of the Mariposa Platform: from the entry of input data, the shape of the different NBS is generated. Each element has a unique identifier and a set of attributes and associated metadata. Your information, properties, relationships and presentations will be stored to generate different projects using the plugin's genetic algorithm.

Given the exploratory and innovative character of this project, the following subsystems will be considered here, taken initially separately: environmental comfort, urban drainage and carbon sequestration. To start using the online digital platform, the user must insert the project area in a georeferenced file (up to the scale of an urban sub-basin) and the input data described in Table 1.

Regarding the urban drainage subsystem, the Mariposa plugin will allow the generation of the shape of its different elements (NBS and retention and detention reservoirs), from performance data in a database previously defined on the platform by the user (Table 1).

For example, instead of the conventional solution of detention reservoirs in geometric volumes formed by flat surfaces - the well-known swimming pools - it is possible to propose a design party that takes advantage of the shapes that are naturally given. The different forms of anastomosed channels that these sections of the reservoir can assume, with the successive branches or multiple channels that separate and meet again will occur from the flow restriction downstream. In the future, it is intended to complexify the subsystem and insert different flow regimes and insert other elements such as spillways, or even quantify the interception of rainwater depending on the planted tree species. Another example is the modeling of the shape and size of rain gardens and biovalleys on sidewalks according to performance data regarding the capture and retention of rainwater and its flow speed.

As for the carbon sequestration subsystem, the Mariposa tree elements will be fed with the related metadata (Table 1), varying according to the species of tree, age, and phasing in the landscape design. Assuming a linear function, the algorithm will measure which is the largest biomass, carbon content and sequestration from the quantitative variation in the number of trees in the project, phytosanitary condition and soil.

This is a first quantitative approach, based on data from trees surveyed in previous scientific research. An example of the challenge posed qualitatively, is the provision of UES related to carbon fixation, in which the increase in the number of trees is directly correlated to the increase in fixation, depending on the arrangement of the tree planting. Thus, in the future, one can think of a genetic algorithm that finds the best performance in the face of the variation of configuration and arrangement of different tree elements of the Mariposa. This parameter will be considered in the long term by the platform, because empirical studies of urban planting and biomass configuration are necessary to be able to feed the algorithm script.

As for the environmental comfort subsystem, the recent coupling of the ENVI-met plugin for Rhino may help to answer how much the planting of a certain tree species (element of the Mariposa) influences the microclimate effects of the study area. This subsystem does not require the user to perform field measurements of environmental variables, configuration of microclimatic and edaphic data, as well as the insertion of georeferenced data with the buildings surrounding the project to perform the simulation of the shape of the elements associated with performance.

In this subsystem, as the arrangement and configuration between the elements is relevant, we try to understand how the return of an exclusive set of an arboreal element differs to a set with a wealth of them and, still, which are the best spatial arrangements for each of the Mariposa elements (eg rain gardens) for thermal comfort. Initially, a simplification with a linear function will be performed in the script of the genetic algorithm, thus, a tree (n) contributes to the decrease in n.x ° C of the surface temperature and 10n trees together 10n.x°C. It is known that the modularity of the elements must vary, considering the scale of the landscape or habitat - regulation of air temperature and humidity, airflow, etc. - acceleration due to temperature differences between the tree mass and buildings. Such variables will be fed into the ENVI-met plugin in an exploratory way, in view of the recent insertion in this model of elements with flowing water flow - such as those of Mariposa (eg rain gardens).

Finally, the current questions to be resolved is how (and if) the variation of the spatial configuration and the composition of the elements influences the provision of drainage, carbon sequestration and thermal comfort UES? Ecosystem services do not follow the same function in relation to the scalar increase of the elements, inserted separately or together. Nor can it be inferred within the same SE a linear function between increasing its provision by increasing the number of elements of the Moth. Rain gardens vary in the provision of SEs both internally - quantity, size, plant species, edaphic conditions, microclimate and local pollutants - as compared to other elements - biovalet, rainwater, etc.

We cannot oversimplify reality to scale projects on the Mariposa Platform. In the combination of the various elements, its degree of importance must be established to choose one option over another (from English: trade-offs between UES), considering that increasing a certain benefit can lead to both an increase and a reduction or loss in others. Often the same element can be important for more than one ecosystem function.

To this end, the user can structure a multicriteria analysis model, assigning different weights to each SE, analyzing them separately and in aggregate levels according to the particularity and objective of each project. Multicriteria Analysis works with the composition of main variables that, integrated, indicate areas suitable for some activity or event, or areas that need some intervention or transformation (Motta *et al.*, 2019). The simulation uses the *Grasshopper* genetic algorithm developed by Motta *et al.* (2019)[9] to obtain the distribution of the elements of Mariposa, in terms of location, area and quantity, generating different levels of adequacy from a set of normalized values and weights defined by users.

[9] The authors developed a script using the Grasshopper® genetic algorithm, which combines the variables automatically until the best possible result is achieved.

Subsystem	Input Data	Output Data	Elemento f Mariposa
Environmental comfort	Field measurements of environmental variables and configuration of model microclimatic data. Air temperature; Average radiant temperature; Wind speed; Air humidity	Difference in air and surface T ° C between sunny, shaded areas and / or close to water elements	Rain gardens Rainforest Rain pond Flower beds with trees, shrubs
Carbon sequestration	Carbon storage tCha-1 Tree and shrub data regarding the amount of carbon (CO2) above ground that is absorbed and stored Biomass, carbon content (kg / species) and carbon sequestration (kg.year-1)	Amount of above-ground carbon that is absorbed and stored Biomass, carbon content (kg / species) and carbon sequestration (kg.year-1)	Flower beds with trees Burlap and soil
Urban drainage	Delimitation of the project sub-basin and flood zones Local precipitation data, runoff, holding capacity, infiltration and water storage in the soil in the current situation Design need for flow (m³ / s) of restriction and volume downstream.	Increased infiltration capacity (%) and soil water storage (mm); Precipitation intercepted by trees; Decreased runoff (mm) Flow speed (m / s); Element shape associated with drain data.	Source control: Rain gardens; rain bed; biovalets; Flower beds with different combinations of trees, shrubs and ground cover Burlap Downstream control: retention and detention reservoirs

Table 1. Design elements of the Mariposa Platform and associated subsystems, related to the provision of regulatory SEs. The output data will be in georeferenced attribute tables (Based on studies by Shinzato *et al.*, 2019; Duarte *et al.*, 2015; Zanini, 2018; Rasera, 2019; Nowak *et al.*, 2013).

In short, as an artificial intelligence technology, Mariposa's tools will have an intrinsic dynamics; it is the performance data that guides the generation of geometric shapes for the elements (eg retention reservoir, rain beds) allowing graphic visualizations that can be easily changed and generating data on water behavior, carbon sequestration, and environmental comfort to assist in creative design processes.

Final remarks

This article discussed the idealization of the Mariposa digital platform, which is structured as a tool to integrate and operationalize complementary landscape projects based on the *Landscape Information Modeling* (LIM) concept.

The platform has an important potential for replicability, considering the scope of the activities carried out for the characterization and diagnosis of hydrographic basins, with the formulation of scenarios and the proposal of measures for their revitalization. It was argued in the text that, based on modeling, simulations can be carried out to assess the degree of response and adaptation to the different scenarios of the technologies involved and, therefore, their intelligence.

Currently, the main current challenges of the Mariposa Platform are those involved in the design and assembly of an online digital platform and the orchestration of the associated plug-ins, as well as in the choice of parameters that best equalize the needs of a Landscape Project.

Finally, it is not a case of defending the instrumentalization of the landscape design by the computer, but rather proposing a model that assists users in the design intervention from the integration of desired parameters, generating greater efficiency in the entire process involved, from its conception to its maintenance. We cannot forget that the computer is a human creation, based on historical, ethical principles and that it should not be the exclusive protagonist in decision making. On the contrary, it is the case of defending the opening of its codes, the social control over the programming, including linked to the formation of the architect, urban planner and landscape architect. It is about understanding the construction of an ongoing agenda on the operation of digital platforms, such as the exploratory application of the LIM process in landscape projects.

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