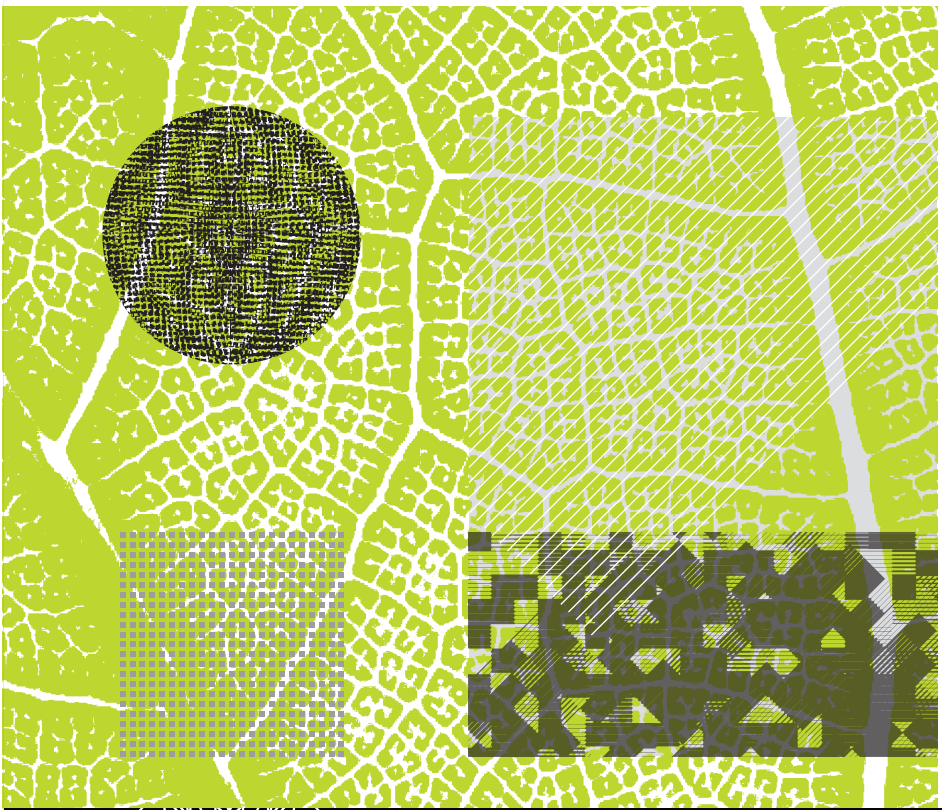
ALFREDO H. BENASSI

BOTANICAL CITY

THE URBAN DESERT TURNED INTO AN OASIS



HABITAT
AND URBAN
GREENING

Processes/Models/Strategies/Tools/Landscaping

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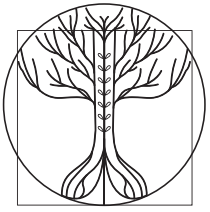


BOTANICAL CITY

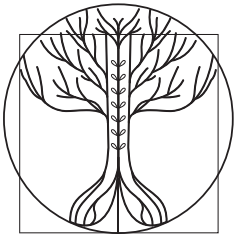
THE URBAN DESERT TURNED INTO AN OASIS

DECLARED OF INTEREST

BY THE CHAMBER OF DEPUTIES OF THE CONGRESS

OF THE ARGENTINE REPUBLIC

ALFREDO H. BENASSI



BOTANICAL CITY

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HABITAT
AND URBAN
GREENING

English version

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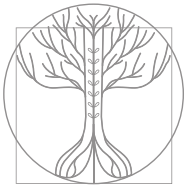

ILUSTRACIÓN ÁRBOL-VITRUVIO:
Frank Zárate
La simetría es el espacio de la igualdad.
Los elementos que componen este árbol se relacionan
entre el balance de la copa y sus raíces, en el medio
el crecimiento en donde el pasado y el futuro convergen.

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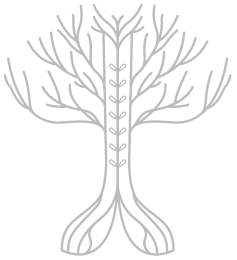
In memory of Roberto Burle-Marx, Latin American landscape designer.



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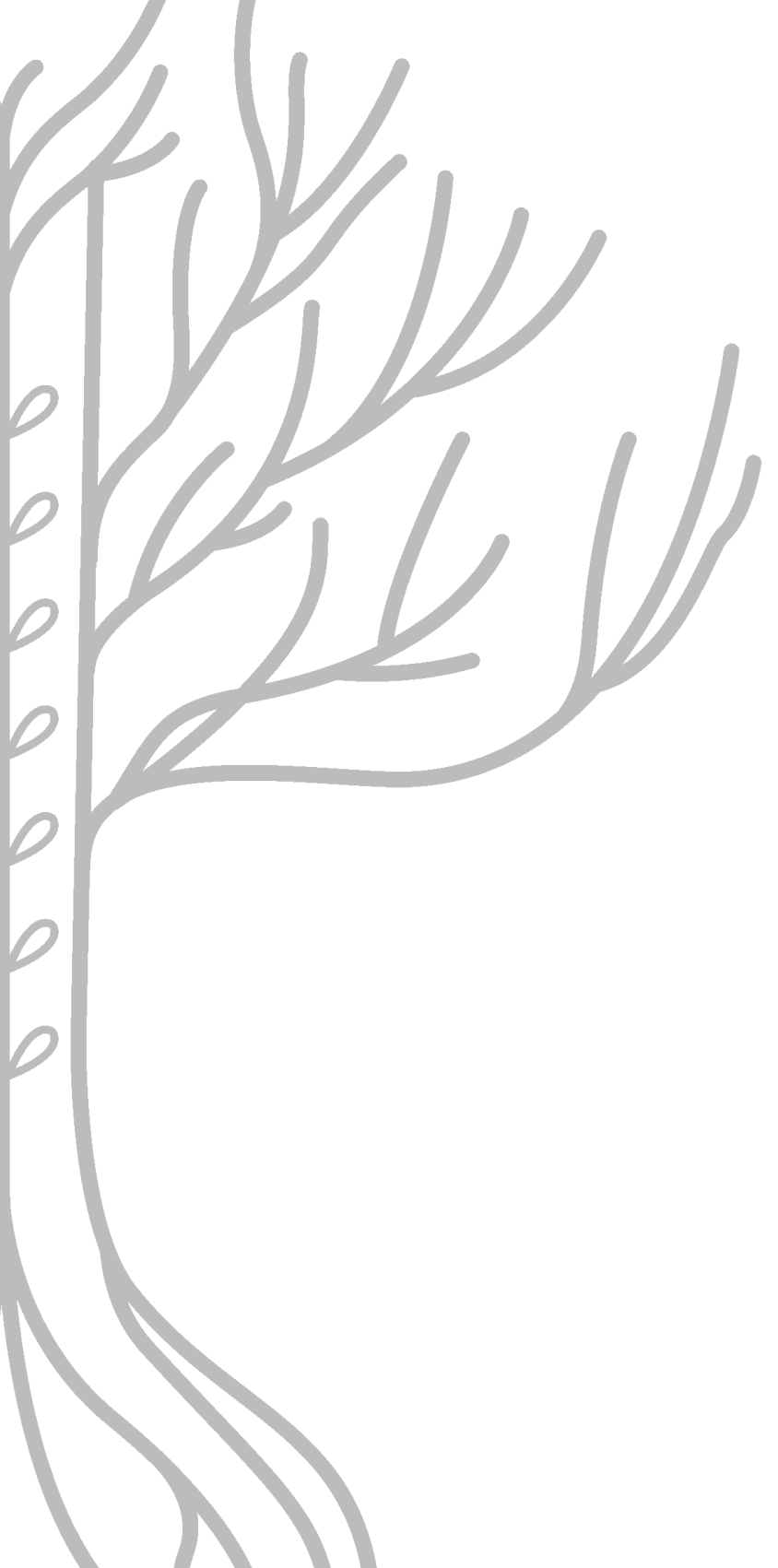

FOREWORD

A paradise amid the urban hustle and bustle

CARLOS G. TERRA
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Translated from Portuguese by Josue Sommer
Translated from Spanish by Marina Menéndez

Landscape as cultural image is a specific form of representation that structures and symbolizes the experiential environment. As an object of symbolization, it was represented from a great variety of materials and in diverse media: painted on fabrics, written on paper or created with soil, stones, water and vegetation on the earth. During its historical development, cultural significance of landscape representation gradually increased and landscape was specially represented in the paintings of Flemish artists during 15th century, and in those of Italian artists, such as Fra Angelico, Sandro Botticelli, Leonardo da Vinci, among others. This landscape was mainly used as background to the main theme developed by the artist. But it is during Renaissance that the concept of *landscape* appears to indicate a new relationship between human beings and their environment. Therefore, this concept is a modern one and its definition, not only as materiality in itself but also as a cultural symbolic construct, begins in Europe in the 16th century. With this meaning, it is present in the recurring memory of human being, in their relation to the environment, as a concept for representation and material operation.

This incipient idea of landscape was based on environment observation.
In Egypt, plants and gardens were painted on the walls of temples; there, diversified vegetation used in ancient spaces is registered. Later, the Roman empire would also bedeck their houses with landscapes in which nature was presented with extraordinary beauty.
Nowadays, we face problems arising from urban sprawling. We ask ourselves how to act upon this sprawling and the resulting landscape, we wonder how cities could be made more comfortable to live in.
Alfredo Benassi, in his book *Botanical City. Oasis in the Urban Desert*, points to the changing significance of historical conceptualizations of landscape and leads us to appreciate the present potential of landscape for developing a more humanized city. Vegetation integrated as landscape into the urban structure would turn it more friendly, more sociable and more sustainable.
This author has been the first researcher in Latin America to gather scholars in a seminar on cultural landscapes, which turned to be pivotal for all those interested in the art of landscape and studies related to green areas. Drawing on his experience and knowledge on sciences of territory,
he offers us a book that places landscape in the process of territorial formation where by cities become environmental cities.
His writing allows us to consider the possibility of a better daily coexistence in contemporary cities, in which human action on habitat, its implications and the resulting modifications come into play.
His experience on the field of landscaping and his

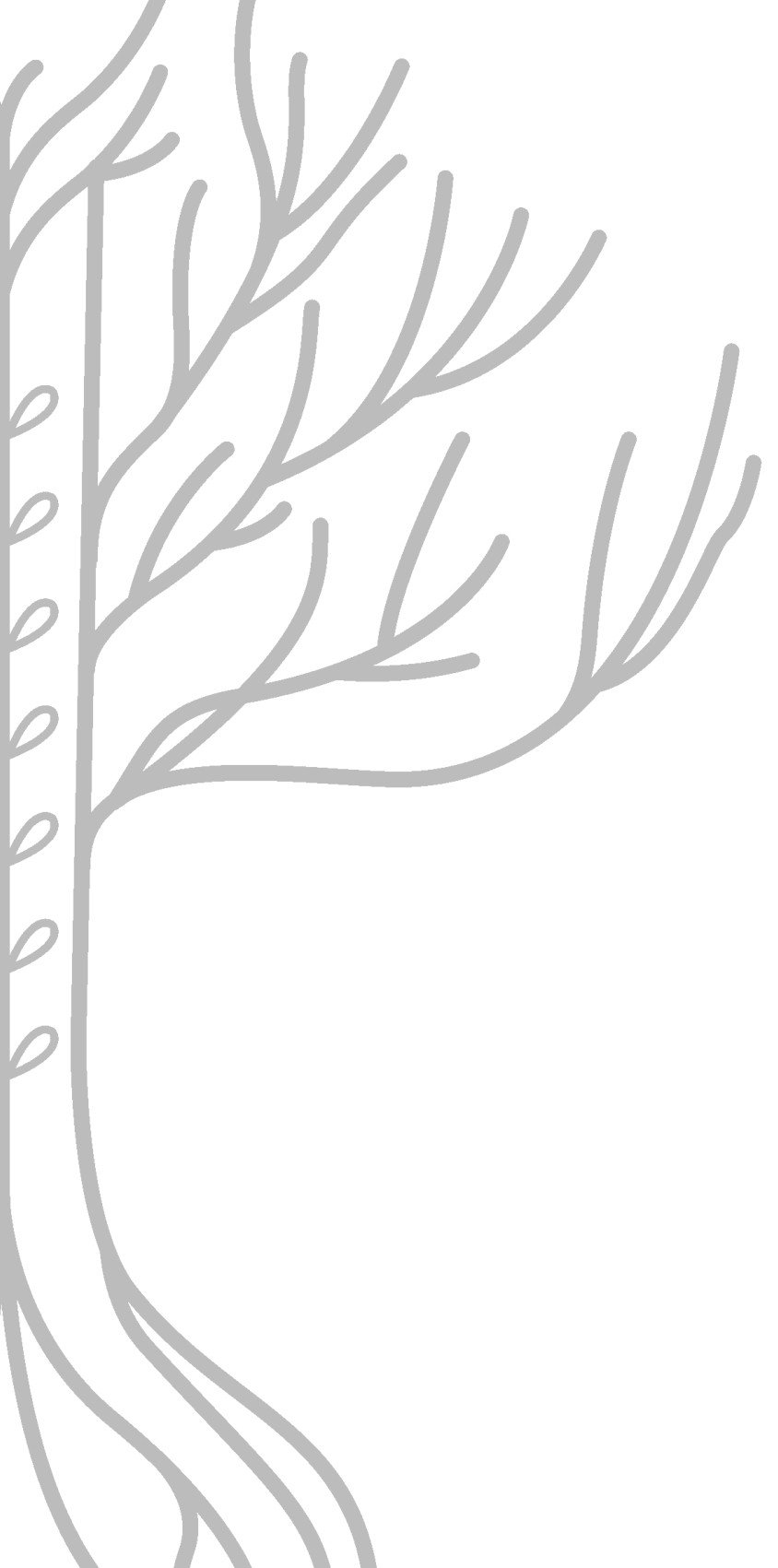
knowledge on landscape management enable him to work with vegetation at different scales of landscape and with different types of projects, supplemented by conservation and restoration of ecosystem, specially those related to its integrity and sustainability.

Furthermore, he pleasantly interprets the process of historical heritage when recognizing the importance of the richness of landscape found in present environments and ecosystems. He also challenges us to think about the integration between nature and culture, of paramount importance today and for the future.

It is known that human beings have always been concerned with the proximity of their places of residence to nature. Sometimes painters were commissioned to register beauty in palaces and surrounding gardens in order to record it for future generations. In a comprehensive book, Benassi records vegetation in cities and its visual implications in landscape while discussing the physical impact as well as the psychic and symbolic implications in which that landscape is the ordinary habitat everyone can enjoy and use in contemporary cities.

The aim of *Botanical City* is to invoke a paradise amid the chaos of contemporary cities. Thus, we welcome this publication, in which residual links between cities and nature acquire new and different shades thus allowing for a reinterpretation of the formatted landscape through references in which space, time, society and culture define the city here revealed.

Rio de Janeiro, May 1, 2015



PRESENTATION

An old tomorrow

There are no solutions in life; there are forces underway.
We have to shape them, and the solutions will come.

ANTOINE DE SAINT-EXUPÉRY

THIS WORK provides a theoretical and pragmatic approach for the incorporation of vegetation in cities. Ultimately, it is an effort to contribute to the imperative need to promote more sustainable cities. Historically, landscaping was a successful practice in anthropized environments that projected with *vegetation aesthetic quality in landscape and environmental improvement of human surroundings*. Nowadays, megalopolitan areas exhibit greater and more complex environmental problems.

Thus, that successful landscaping experience could offer today renewed tools for an urban greening landscaping capable of damage mitigation and environment improvement by means of a *green urban infrastructure* regarded as ecological foundation of environmental regeneration in integrated systems of urban green spaces and greenways.

It is about placing vegetation coverages *in* and *on* the urban artefact so that its vegetal ecophysiology provides the nutrient and energy cycles that maximize energy saving and environmental remediation services aimed at promoting better quality of life.

Landscaping is an international cultural practice that, depending on peculiarities of each society, is required either by private clients for residential, business, commercial or productive areas or by public organisms to intervene public green areas, in street, roads and highways, industrial sites, tourist spots, housing social

policies, and other social and economic-productive activities. These two characteristics highlight a convenient community convergence: private and public.

These landscapings have a history of three centuries and have undergone different paradigm shifts. In past centuries, landscaping had a static stance on landscape, a perspective that projected green areas in static places and with a botanical composition stable over time. That static design required and requires the preservation of a certain state, which demands a considerable amount of energy. Thus, its is key to landscape sustainability to *replicate continuous change* as is the case in nature: nothing is static, nothing develops in isolation.

This challenge of the static and stable perspective hold by traditional landscaping is connected to the phenomenal change in ecology: the revisiting of concepts, which in turn led to a paradigm shift. In this way, the concepts of *stable state* and *biological equilibrium* are replaced by *non-equilibrium*.

The old paradigm emphasized self-regulation and internal stability in ecosystems, and minimized the influence of climate change and episodic events on ecosystem dynamics. The paradigm of non-equilibrium, in contrast, minimized self-regulation and stability in ecosystems, and highlighted the implications of external disturbances in shaping the dynamics of ecosystems. Consequently, this new paradigm claims that the dynamics of an ecosystem is less predictable.

In this way, landscaping—which incorporates continuous structural and functional changes in ecosystems—determines the management of vegetation trajectories, considered as the procedure that fosters autogenia (that which vegetation produces). This leads to a greater ecological autonomy in the projected urban green systems.

From this perspective, private and public projects offer sustained, graded and generalised procedures in order to develop a green urban infrastructure which has greater autonomy and meets the aesthetic, social and environmental needs and functions concomitant in urban planning.
At the same time, these projects constitute a creative triggering for social debate on the role of government and community democratic participation in the social organization and planning of territories.
This is urban greening –in residential complexes, neighbourhoods or buildings– serving daily life landscape, which is habitat and identity, individual and intimate, communal an social.
Botanic city proposes historical experience as a starting point leading to a more generalized and accessible prospective in which inhabitants may develop a landscaping habitat, that is to say, daily styles of inhabiting in which landscape has visual, micro-climate, psychic and symbolic impact. This singularity of urban landscaping is order and chaos, hazard and human planning, organization and complexity. Biology and social construction –products and consequences in complementary and opposing relationships– are both causes and products of their productions. That defines *Botanical city*: landscaping urban programmes open to the unpredictable and subject to continuous interpretation and scientific explanation. Landscape design conceived as open-air classroom and research lab: an engineering of ecological events and their landscape of genes. Thus, this book provide no solutions, but forces underway; it pursues a community pedagogy that may lead to a more change- and life-friendly culture.

PROCESSES

Landscape as purpose

Landscape and landscaping are different but complementary concepts. Landscape is a broad concept that may be defined from different perspectives. Landscaping, in contrast, conceives landscape in relation to specific objectives and a social need: the ideal transformation of human environment. In the past, landscaping was conceived in terms of a an essential practice in territory building, the output of the industrial city. Nowadays, when we face new challenges, landscaping restores its main purpose: transform post-industrial cities to make them livable and beautiful, in harmony with nature.

Landscape, landscapes

THE TERM *landscape* is generally used to refer to visual qualities of the environment. Moreover, diverse study fields use the term with specific meanings and within different conceptual frameworks. Landscape is dynamic and comprises land geomorphology, an ecosystem mosaic, productive systems and its land-covers, all of which create a visual field bearing symbolic meanings for a given society.

A landscape is defined by a scale, a spatial location, and an observer's visual field.

Many laws and conventions try to recognise, legislate and safeguard landscape. According to Landscape European Convention, landscape is "an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors".[1] This definition encompasses natural, rural, urban, peri-urban, outstanding and even banal or degraded landscapes.

In 1972 World Heritage Convention, adopted by unesco Landscape Convention2, issued an international legal instrument that recognises and protects landscape as a natural and cultural heritage of outstanding universal value: "Deterioration or disappearance of any item of the cultural or natural heritage constitutes a harmful impoverishment of the heritage of all the nations of the world." In 1992, the category of *cultural landscapes* was incorporated and defined as "combined works of nature and humankind".

[1] Landscape European Convention, Florence, October 2000.
[2] United Nations for Education, Science and Culture Organization, 17th convention, held in Paris, 1972.

Those landscapes illustrate "the evolution of human society and settlement over time, under the influence of the physical constraints and/or opportunities presented by their natural environment and of successive social, economic and cultural forces, both external and internal."
Irrespective of categories, it is of paramount importance to remember that there are several definitions and concepts of landscape. In this line, the definition and concept of landscape is not established once and for all, but it results from a particular and social perception of territory related to the ways in which a society interacts and has interacted with nature and the social habitat, either to preserve or modify them. From this perspective, landscape may be defined at least from three different points of view: the observer, the observed, and the relations between them. At the same time, visual, spatial, and temporal dimensions are implied. For instance:

1. Who is the observer: a designer, a scientist, an artist, a community? The observation point is a satellite image of vegetation physiognomies, a tourist panoramic view, the image of cities or countryside from a rural road?
2. What is observed: ecological structures and functions in a regional mosaic? Geographical factors and features of earth's surface? Is it a land design practice?
3. Which is the type of relationship between the individual and the environment: a large biome, a botanical relict urban or productive activities have eroded? Is it a social need to face a built-in or degraded environment?

Landscaping as practice in anthropic environments

EVEN IF, as stated, landscape is defined from different perspectives, landscaping, in contrast, is guided by a specific objective: finding a solution, by means of vegetation, to two main issues. One is formal and spatial solution of landscape regarded as appreciation and quality of image. The other is improvement of human environment.

Nowadays, the deterioration of visual quality and the poor environmental quality –an increasing tendency– in huge urban settlements demand landscape design, considered as a renewed and powerful tool to improve urban environment, both landscape environment and physical and biological appearance in relation to urban microclimate and mitigation of the negative effects on humankind produced by cities, considered as inert built up areas on a territory.

Basically, landscaping consists of cultural, artistic, spacial practices and plant cultivation performed in an anthropic site. Thus, landscaping finds its legitimacy when, in an anthropic site, quality of landscape constitutes a scarce resource in a community, a social sector or a residential area. It may be about valuable degraded heritage, an area where nature has been plundered, or any other area made barren by urban construction processes or by extractive or productive activities.

Landscaping practices, then, appear as an intentional activity on the components of a site.

These components, and their quality or degradation, as well as factors affecting them constitute the environmental area on which the designer intervenes and projects. That is the landscape of landscaping. Ultimately, landscaping practices become meaningful in the following cases:

- when degradation of environment calls for intervention without delay because a community is exposed to it;
- when there are no functions meeting social demands and conditions in an area need to be improved in order to adapt them to other uses;
- when there is an excellent function, a stable conjunction between use and resources, and the objective is to protect and preserve those functions and their ecological value;
- when the design of a project, or group of project, requires a practice that identifies the need and relevance of avoidance, mitigation, and compensation measures and procedures on resources affected by the project.

The professional landscape designers acts on the planning and landscape designing phase both in public and private domains.

- Private domain: urban single-family dwelling, condominiums, housing, country clubs, industrial belts, social and sport clubs, memorial parks, rural houses.
- Public domain: tree planting along streets and esplanades, treatment of roadway accesses, highways, routes and roads. Small squares, main squares, local sport centres. Urban and peri-urban parks, regional park, scientific educative park, educational farms, social programmes, botanical gardens, esplanades. Seaside and freshwater resorts. Natural parks, wildlife reserves, historic gardens, campsites and shelters. Memorial parks, urban cemeteries. Fair venues, markets, agroindustrial exhibitions.

In landscape designing the following items are comprised, influenced and managed:

- vegetation;
- lands and substrate;
- plantations or vegetable morphological and physiological properties to enhance microclimatic conditions and environment;
- plans for the management, preservation and maintenance of landscape biophysical resource;
- plant health, pest control, diseases, vectors in public or private residential or landscape areas.

Landscape designer also acts on ecological components: elements, factors, and organisms. To summarize, we can mention:

- native or naturalized vegetation. Implanted or spontaneous;
- land and substrates derived from dredging, mining, organic recycling and associated components;
- edaphic, water, vegetable and microclimate local improvements in environment;
- tangible and intangible vegetable values a site may have in connection to its cultural, exotic, or botanical diversity features.

Moreover, landscape designer may also participate in the following professional activities:

- management; planning; design, engineering and control;
- programming; landscape diagnosis, valuation and assessment;
- preliminary planning; projects; costs, budget, and tendering specifications;
- certifications, reception of temporary works and permanent works;

- execution, project management and representation;
- construction management;
- assessment of landscape resources and estimation of impacts on landscape;
- damage assessment and calculation of severance pay;
- professional audit
- arbitration and third-party expertise;
- membership and evaluation committee in selection of professionals for projects, preliminary plans or call for proposals.
- consulting and advisory services;
- teaching, technical training, promotion;
- research and testing;
- extension and transference of knowledge.

Finally, landscapes that are created not only constitute an aesthetic and emotional experience for citizens, but also enhance environment. That is the peculiarity of this practice. And that is the reason this practice is required in barren, degraded and complex areas dominated by desolation, negligence and depredation: these areas will be attended, regained, restored, forced to reconstitute themselves, enhanced so as to make them livable in a different way.
Whatever the nature of landscape design intervention, developing a socially valuable environment is possible. Restoring, preserving or modifying a state, achieving the desired transformation: that is projective landscaping or landscape as purpose.

Historical paradigm in landscaping

THE TERM PARADIGM means model or example and indicates the organization pattern or theoretical framework or group of demonstrations through which events or multiple experienced are interpreted.
A paradigm is the collection of practices that defined an area of study during a limited period. It represents the general consensus over a group of experiences, beliefs and values; it represents the way reality is perceived and the consequences of this perception.
Emergence and development of landscaping is connected to Modernism paradigm and the associated social and environmental conflicts arising from Industrial Revolution.
During the 19th century, mechanization of rural work and increasing job opportunities in urban factories led to a migration from countryside to urban areas.
These changes had demographic, economic and environmental consequences: population moving from countryside to cities, international migrations, steady growth in world population, mass production, emerging capitalism, emerging companies in the manufacturing industry, unequal exchanges in countries, emerging proletariat and the social question, environmental deterioration and landscape degradation and the consequent irrational soil exploitation and transformation of old cities into industrial cities.
Dynamism and promotion of the landscaping movement were rooted in urban reformation and the increasing real estate revenues derived from wooding and tree planting along streets, boulevards, parks and squares, which imprinted its particular

engineering on the land. Environmental remediation projects in response to environmental conflicts and transference from public investment to private annuity explain landscaping historical relevance, its objective as discipline, its social function in distributing or transferring public investment, and, fundamentally, the present social debate it arises.

A multiplicity of causes converged in the construction of large landscape designs of parks and public gardens. Summarizing, it can be said that landscaping became a projective discipline inspired by the eastern and western pictorial reference pervading eighteenth century English parks, the experience of nineteenth century urban reformations, and the contribution of modern botany. It was modern botany that consolidated the use of internationalized plant species produced in greenhouses, which in turn focused landscaping on specially planted vegetation as a resource.

That explains the propagation, during 19th and 20th centuries, of plants from diverse international phytogeographical origins. The beginning of plant introduction can be found in European sixteenth-century botanical gardens, which spread specimens in Europe or in Eastern and West Indies.

The spread of plants introduced to cultivation was a slow, complex and haphazard historical process which congregated different plant-growing applications. Application of newly introduced specimens encompassed a diverse panorama of production and ornamental purposes, expression coined to designate non profit-oriented cultivation but for landscaping purposes.

Thus, landscaping development in terms of territorial practice was historically parallel to botanical gardens and, in turn, the most important botanical gardens were planned by landscape designers.

To sum up, the emergence of landscaping historical paradigm draws on the influence of pictorial perspective, cartography, and, specifically and in close connection to, botanic gardens. Landscaping materialized as forestry, topographic and hydraulic work on the territory, either to restore or create landscapes or to regulate and enhance bodies of water, under the influence of romantic painting and its idyllic bucolic scenes depicting shepherds and harvest. This influence derives from the romantic myth that promises "harmonious interaction between human beings and nature". However, this promise required an engineering that turn swamps into lakes, wastelands into gorgeous parks.
This landscaping –regarded as environmental tool– gained momentum during the second half of 19th century, in Paris, when it became a standardized experience of urban sanitation, together with sewerage, running water, public lighting, railroads, and streets suited to public transportation.

Towards a present paradigm

IN THE PAST DECADES we have witnessed a paradigm shift in a new scenario characterized by urban, environmental and social complexity. In order to understand these new social and ecological phenomena landscaping deals with, we need to build on Edgar Morin's concept complex thinking. Morin (2008) states that complexity derives from Latin complexus, which means what is woven together, and that complex thinking is "animated by a permanent tension between the aspiration to a knowledge that is not fragmented, not compartmentalized, not redactor, and the recognition of the unfinished nature and incompleteness of any knowledge".

Complex does not mean complicate, let alone obscure or abstruse; it refers to this mode of thinking that integrates instead of separating, connects instead of compartmentalizing.
Now, the great paradigm in western culture from seventeenth to twentieth century –within which landscaping emerges as a discipline– unlinked the subject and the object: the first referred to philosophy, the second to science. But, to quote Morin: "However, "ecologised" thought must necessarily be freed from this yoke and referred to a complex paradigm where autonomy of the living being, conceived as a self-eco-organising being, is inseparable from its dependence. The organism of a living being (self-eco-organising) works without respite, and degrades its energy to maintain itself. To renew it, it extracts it from its environment, on which it thus depends. Therefore, we need ecological dependency in order to ensure our independence".
In this line, the reintegration of complex thinking helps us to understand change in scale and the associated environmental and mega-urban social conditions. Change is constant in any system under study because nature is constantly changing, repairing organisms or functions, recycling organisms, elements and materials. The concepts of ruin and standstill do not apply to nature because it continuously flows, changes, and perpetuates itself.
However, botany –from which landscaping derives– was applied to the study of plants, dissecting and isolating them from environment. So, from the sixteenth century modern botany studied specimens isolated from their environment, i.e. their ecosystem. As explained above, from eighteenth century onward the multiplication of botanical gardens was parallel to the introduction of botanical collections from faraway countries. Scientific research and recreation converged in botanical gardens

and zoological gardens: a visit to "international nature". Research on propagation and acclimatisation stimulated the widespread production of specimens in greenhouses, which resulted in a great variety of plants in public and private parks and gardens.
This international botanical diversity can be found in public and private parks and garden, first in Europe and later in different cities of the world, from eighteenth to twentieth century.
While acknowledging the contribution and historical effectiveness of landscaping in producing a legacy of parks, gardens and green areas, now it is necessary to acknowledge and enhance social and environmental services, and fundamentally the internal ecological processes in green areas and greenways so as to find the key to a greater urban sustainability and to the debate on social distribution of public revenue.
Urban reforms during nineteenth century acted as a response to urbanization and two subsequent factors: the need for a healthier urbanism to deal with epidemics, such as cholera and typhus, and the need to adapt the city to developing rail transport. In a similar way, nowadays the environmental and socio-economical scene is complex due to the growing rate of mega-urban areas at a global scale. The need for sustainability and distribution of social resources –particularly in green areas– is included in a wider debate about territory and arises out of five contemporary scenarios:

1. The exponential growth in urban population and the debate on the related ecological footprint and sustainability in those areas.
2. The tendency in urban world population and the increasing shortage in food and drinking water.

3. The poor environmental quality in megalopolitan areas, where vegetation mitigates its negative effects and conflicts.
4. The growing demand for urban lands and plans for social inclusion, and the need for recreational areas as a social integration tool.
5. The availability of digital satellite cartography, real-time geographic information and thematic statistics, plotted in georeferenced digital maps.

Everyday landscape

A GLOBAL PHENOMENON is developing along with those widespread changes: inhabitants become aware of and value –besides outstanding tourist landscapes– their own everyday landscape, that in which they live, meet up or stroll around. This everyday landscape is perceived in terms of reference and identity. Whether private or individual, public or social, landscaping is the result of urban and residential greening in the permanent process of inventing a city.

Indeed, it is in those everyday landscapes, where inhabitants live most part of their lives, that the concept of landscaped habitat takes on meaning: it is the residential or working place, projected with vegetation to enhance visual and biophysic features of urban environment and buildings.

This concept also encompasses territorial policies that integrate a set of practices relating to agricultural production and social housing, public investment in services and health facilities, education, public safety, and sustainable and ecological regulation of private land plotting. These policies of social inclusion and integration are materialized according to three parameters:

- Access to land and housing: real estate market, land, social housing and urbanization of slums and shanty towns.
- Greening neighbourhoods: public services infrastructure, facilities, buildings greening, urban greening, alternative sources of energy.
- Intercultural integration: community organizations, production of goods; social, economic and cultural services, art, multimedia, socio-economic development.

In this context, urban greening encompasses the use of plants in solving environmental problems, increasing green spaces, rehabilitating degraded lands for productive use, etc.
The term greening is primarily applied to the development of green covers in buildings, e.g. rooftop gardens. In a scenario dominated by increasing energy shortage, this new technology is set up to address energy saving in buildings and then it is applied as urban greening, which brings about many additional benefits. It mitigates urban heat islands in densely populated cities and it also improves the quality of landscape.
Greening residential and working spaces, neighbourhoods and buildings contributes to enhance inhabitants' quality of life and prosperity. The United Nations redefines and broadens the concept of prosperity of cities beyond the solely economic dimension. un also suggests that other vital dimensions such as quality of life, adequate infrastructure, equity and environmental sustainability should be included.
The State of the World's Cities report 2012/2013 mentions some policies that guide the conceptualization of prosperity: Social equity and quality of life go hand in hand.
Equitable cities generalize access to urban commons and public goods, preventing private appropriation and expanding the scope for improved quality of life for all.

Effective public safety is a fundamental 'common good' that enhances quality of life for all, and is a major foundation of urban prosperity.

Cities that re-evaluate their notion of the public and thereby provide green areas, parks, recreation facilities and public spaces demonstrate a commitment to improved quality of life. Having access to public spaces does not only improve quality of life, it is a first step to civic empowerment on the way to further institutional and political spaces.

In this line, changing housing conditions is based on social, environmental, ecological and cultural inclusion. Materialized in public policies, this change faces spatial, ecological and social fragmentation, acknowledged as a critical issue in urban settlements.

In short, urban landscaping practices and the use of ecologically adequate technologies play a significant role in environmental mitigation and rehabilitation and improvement and recovery of urban public and private spaces. The concept of landscaped habitat epitomizes this idea.

A tendency towards the use of vegetation as an environmental strategy is confirmed by diverse urban experiences (Benassi, 2010). Replacing natural land covers with impervious urban surfaces –concrete, asphalt and other inert materials– produces urban heat islands. Absence –or poor conditions– of green and blue areas deepens heat islands. Conversely, vegetation sequesters carbon and reduces electricity demand and fossil fuel consumption. Besides, during the turn of twentieth century industry cities called for restoration of obsolete areas, so obsolete railways, train stations, and ports were replaced by greenways and parks. Technological transformation and changes in post-industrial urban service economy resulted in unused areas and building.

Accessibility to public transport and highly-specialized urban connectivity configured new spatial patterns. Public investment focused on vegetation design and recreational use in urban space results in better distribution of public funds because the movement network runs through and connects diverse social sectors from different income levels. It makes it one of the most democratic deployments of public funds.

Another aspect relating to the social habitat issue is the need to incorporate social landscaping to social housing programs. Housing projects build up cities, consequently urbanization of neighbourhoods and shanty towns poses the question of public space.

It is an integrative process that focuses on the issue of regaining the urban space, formed by public space synergy, and the private residential space, both of which converge in the concept of habitat.

There is a tendency in landscaping design as regards deterioration of freshwater resources. To face water need, landscape projects select plants according to Plant Functional Types (PFTs)[3] –such as xerophytes, halophytic, summer-dormant bulbs, phreatophyte species–, through the projective water efficient landscaping, that is, grouping plants with similar water requirements in hydric-adaphic nuclei.

On the other hand, greening of buildings offers lush vegetation, vegetated roofs or vertical gardens. It has significant impact on environment mitigation: air pollution removal, carbon sequestration, reduction of heat due to evapotranspiration, stormwater management, retention of rainwater, energy conservation through heat insulation and reduction of noise pollution. There have also been experiences in greywater treatment

3 The topic of Plant Functional Types (PFTs) will be discussed in chapter Tools.

using phytomediation or bioremediation. Rizosphere symbiosis and capturing of anions and cations have the capability of concentrating radicals and heavy metals.
We can also mention the benefits of vegetation –as a capturing agent of formaldehyde, benzene and carbon monoxide– in air quality of houses, offices, hospitals, hotels, restaurants and other non-residential spaces.

Table 1. Trends in urban greening

Restoration of urban obsolete areas, lineal parks and greenways

Concept	Opportunities	Benefits
During the late 20th century technological transformation and changes in global economy pushed dirty factory sites outside cities while obsolete railways, train stations and ports left vacant lots and buildings.	Unique urban sites and inner surrounding. Spatial configuration, accessibility and urban connectivity specifically oriented to transport and as a new service.	Greening recycled urban areas, with an emphasis on great scale "urban garden" and green profusion in neighborhoods. Investment ensures equitable distribution because lineality cuts across different urban and social sectors.

Urban greening

Concept	Opportunities	Benefits
Nature recovers its leading role in urban and rural life because plants improve sustainable quality of life. It involves an acceptable and coherent recovery of flora and fauna.	Greening buildings, streets, squares and open spaces in cities, highways, railway lines, circulation areas in general and peri-urban areas. Green ecological covers in roofs and walls.	Sequestration of particles in the air. Oxygen and CO^2 exchange. Reduction of heat by evapotranspiration. Retention of rainwater and stormwater management. Energy conservation by heat insulation. Reduction of noise pollution.

Phytoremediation and environmental bioremediation

Concept	Opportunities	Benefits
In certain plants rhizosphere microbiota symbiosis can concentrate metals in their tissues and in some cases -by themselves or through the bacteria in their roots- they can intake and degrade pesticides, and hydrocarbons in soil or water.	The "garden filters or purifying gardens" and other technologies such as Landfarming or Land Treatment constitute biodegradation methods for soil removal or irrigation, use of fertilizers or microorganisms.	It is an emerging technology for remediating air, soils, sediments, surface and ground water contaminated by toxic metals and organic contaminants. It promotes flora that absorbs dangerous compounds.

Carbon sequestration

Concept	Opportunities	Benefits
The increase in atmospheric CO^2 is a global concern. Trees use CO^2 for growth and storage in the wood, over and under the ground. About half of the weight of a mature tree is elemental carbon.	Carbon offset encourages reduction in emissions of CO^2 and activities working against it. An urban tree is 4 to 15 times more effective in reducing atmospheric CO^2 a rural tree.	Urban forests and plants offer environmental, social, and cultural benefits. In urban heat islands, they save energy by reducing consumption of electricity from fossil fuels.

Social landscaping and integration culture

Concept	Opportunities	Benefits
Social housing programmes for low-income sectors should include a landscaping plan because housing projects build cities. And the appropriation of the habitat is axial in social integration if there is a democratic reconquest of public space.	Considering public space as the gradual development and implementation of a community landscape on the basis of cultural identity stimulating and consolidating forms of social integration.	Improvement in quality of living and landscape as a dynamic reflection of social integration. On three basic aspects: 1. Public engagement; 2. Materialization of landscape and community identity, democratic 3. Democratic custody of areas.

Xeriscaping

Concepto	Opportunities	Benefits
Deterioration of fresh water resources as regards quantity (overexploited aquifers, dry rivers, etc.) and quality (eutrophication, contamination of organics, saline intrusion, etc.) requires optimisation of use. Designs oriented to rationalisation of water and drought-tolerant species.	Foreseeing need for water by 1. Appropriate selection of native vegetation or from similar climates, functional types: xerophyte, halophyte, summer-dormant bulbs and phreatophyte species. 2. Water zoning: grouping plants with similar watering needs.	Conservation of water in the soil by improving its structure and an organic layer on surface obstruct evaporation. Lower maintenance, which saves energy. Enlarged (by local native species) habitat for bees, butterflies, and other beneficial fauna in the area.

Houseplants for reducing indoor pollution

Concepto	Opportunities	Benefits
Polluted urban outdoor now carries a greater number of pathogenic microorganisms or toxic chemical agents introduced by industrial materials. People suffering from "sick building syndrome".	The use of plants in hotels, offices, restaurants and unusual spaces such as "green gardens" in hospitals. The most studied species showed significant efficacy in the capture of formaldehyde, benzene and carbon monoxide.	It is difficult to keep quality of air in homes and offices due to presence of new materials in construction, cleaning products, malfunction of equipment. Impact on humidity, foliar dust retention and volatile substances sequestration via the stomata.

MODELS

Urban Green Infrastructure

For landscaping practices to be a sustainable contribution to megalopolitan territories, to interact with regional territorial and environmental policies, with social housing programs, with the supply of the real estate market, in short, to intervene in the complex present city, a *green urban infrastructure* planning is necessary.
To attain this, it is necessary to know and interpret urban vegetation and to propose territorial models that take into account continuous change in landscape and vegetation, and present urban transformations.

Urban Vegetation

THE STARTING POINT for a practical and theoretical approach to modern landscaping is to interpret *urban vegetation*. In contrast with traditional technical approaches, this book proposes the concept of urban vegetation, that is vegetation in urban landscaping.

Urban vegetation is added up as an assortment to any other vegetation covers, regardless of their origin.

Today the concept of urban vegetation encompasses vegetation derived from protection, incorporation, plantation or cultivation in private or public urban spaces, and related to bioclimatic impact and environmental mitigation. It integrates green land covers into the built fabric, such as forests, jungles, swamps, mangroves, weeds along shoulders of highways, urban wooding, growing areas, gardens and grass. Implanted or spontaneous in or on the urban fabric, it is an integral part of landscape and contributes to urban projects and territorial planning. This type of vegetation produces photosynthesis and stores information about nature, but when integrated into the urban artefact ecosystems have urban legitimacy, i.e. it is the human factor that validates them.

In this line, this type of vegetation represents a second nature, which is cultivated, and simultaneously a third nature, considered from an artistic perspective in relation to a cultural conceptualization of beauty. That is, that vegetation reflects –and results from– symbolic elements.

Moreover, vegetation is also mediation because there is no direct access to plain vegetation in the urban space; nature is what human beings believe nature is. So, vegetation mediates between social objectives, symbolic purposes and hazard in the system of urban artefacts characterized by continuous change.

In a nutshell, a landscape of culture and a culture of landscape. In the past two centuries urban tree planting and landscape in open spaces materialized within the fabric of the urban void, a fabric formed by streets, squares, highways, ring roads. Landscaping accurately turned these areas into vegetated spaces, either for recreational or circulation purposes. That vegetation played a role in the integration of urban landscape –a morphological diversity of buildings and dwellings– and, at the same time, it brought about a bioclimatic enhancement of the urban micro-climate.
This tradition consolidated a tree and green areas heritage and, during the industrial expansion in 20th century, plants from different origins flourished spontaneously in waste lands. Those "green urban patches" constitute an heterogeneous group of open and lineal areas systems, namely:

- areas with a specific and particular structure and composition, with a definite design and function, that are protected and preserve in the traditional way;
- remaining land and natural vegetation areas that have survived in the urban fabric;
- communities of diverse naturalized species, different from original vegetation but with autonomous evolution, or miscellaneous natural and exotic species.

In the city, different environmental conditions derive from disturbances caused by intense human settlements in the urban habitat. Thus, urban greening functions as protection, incorporation or implementation of vegetation growing for landscaping purposes, unrestrictive use and environmental mitigation.

Within the megalopolis scale, such procedures include management, planning, design and engineering, management of anthropized vegetation systems contributing to an environment suitable for life quality in the city.

Territorial models

URBAN VEGETATION, in a dynamic state, results from landscape design, engineering and management and can be articulated as *green urban infrastructure*. In other words, a system of green and blue areas and pathways joined to and integrated into the built up area of rough, lifeless rooftops, sidewalks and streets. Therefore, we are dealing with open vegetated spaces teeming with vegetation, bodies of water and watercourses that display the biological cycles of matter and energy in ecosystems, thus offering environmental and visual quality as well as quality in services and usage, etc.
In this section we propose four theoretical models that aim at providing an explanation to examine landscape territory and management and planning of urban green infrastructure. That is, the aim of these models is to introduce the issue and to advance strategies and tools for intervening in the territorial landscape. The models, in a hierarchical order of complexity, are:

1. Landscape scales.
2. Green territorial units.
3. Public use and access.
4. Plant associations.

Landscape scales

A *scale* is a category for spatial analysis, it is a relational concept. The term scale is primarily used to refer to mathematical relations between a real object and its representation in a layout or map. In landscaping, it is used to explain landscape processes and states, that is, how a landscape unfolds in a certain space and time span.

Scales allow different perspectives on landscapes; in our case, from ecological factors in relation to vegetation, and from vegetation to its influence on landscape and urban environment. In order to understand vegetation as a constituent phase of urban infrastructure, it is necessary to determine the influence of structural and functional ecological components, which shape a mosaic of ecosystems.

In that mosaic, ecological processes depend on spatial relations and develop in a specific heterogeneous space. Spatial heterogeneity takes place when at least one variate or biologically significant factor varies spatially. Thus, a landscape necessarily implies spatial heterogeneity and, consequently, those ecological processes are bound to the scale concept, which, in turn, allows their translation into qualitative and quantitative terms.

Landscape scales help us to understand scales of ecological factors that determine diverse *plant associations* –communities embracing vegetable organisms and all their particular environmental conditions– that recur in ecosystems.

Landscape scales capture hierarchical relations of superordination and subordination: at a regional level constitute a *mosaic* (heterogeneous grouping of systems), at the urban level, a *fabric* of the interwoven public and private spaces, the built urban morphology, and at the local level, a *space-environment* regarded as residential habitat.

Table 2. The scales of landscape

The regional condition	The urban condition	The local condition
Mosaic	Fabric	Space-Environment
Zone	City	Residential habitat

These different landscape scales allow for the interpretation of the anthropized state, a grading scale between anthropic activity and pristine ecosystems, or for the differentiation between diverse environmental states with different levels of human modification. These modifications appear in a wide range of landscapes, from productive extensive and intensive crops and livestock farming to urban space.

Green territorial units

There is a great variety of green spaces and pathways, flora and fauna reserves, tree-lined streets, highways, esplanades, private and public parks and gardens, as well as a series of vegetated spaces for – among others– recreational, educative, cultural, and environmental uses. In contributing to life quality in urban areas, these vegetation patches integrate ecological purposes with social needs.
Historically, there has been a conflict between hierarchical levels in nature organization and the different scale levels in the socially constructed landscapes. Within production of urban residential land, infrastructure and services are more market-oriented than committed to preservation or enhancement of ecological functions or maintaining environmental urban quality through an adequate proportion between green and blue areas and built dwelling or infrastructure areas.
It should not be neglected that living organism constitutes a

hierarchical biological organization in itself –genes, cells, tissues, organs and systems– within a higher-level organization, such as animals or plants. That is why they integrate population with organisms of the same species. At the same time, these populations are embedded in a community, that is, a group of populations of different species.
Ecosystems are a level of organization that integrates communities interacting with the environment in a spatial –thus, hierarchical– distribution in the megacity. An ecosystem is a group of living organisms from different species that share space and time, interacting among them and with the abiotic environment. It is an open, self-regulated biological system constituted by biocenosis and its functional processes or eco-functions. Ecological hierarchy is the interconnection and organization through which high-level organisms organize, limit and control the behaviour of lower levels.
Within the urban environment, urban vegetation has the potential to relate –in the urban fabric– the main spatial categories deriving from landscape ecologies to those traditional units of landscape planning. It aims at producing physical and functional connectivity.
In this way, all the elements in a territory can be assimilated into a hierarchical system: higher superordinate orders and lower subordinated orders. According to the scale model, for regions and cities we consider (Burel y Baudry, 2001):

- matrix: the prevailing element in landscape. In rural landscapes, the concept of agricultural matrix is used to designate the set of parcels for intensive or extensive crops. Within the matrix we have green belts –floriculture, horticulture and nursery–, that are intensive production systems.

- patches: landscape elements defined by size, form and type. Continuous surface areas in which a local population find all necessary resources and that is separated from other favourable patches by an unfavourable patch.
- biological corridors: linear landscape elements whose physiognomy differs from from the surrounding environment. These corridors connect and conduct ecosystems through the urban space. They may be groves, riverbeds, creek lines or linear parks in cities. Corridors provide for connectivity among metapopulations.

In cities:
- social hubs;
- grid and street fabric
- open spaces of typologies and sizes.

Table 3. Green territorial units

Regional mosaic			**Urban fabric**		
Region			**Cities**		
Matrix	**Patches**	**Corridors**	**Hubs**	**Grid or fabric**	**Open spaces**
Extensive and intensive, rural and peri-urban production systems	Blue areas lakes, lagoons, bodies of water	Rivers, streams, banks, coasts	Green paths and linear parks	Accesses and traffic hubs, streets, boulevards, avenues	Urban Park Blue areas sports fields
Urban and industrial miscellaneous	Regional park Silviculture	Railways and highways	Greenways Interurban highways	Tree-lined and landscaped esplanades	Squares, small square, public garden
Phytogeographic representation National parks	Natural reserves Natural parks	Continuous slopes	Urban streams bodies of water, coasts	Tree-lined and landscaped sidewalks	Caves, quarries, green spaces on slabs

Thus, for example, in a system of green pathways and spaces we can articulate:

- creeks and obsolete railroads, as potential greenways and pathways;
- combining creeks and railroads: bridges, stops and information signals;
- old rail stations with receptive capacity, food service, security service, first aids, toilets;
- other access areas to natural spaces and regional cultural parks, to periurban and rural productive systems;
- preservation of local ecosystems and possible participation of NGOs in educational and interpretation programmes on ecology, socioeconomics and local production.[4]

Such integrated systems are more self-regulated and allow for corrections and adjustments, within a management plan with feasible and functional variants.
Approaching an integrated landscaping territorial model would provide the tools and strategies required to enhance an integrated and functional system of efficient management units –which encompass different spatial categories–, that should be managed and projected. Thus, landscaping restores highly degraded environments on the basis of four guiding principles:

1. It is the eco-functional groups, and not fractions, that should endure; it is the functional capacity of the system, and not the plant as an isolated element, that should be maintained.

4 Plan Bicentenario ciudad de La Plata. Benassi y otros, 2008.

2. It is needed to connect recreationally and to link systematically in order to relieving and decentralise land uses and, consequently, to streamline the number of people on green absorbent surfaces. That means restoring natural corridors, namely watercourses, wetland borders, river banks and potentially green corridors, such as obsolete railways, shoulders, freeways with green areas designed according to new landscaping criteria. Instead of traditional model of urban parks to line freeways, we propose relict native flora or reintroductions, or even introductions, of flora that do not need regular maintenance so as to create more interesting and creative landscapes.
3. In relieving land use, landscape quality would be guaranteed by an interconnected system; it is the territory as a whole –and not the square or the urban park as "isolated islands"– which is enjoyable.
4. In a system, numerous recreational and cultural stepping stones turn it into an active promenade that includes receptive capacity instead of conceiving it as just a path leading to a recreational-cultural destination.

Use and public access

Urban green spaces are part of the open public space for recreational and aesthetic uses. Cultural, civil and institutional, commercial, social and recreational activities take place within green spaces. Scales of social use depend on the purpose spaces were created for, the type of public access and use. It is therefore necessary to define variants according to access and purpose. Green covers *in* and *on* built up areas, regardless of their origin, are intended to create a system of spaces, surfaces, pathways and greenways in a physical and social context that allows to assess

the functional influence of every space and green network in order to enhance quality of life in the city.

The green urban network comprises green areas and tree-lined streets, sites of memory or landscape spots of unique, outstanding value, historical testimony or from historiography chronicle, intangible archaeological site or outstanding cultural expressions or others that are granted a particular protection status due to an outstanding value.

Squares, parks, roads, rivers, lakes, sea, seashores, all are specially valued by the community. Hence, the State has protected them, according to Public Law, by a special legal status qualifying them as property of the public domain with specific characteristics –inalienable and imprescriptible– that safeguard them from trading (sale and leasing, etc.) under Private Law and that only allow procedures regulated by Public Law: temporal and revocable permit of use.

Legislation on green spaces determines surface indexes for green spaces and absorbent surfaces, recommended internationally and regulated by different urban codes. Traditionally, open and public green spaces were defined as those public areas (in which vegetation and landscape predominate) whose main function is to provide recreational opportunities to the community and to contribute to the environment purification.

The public green space allocation of a minimum 10 m^2 per inhabitant is internationally widespread. It is worth mentioning that streets, rivers and greenways are not considered; that I to say, this criteria is only applied to squares, plazas, urban and regional parks. However, we can find good examples, such as Curitiba, Brazil, with a ratio of 50 m^2 of green spaces per inhabitant.

On the other hand, parcel spaces are those areas for urban and rural lots; due to their purpose, spaces for urban parcels are

designated building spaces. In urban areas, exurban residential areas, industrial sites, and spaces for other uses as well as in rural areas limitations to the use of land are imposed by FAR[5], with a maximum allowable FAR not higher than 0.6. Minimal indexes –a standard 10 m² per inhabitant– of open public green areas are discriminated according to space type and distances: for private space, the building floor area cannot exceed 60%, leaving the rest as absorbent surface.

Table 4. Free green area per capita discriminated by type of space and distance

Public green space	Small square or neighborhood garden	Neighborhood square	Urban park	Regional park
Use	Daily		Regular	
m²	3,5 m²		2,5 m²	4 m²
Distance and time	Up to 500 m		1000 m or 1/2 hour	Up to 1.1/2 hour
Private absorbent empty space	FAR: Land use restrictions Built-up area up to 60% of parcel			

However, these urban standards take into account only qualitative factors. They do not consider geographical latitudes, weather conditions nor regional flora for determining quality and quantity criteria of vegetation. Neither do they consider the social and environmental impact that vegetation provides. On the basis of the model above, we propose a revision of social use based on the scales and objectives of different spaces and according to the types of access and public use.

5 Floor Area Ratio (FAR) is the relationship between the total floor area occupied by a building and the surface of the un-built parcel.

In this way, open spaces become green spaces along with urban natural reserves and linear spaces that interconnect then ecologically and socially. That is why the main issue to consider is unrestricted public access; then, spaces with certain type of restriction, but which in a way hinder the objectives that lead to their creation and preservation: recreational, educative an socializing function. It is important to highlight that surfaces in core and buffer zones and those regulating the flora and fauna are not taken into account in the allotment of green square metres per inhabitant because only green square metres in unrestricted public access are considered. On the other hand, the objective is considered according to how long the public stays and how it circulates either for daily use, periodical use or camping. Camping is only considered legally in private space registered as "campsite".

As for purposes based on social connectedness and biological connectivity, a priority order is perceived in the social connectedness –the weakest and in-need users being the most important–: pedestrian and bicycle access, access by train with bicycle carriage facilities, access by train without bicycle carriage facilities, access by public transport, access by private charter or tour, access by private vehicle only, access by individual motorbike.

A scale of decreasing weighting.

This model also considers biological connectivity for flora and fauna, on one side, and for the public, on the other, either human-made or natural corridors.

It also provides for cases of corridors with mixed connectivity, either social or biological.

Table 5. Purpose of the spaces relative to type, access, circulation, and recreational uses

Green areas **Purpose**	**Natural and urban reserves** **Purpose relative to access**			**Interconnection** **Purpose relative to duration of stay**		
Access **Unrestricted**		**Access** **Optional**	**Access** **Restricted**	**Duration** **of stay**	**Circulation**	
Daily use	**Regular use**		**Research**	**Annual /** **seasonal**	**Courses** **walkways**	**Fabric**
Garden square Neighborhood square Urban park	Regional park Educational area Regulatory zone or buffer		Core area	Tourism Camp	Green pedestrian connection	Sidewalks and esplanades

Population: m²/pp Population served.
Purpose relative to access: Unrestricted use, optional use, restricted use, educational and recreational area, buffer zone regulating biosphere reserve, core area intangible nature.
Purpose relative to duration of stay and circulation: daily use, regular use, camping
Purpose relative to social connection and biological connectivity:
Social connection: 7 pedestrians and cycling-pedestrian, 6 train + cycling, 5 train - non-cycling, 4 Public transport, 3 Charter-tour, 2 private vehicle, 1 Mopeds. (assigned values should decreased as weighting)
Biological connectivity: Artificial corridor, natural corridor. Mixed connectivity (social + biological).

Taking into account the model of green territorial units, it is possible to make inventories –according to public domain– of the elements in the matrix, patches and corridors as considered by landscaping ecology, which in turn facilitates their management on the basis of purposes and social access or restricted public access. At the same time, that allows to discriminate units within the private domain which require, in any case, to be handled in a different way.

Table 6. Matrix-inventory of regional mosaic

Cadastral information	Matrix			Patches			Corridors			TT
Legal domain	**Pub.**	**Priv.**	**Mix.**	**Pub.**	**Priv.**	**Mix.**	**Pub.**	**Priv.**	**Mix.**	**km²**
Area units and % km²										
Purpose according to public access										
Unrestricted access										
Optional access										
Restricted access										
Recreational and educational area										
Buffer zone regulating reserve										
Intangible core area or reserve										
Biological connectivity										
Artificial corridor										
Natural corridor										
Mixed connectivity (social + biological)										
Total according to domains km²										

Finally, inventory is made –for the urban fabric of pathways and open public spaces– according to type of user in a priority order, from pedestrian or cyclist down to motor vehicles (public or private), so as to highlight the relative weighting and social importance of different urban spaces, which are the subject of planning and inversion.

Table 7. Matrix-inventory of the urban fabric

Connectivity relative to main purpose and use	Highways, roads, green trails, linear parks connectors	Grid and urban fabric	Open areas and green covers	TT Hm²
Area and % Hm² - Has				
Social connection				
Pedestrian				
Cycling				
Train + cycling				
Train - non-cycling				
Public transport				
Charter-tour				
Private vehicle				
Moped				
Unrestricted use				
Optional use				
Restricted use				
Daily use				
Regular use				
Camping				
Totals by type of GW or GA				

Table 8. Regional management of megalopolitan green infrastructure

References

Domain
PU: Public
T: Type code
PR: Private

Magnitude (Size)
TA: Total Area

Purpose: type, use, access, duration of stay and circulation
Purpose according to type:
SS: Small square
SQ: Square
UP: Urban park
RP: Regional or Naturalistic Park
Flora and Fauna: natural reserves
Purpose according to access:
UA: Unrestricted access
OA: Optional access
RA: Restricted access
REA: Recreational and educational area
BA: Buffer zone regulating reserve
CA: Intangible core area or reserve
UU: Unrestricted use
OU: Optional use
RU: Restricted use
Connectivity purpose
A: Priority social connectivity: Pedestrian. Cycling. Train + cycling. Train + non-cycling. Public transport. Charter-tour. Private vehicle. Moped.
B: Biological connectivity: Artificial corridor Natural corridor
C: Mixed connectivity (social + biological)

Unit of analysis	**Domain and magnitude**					**Purpose**										
GPS, GIS	**Cadastral polygonal Topographic: Topographical surveying**					**Recreation/ Education**				**Reserves Flora-Fauna**			**Connectivity**			**TT**
	Domain Fiscal condition				**Mg**	**UA + (INDEX: m² pp.) Daily and Regular Use**					**OA**	**RA**	**Duration of stay and circulation**			
Qualitative. Use and access	**PU**	**T**	**PR**	**T**	**TA**	**SQ**	**SQ**	**PU**	**PR**	**REA**	**BA**	**CA**	**A**	**B**	**C**	
Qualitative-Quantitative. Conditions. Remote Sensing: Area %	**AREA**	**AREA**	**AREA**	**AREA**	**AREA**	**AREA**	**AREA**	**AREA**	**AREA**	**AREA**	**AREA**	**AREA**	**AREA**	**AREA**	**AREA**	**AREA**
Regional or Naturalistic Park																
Flora and fauna reserve																
Blue areas: Seaside and freshwater																
Permanent, seasonal																
Fresh, brackish																
Artificial, natural																
Major courses																
Minor courses																
Ponds																
Lagoons																
Lakes																
Large lakes																
Quarries, dikes, etc.																
Biological connectivity																
Artificial corridor																
Natural corridor																
Mixed connectivity (social + biological)																
Social hubs Highways, roads, green trails, linear parks connectors																
Grid and urban fabric																
Open areas and green covers																
Totals by domain Km²																

In this way, a system formed by different spaces and greenways can be formalized from a typological, legal and functional-territorial perspective. This model intends to, on the one hand, accomplish an interconnected system of *green urban infrastructure* so as to yield social and recreational capacity and quality and, on the other hand, to integrate structures and functions within and between ecosystems into the functional relations –among water, fauna and flora– in the region.

Plant associations

Cultural landscape is characterized by a myriad of environmental units that, according to their form and transitions, shape either a gradient or sharp edges between their different anthropized units. In order to understand the variety of flora and fauna, either original or anthropized, we resort to an ecological model based on *life zones*. Leslie Holdridge[6] developed this concept when he discovered that units affects not only vegetation but animals too, and that each unit generally predicts an ecologically different type of habitat and, consequently, a different type of life.

Holdridge classifies life zones according to four factors determining local biological association: climatic, edaphic, atmospheric and hydric.

A plant association is defined in terms of environmental second-order –or localized– factors, such as soil, drainage, topography, strong winds, fog and precipitation distribution, even when heat, annual precipitation and moisture are the main factors regulating environment. Variation in second

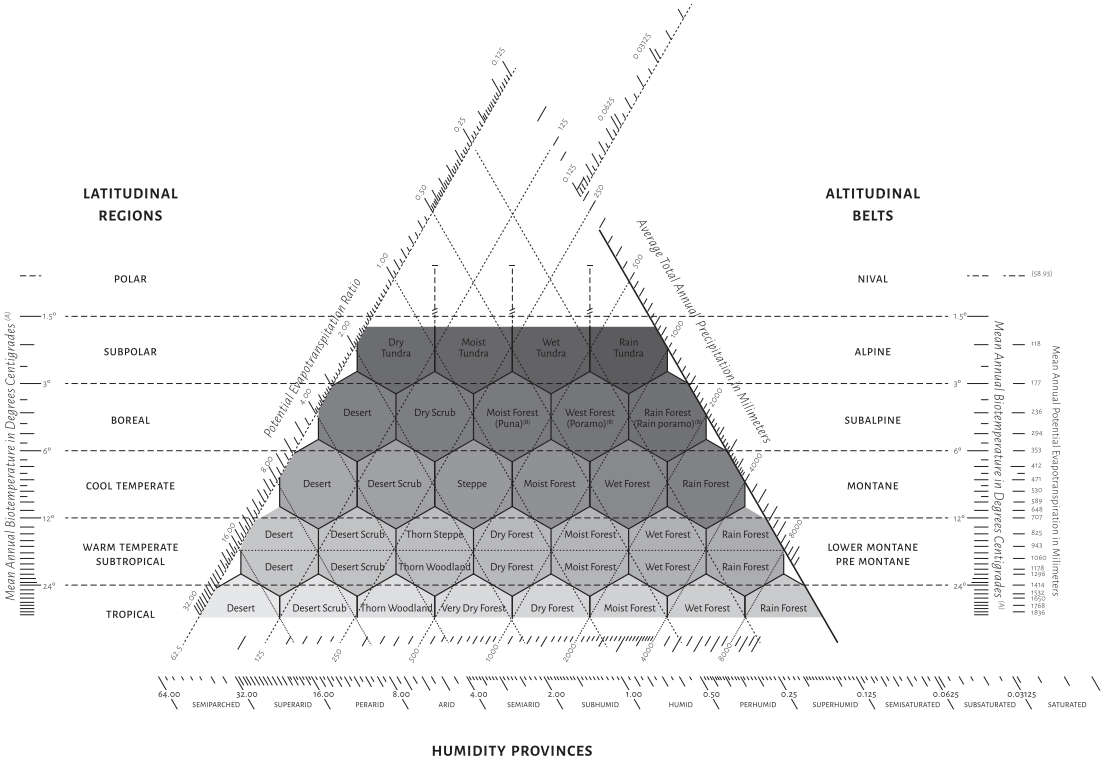
6 Leslie Holdridge (1907-1999). He was an American ecologist and dendrologist. In 1947 he first published "Determination of world plant formations from simple climatic data", revisited in 1967 (Life Zone Ecology).

order factors determines or subdivides big life zones into ecosystems, which comprise clusters of smaller environmental conditions and, consequently, of local expression. However, it is also possible to establish many combinations of climatic, edaphic, atmospheric and hydric associations (Holdridge, 1967). Then, the term association not only refers to a community of specific organisms, but also a specific context of environmental conditions.

This allows us to refer to a specific environmental unit and to map it as an area, regardless whether the original flora and fauna community remains pristine or, conversely, is deeply modified by human activity. In this system of life zones, an existing vegetation not always correlates with the designation of the corresponding life zone. Temporal changes in ecosystems can be produced by natural succession or introduced by human beings, animals or uses of land. Traditional landscaping has manipulated those factors from its origins through its development as vegetation, topographic and hydric engineering.

Thus, Holdridge proposes a model of elements and geographical factors variables at a regional and local scale, with a close relationship among vegetation, design and engineering. Landscaping intervention in highly anthropized or degraded environments could base it project on variables relevant for vegetation, to protect them either in their natural succession processes or in case of degradation of the supporting soil or fill, a mix of horizons or desurfaced uppermost horizons. This entails knowing climatic elements and ecological factors influencing certain types of plant associations, as well as their weigh in terms of scaled factors.

Clases de Holdridge



(A)
bio = Mean of unit-period temperatures with substitution of zero for all temperature values below 0 ºC and above 30 ºC respectively. (This formula is tentative pending further investigation).
(B) = In Tropical Subalpine Only

In order to determine a life zone, mean annual temperature, total annual precipitation, ground elevation and diagram of life zones should be obtained. Mean annual biotemperature is determined, based on mean monthly temperatures, considering zero temperatures below zero or above 24° Celsius, depending on latitude:
Biotemperature: : Tbio = t – (3*Latitude/100) * (t – 24)\2).
Where t is the mean monthly temperature in degrees centigrade and tbio= mean monthly biotemperature.
The diagram makes it possible to identify the point at which biotemperature and precipitation meet, this point falls within an hexagon containing the names of existing primary vegetation –or vegetation expected under normal conditions–. Next, the altitudinal level of the life zone regions is identified to the right of the diagram –determined by differences in biotemperature–. And finally, latitudinal region is identified at the vertical scale to the left. Each of them, altitude and latitude, corresponds to an equivalent at the altitudinal base to the right of the diagram.

The classification in Holdridge's model:

01. Polar desert
02. Subpolar dry Tundra
03. Subpolar moist Tundra
04. Subpolar wet Tundra
05. Subpolar rain Tundra
06. Boreal desert
07. Boreal dry Scrub
08. Boreal moist Forest
09. Boreal wet Forest
10. Boreal rain Forest.
11. Cool temperate desert
12. Cool temperate Scrub
13. Cool temperate Steppe
14. Cool temperate moist Forest
15. Cool temperate wet Forest
16. Cool temperate rain Forest
17. Warm temperate Desert
18. Warm temperate Desert Scrub
19. Warm temperate Thorn Scrub
20. Warm temperate dry Forest
21. Warm temperate moist Forest
22. Warm temperate wet Forest
23. Warm temperate rain Forest
24. Subtropical desert
25. Subtropical Desert Scrub
26. Subtropical Thorn Steppe-Woodland
27. Subtropical dry Forest
28. Subtropical moist Forest
29. Subtropical Wet Forest
30. Subtropical rain Forest
31. Tropical Desert
32. Tropical desert Scrub
33. Tropical thorn Woodland
34. Tropical very dry Forest
35. Tropical dry Forest
36. Tropical moist Forest
37. Tropical wet Forest
38. Tropical rain Forest (Pluvisilva).

The starting point for a green landscape engineering should be to identify different ecological elements and factors influencing the diverse plant associations. From the panorama of elements and factors, we consider an engineering able to deal with a gradient of environmental states that guide diverse multi-scaled or qualitative different vegetation strategies.

Table 9. Ecological elements and factors

Climate elements	Solar radiation Temperature Humidity Winds Precipitation Evapotranspiration Heliophany Barometric pressure
First order factors. Meso-climatic	Geographical latitude Geographical altitude Orography and topographic relief
Second-order factors. Microclimatic	Edaphic properties, slope, shading or exposure Water conditions Vegetation type and degree of coverage Relief
Urban elements and factors	In large urban scales these factors are modified as ecological neo-factors from the point of view of urban vegetation. The concept of vegetation site in the urban environment is extremely changing, diverse and unpredictable, even at minimal localised scales: the building morphology has a direct impact by reducing solar radiation, wind in turbulence, buried soils lacking exchange of atmospheric air. These built-up areas make up huge impervious urban surfaces.

Using Holdridge's model with mean temperature in the urban climate could indicate a movement or shift within the life zone corresponding to the urban region or the unit under study.
It could even be the case of skipping a cell, providing a plant potential in order to investigate new Plant Functional Types (PFTs) introduced by landscape design to mitigate or solve functional environmental problems in those particular urban condition.
Thus, using Holdridge's Model would allow for a regional theoretical model and a local engineering of second-order factors, as supporting system of actual or potential plant associations, and a repertory of experiments with Plant Functional Types on tensions conditions and environmentally endangered areas.

Table 10. Climatic elements and factors on regional scales

Regional environment **Regional geographical elements and factors**	**Urban environment** **Neo-Factors** **Urban vegetation: spontaneous and cultivation**	**Local environment** **Local ecological factors**		
Climatic elements and factors	**Elements and factors of the urban neo-climate**	**Edaphic factors**	**Atmospheric factors**	**Water factors**
The regional condition	The urban condition	The local condition		
The mosaic landscape	The fabric landscape	The site-environment landscape		
Region scales and measures km^2	Cities scales and measures hm^2 or ha	Places scales and measures m^2		

STRATEGIES

Projects in time and space

In the field of landscaping, the scope of planning and designing projects extends beyond maintaining and enhancing urban spaces with vegetation. Planning present landscape entails developing territorial strategies encompassing the political dimension as well as biological activities in the city. Thus, planning and designing is playing with a crucial variable: constant change in urban vegetation. Within this context, landscaping pays attention to those changes and that randomness so as to weigh, assimilate, direct or redirect them. So, to intervene extends beyond maintaining vegetation; it is liberating autogenic change in nature, triggering new ecological activities.

The hard-to-accept change and randomness

IN THE URBAN SPACE, plant communities implanted by landscape design as well as spontaneous or ruderal[7] communities are subject to randomness, unpredictable events, that is why there are no stable conditions en the plant trajectories and succession. Stochastic processes and succession of random variables are more important than determinants in spontaneous succession of urban biocenosis, closely related to territorial, environmental and cultural history of the city.

As Hough (1998) states, there i a contradiction of values in the city: "two landscapes have long existed side by side in cities. The first is the nurtured 'pedigreed' landscape of mown turf, flowerbeds, trees, fountains and planned places everywhere that have traditionally been the focus of civic design. Its basis for form rests in the formal design doctrine and aesthetic priorities of established convention. Its survival is dependent on high energy inputs and horticultural technology. Its image is that of the design solution independent of place: it can be found everywhere from Washington DC to Jakarta, Indonesia; from the city centre to the outlying suburbs. The second is the fortuitous landscape of naturalized urban plants and flooded areas left after rain that may be found in the forgotten places of the city. Urban 'weeds' emerge through cracks and gratings in the pavement, on rooftops, walls, poorly drained industrial sites or wherever a foothold can be gained.

They provide shade and flowering ground cover and wildlife habitat at no cost or care and against all the odds of gasoline fumes, sterile or contaminated soils, trampling and maintenance men".

7 Plants, species or plant communities growing in anthropized areas, such as roads, debris, patios, roofs, etc.

Composition of initial species –either by landscaping project or growing ruderals in disturbed land– determine unpredictable change if allowed to develop autonomously, that is, without landscaping management or redirection. Hough also points out that there is also a third landscape "hidden away in back alleys, rooftops and backyards [...] expressing rich cultural traditions, and the imperatives of necessity. The forces that shape the built vernacular, in fact, have remarkable parallels to the fortuitous landscape. Both have evolved in response to minimum interference from authority."

A key to sustainability in urban vegetation would be that the three landscapes –formal, ruderal and domestic, as anthropic and neo-ecological emergents– could be integrated into the city according to the landscaping project. These three landscapes represent guided processes as well as autonomous processes unfolding in a spatial heterogeneity and bearing diverse ecological states. In this context, it is also important to address group expectations related to desired landscapes as well as interculturality, that is, fostering dialogue, agreement, integration and coexistence among diverse cultures.

This threefold integration could be made possible by a model of dynamic green covers that would allow to continuously monitor and evaluate stochastic states and changes as well as management plans. Thus, *management* replaces the traditional concept of *maintenance* and constitutes itself into a type intervention that incorporates constant change into green urban spaces and greenways. This management would lead to an estimated dynamic and crucial balance between autogenia in the vegetation system, social services, bioclimatic enhancement, flora and fauna protection and environmental mitigation across different urban scales.

A proposal for landscaping intervention

INTERVENTION implies actions and procedures informed by a theoretical background. So, from this perspective, we propose to identify the *territorial conditions* and *landscape circumstances* of any site to be intervened. Based on the analysis of conditions, we can distinguish the level of intervention according to:

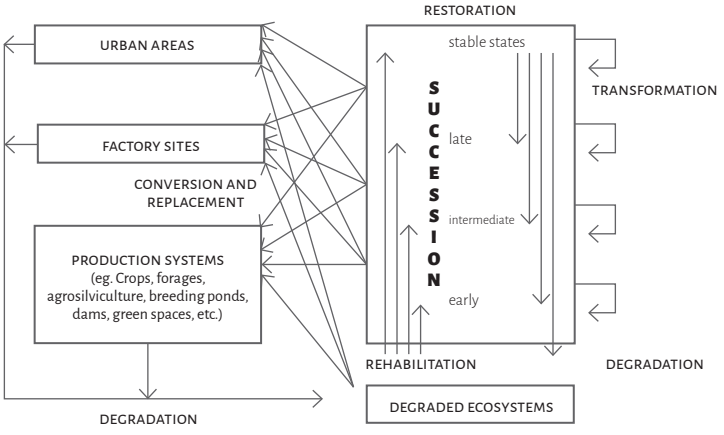
1. domain: public or private;
2. size or scale of the site;
3. purpose or objective: function, programme and uses, simple and intensive or high complexity and diverse. Programming organizes, relates, complements and distributes spatially purposes and integrated uses.

Estas condiciones territoriales en las escalas del paisaje se traducen del siguiente modo:

Table 11. Territorial conditions

The regional condition	The urban condition	The local condition
Mosaic	**Fabric**	**Site-Environment**
Region	**City**	**Place**
1. Complexity of legal domains, management skills: fiscal, public and private. 2. Production systems and services systems, green reserves, flora and fauna, etc. 3. Touristic functions and territorial regulatory functions.	1. Domain: public and private. 2. System of green areas and trees as urban vegetation. 3. Environmentally regulatory, cultural and recreational functions.	1. Domain: public or private. 2. Magnitude of the surface of the plot polygon. 3. Program of residential needs.

Ecosystems in the regional, urban and local landscape scales represent a gradient of states, from relatively pristine states to those strongly modified by human activity, and to the point of extreme degradation. Strategies of use and management of ecosystem are based on those scales according to the level of anthropic disturbances.



Use and management strategies in ecosystems
(taken from Jorge Frangi, 1998)

At the same time, *levels of intervention* are derived from these conditions: an emerging process of social purposes in order to perform actions through plans and projects in different areas and at different levels.
On the other hand, identifying landscape circumstances supposes interpreting the environmental state of a site. According to the contingency of the state of vegetation resources, a site can be categorized as *consolidation, representation, fragmentation or degradation* (Benassi, 2010). Circumstances result from the environmental history of the site to be intervened. Based on this result, a possible trajectory of plant succession

is interpreted and different types of *autogeneic* or *allogeneic* changes are verified at different levels. If this interpretation is left unaddressed, projects would be decontextualized, arbitrary, and would not contemplate the limitations; besides, potentials to integrate an integral management would be disregarded.

Changes in vegetation
(taken from Silvia Bocanelli, 2006)

<table>
<tr><td colspan="2">a. Phenological changes: these are changes that affect vegetation physiognomy seasonally due to their life cycles.</td></tr>
<tr><td rowspan="2">b. Changes in composition: coverage and frequency of species</td><td>Autogenic changes: changes induced by vegetation itself, it is an autogenic succession (the gradual modification of the fertility of soil or changes in the humidity produced by the accumulation of plant litter).</td></tr>
<tr><td>Allogeneic changes: changes not induced by vegetation but by external factors (fires, hurricanes, floods, avalanches, etc. which cause the death of local populations to be replaced with new ones).
Primary succession: succession on a bare area where there was no vegetation.
Secondary succession: succession on areas that once had vegetation but it has been destroyed.</td></tr>
</table>

Landscape circumstances are:

- **Consolidación:** consolidated traditional green spaces and tree-lined streets.
- **Representation:** reserves or spaces with valuable flora and fauna functionally related on a territorial mosaic, but vulnerable and exposed to intensive uses and urban treading. In this category we also include historic gardens and parks, and landscapes of unique, outstanding value, historic or

archaeological intangible value or outstanding cultural expressions, which are granted a particular protection. Geographical, geomorphological and hydraulic landforms are included.

- **Fragmentation:** fragmented spaces surrounded by an urban vegetation system or regional mosaic. Fragmented spaces exhibit dysfunctional native or naturalized remnant vegetation and are associated with regression or change in soil. A plant patch or parcel involves and develops diverse functions in the ecosystem, and its surface –devoted to different uses and occupancy– can be fragmented. Any fragmentary subdivision hinders an integral treatment aimed at developing new uses and functions in the ecosystem.
- **Degradation:** structurally degraded spaces that have lost their systemic functions, and cannot cater for social or environmental services.

Working with circumstances implies dealing with green spaces and pathways, watercourses and bodies of water, natural flora and fauna reserves in which we may find:

- valuable functional flora representations, which still have functional relationships with a mosaic, exposed to urban treading;
- fragmented spaces in regression within a regional mosaic;
- structurally and functionally degraded spaces that cannot provide social or environmental services.

At the same time, different *types of intervention* are derived from these circumstances resulting in vegetation strategies and application of different tools.

Vegetation strategies

Unlike pristine ecosystems, in green urban spaces productivity is measured against environmental and recreational services, stability of cycles and the public and social use of its components. So, intervention faces different types of sites and environmental states.

Environmental state or landscaping circumstances, as aforementioned, are: consolidation, representation, fragmentation and degradation. Based on these four standardized states, three possible *vegetation strategies* are defined:

1. **Conservation:** it implies minimal, or eventually none, human intervention in the ecosystem to be protected, leaving it to develop freely –autogenia– even if administrative policies and non-disturbing activities in the environment are required.
2. **Transformation:** this category, based on the functions of the ecosystem, modifies the structure of the natural or anthropic system while keeping part of the structure unaltered so as to achieve a worthy goal. In this way, the system is guided towards predominance of organisms that provide certain benefits. A classic example is management of forests for wood supply or the adaptation of certain areas in a forest to visitors' uses.
3. **Conversion:** to replace an ecosystem with a different ecosystem by human intervention. Any type of productive cultivation is a conversion, either species-specific or consortial. A classical example are trees and herbs cover in squares or promenades where the original surface was dune or steppe.

Synchrony and diachrony

BASED ON levels and types of intervention, we work with two strategies that constitute necessary perspective to intervene in a territory: synchrony and diachrony. It is worth mentioning that synchrony is defined by the coincidence in time or simultaneous events or phenomena. Diachrony, conversely, refers to evolution across time.

We propose the following theoretical framework: during intervention, specifically during the assessment of conditions, landscape designers work from a synchronic perspective on the different vegetation areas and takes into account the whole mosaic, i.e. observing each site from the multiplicity of social uses and requirements. In this way, they determine whether the purpose is biological –flora and fauna– or social, or sometimes a concurrence of social and biological purposes, but always in comparison to other sites.

On the other hand, types of intervention –landscaping circumstances– determine which vegetation strategies can be applied to a site according to structural and functional ecological impact across time, that is, a diachronic monitoring process. It may be the case that owing to the homogeneity of a site a diachronic strategy may be apply, or that complexity and heterogeneity –in a mosaic, for instance– may require diverse diachronic strategies, that is, establishing different vegetation sequences for the different areas within a site.

In short, green urban infrastructure management requires –taking into account the territorial matrix model– synchronic levels and diachronic types of intervention that unfold across time and space: synchronic picture of sites with diverse social and biological services and purposes and diachronic picture of plant succession trajectories based on vegetation management.

This approach is of relevance to landscaping, environmental and urban purposes, providing environmental services and to meet social requirements. This entails the complex and difficult adjustment of an intervention encompassing preservation of biological diversity as well as maintenance of intensive social uses in a megacity.
As social uses are spatially dynamic and change over time, it will be necessary to device different strategies leading to vegetation trajectories with mitigation and quality of use purposes.

Types of projects

TAILORING different types of projects to different sites makes it possible to establish a mixed –fiscal, public, private– *certification scheme* of good environmental practices for landscaping intervention. Certification, as a voluntary mechanism, contributes to improving management of different natural and social environmental resources.
Its objective is monitoring systems, projects and construction works and their legislation, and issuing certificates to those who comply with responsible activity regulations and carry out follow-up actions, in the public and corporate fields. It evaluates and certifies good use of physical-ecological resources.
However, this certification by no means evaluate aesthetic, moral or social criteria since it guarantees absolute freedom of landscape expression in public space within the framework of interculturality.
But it evaluates and certifies use of physical-ecological resources in management of environment. Neither does it control nor certify administrative and financial aspects, that fall under different areas of competence.

By means of public protocol and labelling, certification enables users of and clients for public and private works to identify –i.e. labelling– different undertakings, projects and works, recycling and natural resources preservation procedures, rationalization of supplies, ecological substrates against soil depredation, equipment made of recycled –industrial, urban, production waste, etc.– material.

The certification also contemplates biosafety of the application of agrochemical against vectors in phytosanitary practices to guarantee they are innocuous for human beings, animals and the environment. Moreover, it considers urban practices that take into account eco-social aspects of management, projects and works as well as production of goods and services related to landscaping.

The certification constitutes a a voluntary mechanism and a technical and environmental policy instrument. In this line, it can be regarded as a landscaping policy instrument based on Catalogues and Landscape Watch in individual private or public sites.

Certification standards should promote landscaping in a variety of sites –with their own specific characteristics and functionality– while integrating them into a wider inventory that would foster sustainable global balance and regional biodiversity. Based on these aspects, the certification could hold a significant influence if applied systematically in order to improve landscaping practices, including the implementation of natural reserves, corridors, coastal areas with monitoring systems and sanitary tracking.

As aforementioned, each circumstance (representation, fragmentation, consolidation and degradation) allows for a suitable vegetation strategy (conservation, transformation

and conversion). Once the strategy is defined, the type of project will ensue according to the purpose of site in a specific circumstance. Below, different projects possibilities are developed.

Protection: functions are assessed and ecological structures are protected while providing for the purpose and controlling uses. unesco contemplates protection for biosphere reserves, defined by The Statutory Framework of the World Network of Biosphere Reserves as "areas comprising terrestrial, marine and coastal ecosystems or a combination whereof, which are internationally recognized within the framework of unesco's Programme on Man and the Biosphere (mab)." Article 3 of the Statutory Framework establishes three complementary functions biosphere reserves fulfil and highlights exploration and demonstration of approaches to conservation and sustainable development on a regional scale.

Man and the Biosphere Programme
(mab) unesco

Biosphere reserves, functions, and requirements
I. Conservation: to contribute to the conservation of landscapes, ecosystems, species and genetic variation.
II. Development: to foster sustainable economic and human development which is socio-culturally and ecologically sustainable.
III. Logistic support: to provide support for projects related to demonstration, education and training on the environment as well as research and monitoring projects on local, regional, national and global issues of conservation and sustainable development.

General criteria or requirements to designate an area as a biosphere reserve:	
1. It should contain a mosaic of ecological systems that represents major biogeographic regions and comprises a progressive series of human intervention forms.	
2. It should be of value for biodiversity conservation.	
3. It should provide an opportunity to explore and demonstrate approaches to sustainable development on a regional scale.	
4. It should be sufficiently large to serve the three functions of biosphere reserves above mentioned.	
5. It should fulfil the three functions listed above using the following zoning system:	a) one or more legally established core areas devoted to long-term protection in accordance with the objectives of conservation of the biosphere reserve, sufficiently large to meet these aims;
	b) one or more clearly identified buffer zones, that surrounds or is contiguous to core area(s), where only activities compatible with the conservation objectives can take place;
	c) an outer transition zone which fosters and contains sustainable use of resources.
6. It should enforce organizational provisions that facilitate involvement and participation of an appropriate range of sectors, including government authorities, local communities and private enterprises, in planning and implementing the functions of the biosphere reserve.	
7. It should have also taken measures to provide:	a) mechanisms to manage the use of resources and activities in the buffer zone(s);
	b) a management plan or policy for the biosphere reserve;
	c) an authority or an institutional mechanism responsible for implementing that policy or plan;
	d) research, permanent observation, education and training programs.

Restoration: ecological restauration is defined as an intentional activity that initiates or accelerates the recovery of an ecosystem with respect to its health, integrity and sustainability.
Frequently, the ecosystem that requires restoration has been degraded, damaged, transformed or entirely destroyed as the direct or indirect result of human activities.
In some cases, these impacts to ecosystems have been caused or aggravated by natural agencies such as wildfire, floods, storms, or volcanic eruption, to the point at which the ecosystem cannot recover its predisturbance state or its historic developmental trajectory (ser, 2004).[8]
As regards landscape intervention, restoration is an appropiate term only in the case of legal recognition of historic gardens and parks. As for the restoration of historic gardens, the *Florence Charter*[9] constitutes a specific protocol.

Rehabilitation: functions are restored and structures are reintroduced so as to further objectives related to services and uses. It shares with restoration a fundamental focus on historical or pre-existing ecosystems as models or references, but the two activities differ in their goals and strategies. Rehabilitation emphasizes the reparation of ecosystem processes, productivity and services, whereas the goals of restoration also include the re-establishment of the pre-existing biotic integrity in terms of species composition and community structure. Nonetheless, restoration, as broadly conceived herein, probably encompasses a large majority of project work that has previously been identified as rehabilitation.

8 SER, Society for Ecological Restoration, Science & Police Working Group, October, 2004.
9 This Charter, related to preservation of historic gardens, was drafted by the International Committee for Historic Gardens ICOMOS-IFLA in a convention held on 21 May 1981 in Florence, city that gave name to the charter. The Charter was adopted by ICOMOS on 15 December 1982 as an addendum to the Venice Charter.

Enhancement: new functions are incorporated and pre-existing structures are assimilated, blended into new structures so as to reorganize new uses. It deals with revision and adaptation of uses of a site, to remediate defective functions, to add up structures to ensure functions, and to organize present uses.

Recovery: major modification of functions, complete reshaping of defective structures for social uses, and recreation of objectives and uses. It is a project that innovates as an integral part of a greater urban project or of a total conversion of an urban area. Through implantation or re-implantation of structures, a new functionality is created for new carrying capacity.

Green covers on concrete slabs: creation of horizontal or vertical substrates whose physical, chemical and biological characteristics turn concrete slabs and walls into vegetated surfaces that can provide greater benefits. These systems can be extensive, semi-intensive or intensive depending on the type and characteristics of substrates and green covers.

Table 12. Levels, types of intervention and types of projects

<table>
<tr><td colspan="2">Synchrony: Synchronous strategies, planning taking into account the social and biological purposes of each site in the territorial context.</td><td colspan="4">Diachrony: Diachronic strategies, intervention on the site taking into account the monitoring of trajectories during vegetal succession)</td></tr>
<tr><td colspan="2">Landscape conditions</td><td colspan="2">Landscape circumstances</td><td>Types of projects</td><td></td></tr>
<tr><td rowspan="3">Levels of intervention</td><td>Legal domain</td><td rowspan="3">Types of intervention</td><td>Representation
(Conservation strategy)</td><td>1. Protection
2. Restoration</td><td>Plant associations are evaluated or restored and plant species are protected or reintroduced. Supervision of the performance of the site, uses are controlled and examined.
Management of spontaneous plant succession.</td></tr>
<tr><td rowspan="2">Magnitude or scale</td><td>Fragmentation
(Transformation strategy)</td><td>3. Rehabilitation</td><td rowspan="2">Plant associations are repaired or incorporated and plant species are added or assimilated. Arranges and rearranges uses.
Management of scheduled plant succession analogous to secondary plant succession.</td></tr>
<tr><td>Consolidation
(Transformation strategy)</td><td>4. Enhancement</td></tr>
<tr><td>Purpose or objective</td><td>Degradation
(Conversion strategy)</td><td>5. Recovery</td><td>Plant associations are modified or introduced and plant species are implanted or re-implanted. Establishes and allows uses.
wManagement of plant succession analogous to primary succession.</td></tr>
</table>

TOOLS

Planning and designing urban vegetation

In landscaping, selection of species has an enormous potential for green urban infrastructure. However, landscape design in megacities should contemplate degrees of uncertainty deriving from modified factors in urban micro-climate and substrates that make prediction of vegetation species behaviour impossible. Ecosystems are heterogeneous and highly dynamic, and require a continuous monitoring that combines the spontaneous with the implanted. The challenge is to obtain green covers that could go through their natural cycles under tensions and environmental risks while adapting to social requirements of urban dwellers.

Successful plant species

IN ORDER to deal with *successful plant species*, it is of paramount importance to take into account that, compared to natural ecosystems, urban environments are deeply altered by several causes. To name some soil alterations: non-edaphic land-fills (such as demolition debris) may be found on green surfaces or potential green spaces, material from deep soil layers (excavated in urban and peri-urban quarries) may also be used as fill, we may find spaces where upper horizons have been desurfaced, and construction work may produce mixing of soil horizons. This prevents landscaping project from getting baseline certainty and prediction about substrates or urban microclimate and the related behaviour of plant species in green spaces and greenways.

In this context, landscape design constitutes a divergent practice, different from productive crops scheduling or site quality assessment performed by forest mensuration.

A forest site is related to a particular tree species, its genetics and its cultivation technology. Forest mensuration characterizes the potential for growth in a specific area or space based on four factors: climatic, edaphic (soil depth, texture, chemical composition, moisture, pH, microorganisms, etc.), topography (slope, aspect, altitude and exposure) and competitiveness (other trees, vegetation, animals, human beings, etc.).

If there is spatial variation in these parameters, there will also be variation in plant growth. So, spatial variation in soil, coupled with a high degree of uncertainty in vegetation prediction, makes landscape structure and its ecosystems highly dynamic and heterogeneous. All this confirms that urban

landscaping requires constant monitoring and management, adjusting green covers to the implanted, the spontaneous, highly stochastic vegetation. Thus, site landscaping implies measuring aforementioned properties of forest site quality, but it must also take into account spatial discontinuity and its impact on the vegetation morphology it produces and manages according to environmental and social services.

There exists a potential for edaphic mitigation or soil regeneration in upper layers, as well as in maximum rooting depth, by means of manufacturing compost substrates (*in-situ* or *ex-situ*) over organic recycling of municipal solid waste (MSW) with structural materials other than those from edaphic origin, such as demolition debris and the spoil from dredging rivers or inland ports, among others. This possibility of applying physical amendments and chemical amendments provided by the Soil Sciences materializes in the construction of different beds, which form the substrate that provides attachment and nourishment to plants in the absorbent surfaces of parks and squares as well as in green roofs.

Moreover, water balance is modified by sealing in urban basins, which produces runoff drainages, or by a different local balance when rainwater is drained onto the lawn or into regulating lakes in big urban parks. Balance among precipitation, moisture and evapotranspiration is modified because precipitation is interfered and collected by rooftops, terraces and walls, or it is absorbed by green spaces, which makes balance by evapotranspiration quite unpredictable. Humidity varies in each micro-site due to the special balance of alterations in all the remaining elements and factors, for instance: masses of moist air without significant movements and enclosed in small spaces devoid of sunlight or, conversely, sudden change in

humidity due to drying wind velocity proportional to height of terraces and balconies, or in parking lots, big airports, industry sites, fairgrounds, etc.
In this urban landscape, fragmentation exhibits a significant variety of environmental units whose abrupt boundaries or gradient transitions make it impossible to predict morphology. In many cities, benefits from ecology and landscape do not always derive from forests, parks or green rooftops; they may originate in blue components like the sea, lakes or rivers. Their abrupt boundaries with urban built-up areas cause problems mainly associated to contamination produced by spoil drained into their waters. A good environmental management must aim at preventing or restoring those types of degraded ecosystems. Because of all these urban characteristics, selection of species for a landscape project represents a huge potential for a green urban infrastructure if the ecological, morphological, phenological and physiological concept of urban vegetation is expanded to include *Plant Functional Types* (*PFTs*). This implies considering different plant species according to the functions they perform in the reproduction of an urban ecosystem through the evolutive adaptation of the species characteristics. This type of structural/functional grouping juxtaposes formal features of tradition with functional characteristics reflected in designing; that is to say, the complex and necessary relationship between selected and implanted plant species and the set of prevailing hostile environmental conditions. The selected species, or group of species, that can proliferate in novel urban factors and that go through their life cycles providing plenty of services are called successful plant specie.
This concept is open to interpretation and application; it is about the functional and structural possibility a plant species,

or group of plant species, has to go through their natural cycles under environmental tensions or risks of a specific urban area. Now, a plant species is successful in a particular environment and for a specific period as far as a certain environmental state lasts and changes happen.

Plant Functional Types (PFTs)

ENVIRONMENTAL TYPES of plants derive from research on of Plant Functional Types (PFTs) and their application in landscape design. PFTs constitute a group of species exhibiting similar responses to the environment and similar effects on the ecosystem functioning. In the present megalopolitan panorama, PFTs constitute a potential repertory of bio-environmental tools in the complex, random and highly dynamic urban environment. The PFTs approach offers the best tools to understand species' response to climate changes and changes in land use and how biodiversity affects ecosystem processes, and the goods and services human societies obtain from them (Díaz et al., 2002). It also helps to understand relationships among biodiversity, abiotic factors and ecosystem processes where taxonomic or phytogeographical classifications are not enough to weigh selection of species according to highly specific, diverse and random urban environments.

PFTs are defined by the morphological and functional characteristics of the plants, and they demonstrate which selective factors were more important in their evolution: water availability, temperature, dehydration, extreme seasons, etc. Interpretation of the environment –as in the greening of urban buildings– depends on environmental factors and the inherent

features of the buildings that guide selection and management of plants in the landscape project.

Díaz states that "There are two main ways of identifying PFTs according to ecologically significant features. *A priori* methods are based on a single feature or in a suite of features in order to define different groups; definition precedes a given study. *A posteriori* methods, conversely, are based on data collection on a series of features followed by the identification of PFTs on the basis of simultaneous analysis of all those features. PFTs are not defined prior to the start of the study, but emerge as its result ." [The translation is ours.]

Recuperation of degraded or endangered areas defines *a priori* features of PFTs, in the search for biological responses to environmental tensions in the sites and a balance between degree and duration of works, tasks and subsidy. *A priori* inventory of features of functional types of plants can be made according to type, size, disturbance regime, tensions, risks and stabilization of risk situations, such as sliding or erosion of talus, banks of canals, etc.

Selection of PFTs at the micro-scale of the site is defined is based on ecological, morphological and physiological features that have been identified according to their environmental functions and social purposes. The aim is to use implantation or reintroduction of species in extremely degraded areas in order to restore stability and soil quality, local hydrological cycles and flows, vegetation covers and their resilence capacity.

Selecting species to be implanted is the first step towards a greater functional and structural complexity in contrast with those traditional structures that are more simple, such as the open park prototype, with high density of trees and open, sun-drenched lawns and forbs.

The types of morpho-functional features of predominating plants in an area not only reveal which are the most important selective features –water availability, temperature, herbivory, euthrophication, etc.–, but also determine magnitude, rate and direction of natural processes. Important characteristics to be measured, either in *a priori* or *a posteriori* approaches, are those closely connected to key ecophysiological processes and their relation to the biotic and abiotic environment. It is necessary to identify how different PFTs respond to diverse local regimes, physiognomy, structure of plant association and phenological traits, which are of interest for environmental landscaping. Distinctness of associations, ease of propagation, cultivation and management are also of interest for engineering and monitoring components of a given landscape.

Research into plant functional types begins with local species, localizing and collecting germoplasm available in the region, identifying biological cycle, type (tree, shrub, subshrub or dwarf shrub, herb, liana, epiphyte, parasitic plant, etc.), morphology and specific adaptation of the organography of plants, sexual and vegetative propagation capacity, and functional-association-specific characteristics.

The aim is to discover the propagation technique that fits available specimens in terms of size, quality and adaptability to implantation, and to test response in extreme conditions, low fertility, annual water stress, seasonal stress, skeletal, compacted heavy soils, extreme pH, salinity, etc.

At the same time, it is also important to assess the risks or benefits associated to, for instance, invasive species of unrestrained propagation or site-specific species that only propagate in nurseries, their strategic properties –such as nitrogen fixation in root nodules under nitrogen-limiting

conditions, and mycorrhizas that boost intake of soil nutrients–, and their contribution to the spread of other flora and fauna species, providing them with food and habitat.

Revegetating bare soils with slopes that face face risk of erosion or mitigating damaged caused by construction work requires the identification of plant functional types within available species catalogued according to needs and function, or developing their propagation techniques not available at nurseries.

"In cultural landscapes, exotic species frequently constitute part of the ecosystem, specially as part of cultivation and livestock, or even as ruderals and weed, which are supposed to have co-evolved with them" (ser, 2004).

The aim is to make both native and naturalized exotic species successful in prospering in areas with specific geomorphological, edaphic and microclimatic characteristics in such a way that the system reaches a composition that provides required goods and services, such as establishing pioneering species, producing microclimates, facilitating recreational activities, remediating effluents, edaphic reconstruction, etc.

In landscaping, features of environmental types of plants are defined according to biological responses to environmental tensions, and the balance between degree and duration of facilitation mechanisms like subsidy. Landscape resorts to components and trends, facilitation mechanisms, tensions and degrees of subsidy in crops following strategic guidelines according to objectives.

Tensions may be classify as: *topo-edaphic tensions*, *climatic tensions* and *atmospheric tensions*. In these cases, landscaping tree covers offer protection against wind, soil stability, beds of shade-tolerant species at the different levels of tree canopies, where epiphyte and associated fauna live.

Holdridge Model and plant associations

THE GREAT variety of green covers required in the urban environment is based on plant associations specific to the ecological conditions of a site. That is why Holdridge model enables the transition from a regional theoretical model of vegetation to local engineering of second-order factors, as it is the case of the ecological support system of actual or potential plant associations. Climatic associations take place when values of precipitation and mean monthly precipitation, and biotemperature are normal for the life zone, there are no atmospheric alterations, such as strong winds or frequent fog, and soil constitutes the zonal category. Edaphic associations occur in azonal soil conditions. Atmospheric associations occur on climatic conditions not considered normal in a life zone. Hydric associations occur on waterlogged areas, where soil is under water for all or nearly all the year.
So, basic types of associations are:

- **Climatic or zonal:** they grow on a zonal soil in zonal climate. No environmental factors complicate the expression of first-order climate factors. This is the most representative association of the life zone.
- **Edaphic:** is the area occupied by a community on an azonal or intrazonal soil. Most of the edaphic variations tend to affect the water balance or humidity balance and thus give rise to drier or wetter associations than the corresponding climatic association.
- **Hydric:** is the area occupied by a community growing in shallow waters, where the soil is covered with water for all or nearly all the year. It comprises fresh, brackish and salt waters, but all deep water areas.

- Atmospheric: is the area occupied by a community in climates of cloud forest areas and climates of especially windy areas, such as in mountain peaks. Similar to edaphic in that moister or drier conditions are due to atmospheric variations.
- Edapho-atmospheric: beach thicket community on sand and exposed to strong salt-burdened winds, or a cloud forest area growing over limestone so that neither the soil nor the climate would be zonal.
- Edapho-hydric: vadose soils or soils under shallow water, from mud through sand to gravel and rocks, even within the same life zone.

Holdridge's plant associations and its characteristics

Climatic association	Normal distribution of biotemperature and precipitation relative to latitude, elevation, the hemispheric location and total annual precipitation. Normal atmospheric, geological, topographic or edaphic conditions.	
Asociación atmosférica	**Hot**	Abnormal seasonal distribution of biotemperature for latitude or elevation, e.g. Marine climates. Unusually high, or low, mean biotemperature for latitude or altitude due to advection of heat or cold.
	Cold	
	Dry	Dry season or seasons of longer-than-normal duration and concentration of precipitation in a shorter-than-normal period, e.g. Monsoon climates. Abnormally strong and persistent winds in mountain ridges and littoral areas. Concentration of precipitation in the coldest months of the year, Mediterranean climate.
	Very wet	Precipitation more uniformally than normally well distributed throughout the year for the life zone; strongly marked dry season absent. Frequent fogs and cloud contact with vegetation. Lower-than-normal drying conditions.

Edaphic Association	**Dry**	Shallow soils or bare-rock outcrops. Very stony or gravelly soils. Excessively permeable sandy soils. Excessively drained or very steep soils. Well drained soils with a high concentration of carbonates and other salts. Soils with indurated surface layer.
	Dry-wet	Alternately dry and saturated soils due to perched water tables over claypans (Planosols). River overflow into backwater depressions, hydromorphic and poorly-drained alluvial soils. Predominance of montmorillonite clays on low-slope terrain (Grumosols). Cyclic inundation by salt or brackish water of tidal origin: mangroves, sedge swamp and salt-grass marshes.
	Very wet	Poor internal and external drainage or excess of fresh water from precipitation: poorly drained floodplains and valley depressions in regions of well distributed or high total annual precipitation. Persistent lateral seepage of ground waters into lower-lying surface soils. High groundwater table, year round. Frequent flooding.
	Fertile	Immature soils significantly more fertile than zonal soils as developed in life zone: Flood basins, alluvial terraces, and andosoles.
	Infertile	Soil of markedly inferior fertility relative to the zonal soils developed in the climatic association. Due to senility or special mineralogical conditions of the parent material, such as laterite, serpentine, limestone, shale, sandstones, pumice and other highly acidic rocks.
Hydric Association	Areas covered with shallow fresh or brackish waters during all or the greater part of the year: water lilies, some marshes.	

Green cover is the unit of landscaping

THE LANDSCAPING PROJECT meets social needs by means of green covers. To attain this, it assesses structural proportions and functional relationships between the different covers of the site, it guarantees soil stability and estimates the required types of infrastructure and services suitable for a better load-bearing capacity for social recreational use.
Thus, landscaping solution involves variables from diverse origins:

- spatial variables: topographical polygonal, legal domain, magnitude and scale of the site;
- environmental variables: contingent status of natural resources of the site according to the programmed uses.
- social variables: programmed purposes and types of uses.

All these dimensions are addressed by plant typology variables, materialized in different cover strata through engineering and management of ecological factors of the site. It is from these projective actions that landscaping approach takes green covers as project units and management units, and not the individual specimen as was the case in traditional landscaping.
Projecting different green covers requires an environmental assessment, as well as a prediction of environmental trends deriving from the analysis of *implantation* scale. Next, environmental *landscape traits* of the site are analysed and examined. Finally, all the information is weighed and evaluated according to programmed *purpose* of the site and *bioclimatic models* in order to resort to different groupings of plant species, conceptualized as *plant typology*, and weigh environmental measures to protect resources. Namely:

Implantation: offers the ecological and urban characteristics of the site according to hierarchy and location in the natural unit or in the urban fabric, the nature of significant present or future uses, land occupation, equipment, services infrastructure, traffic and public transport, land value in the real estate market, urban or rural codes, significant projects carried out or to be carried out in the environment and the region.

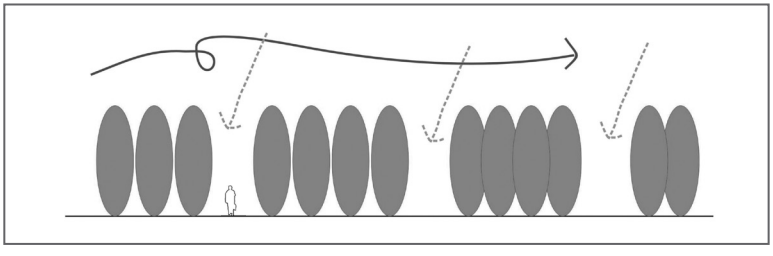
Landscape traits: the pre-existing landscape characteristics that are relevant to the project, such as topographic and geomorphological characteristics, relief, rocky outcrops, the soil and its edaphic characteristics, bodies of water, watercourses, underground streams, plains, vegetation –either spontaneous, implanted, native, exotic, naturalized, endemisms, etc. Traits are morphological or content features that can be recognized –open or hidden– in the site and environment, or even in the contextual framework or implantation. They are the capabilities of the site for landscape design, tradition often referred to them as the *genius loci* or the capabilities of the site. An example may be found in the work of Lancelot "Capability" Brown (1716-1783), who was a pioneer in natural landscape design and created the most important works in the English countryside. Notwithstanding, in his times he was vilified for destroying the old formal gardens. Today he is undoubtedly considered the father of the English Parks.

Purpose: the goal or objectives for the site according to the intended uses. Goals and objectives dependent on regulations, historic value and symbolic character. The surrounding environment and the urban radius of influence and its inhabitants, or the regional population, are considered. Thematic links to distant areas and central urban areas are also taken into account. Pre-existing elements, accesses infrastructure and the nature of adjoining paths, as well as internal functional circulation are also considered. Within the scope of purpose,

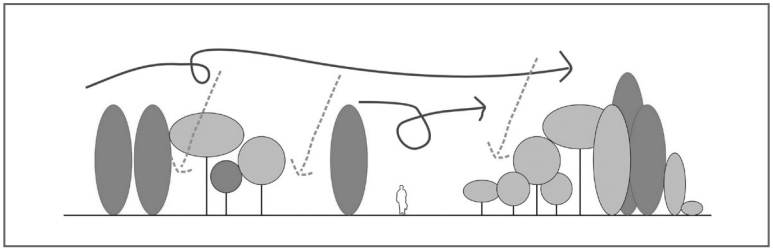
land-use planning is emphasized as part of the landscape project. Land-use planning deals with the scalar distribution of uses and goals derived from the purpose of the site. Thus, planning purposes and uses implies: allocating, organizing, protecting, implanting, distributing, linking and complementing in time and space the social, biological and environmental needs. The land-use planning derives from the goal of a given project and it is never the same: social recreation, protection of flora and fauna and their local ecosystems, intangible areas –because of endemism or archaeological site–, assistance with or participation in projects on territorial infrastructure or similar issues. These planned activities may be intensive or extensive, simple or highly complex, thematic or diverse, have low or high impact.

Bioclimatic models: landscaping purposefully produces a microclimate according to dominant climate variables in a site. Main variables are frequency and persistence of predominant winds, intensity and angle of annual, seasonal or daily solar radiation.

Climate model: warm-cool

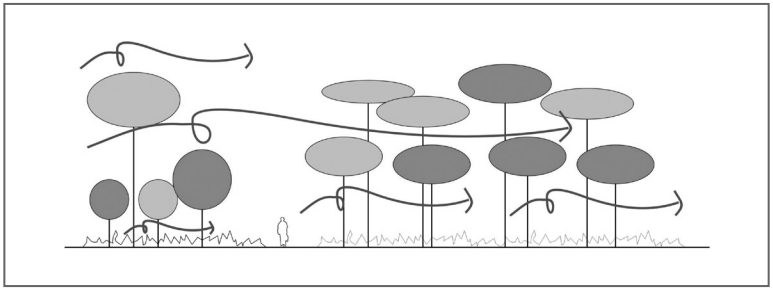


- Distribution per orientation and enhancement of environment.
- Steering or protection from wind: perennials.
- Solar radiation: open pit works.
- Mitigation of rain impact by foliage.
- Decreasing interior temperature range: air column in the forest and confinement of relative humidity.
- Confinement of relative humidity.



Climate model: mild

· Distribution per orientation and enhancement of environment.
· Steering or protection from wind: evergreen.
· Solar radiation: deciduous.
· Mitigation of rain impact: runoffs management.
· Decreasing interior temperature range: quietness and sunlight/shadow. Winter/summer.
· Confinement or dissipation of relative humidity: seasonal.



Climate model: warm tropical

• Distribution per orientation and enhancement of environment.
• Steering of wind. Forest breeze.
• Protection from solar radiation: canopy strata.
• Mitigation of rain impact: interference.
• Decreasing interior temperature range: breeze.
• Dissipation of relative humidity.

Source: Benassi, 2011. *La intervención paisajista*. Carrera de Especialista en Planeamiento paisajista y ambiente. Facultad de Cs. Agrarias y Forestales. UNLP.

Plant typology: groupings or tabulations that facilitate selection of vegetation species for a site-specific project. The first step is to consider the desirable adult state of the *morphological* characters, consisting of structural plant type, its magnitude and its specific shape, the *phenological* characters, periodical seasonal changes in the vegetative (sprouting, foliation and abscission) and reproductive phases (reproductive differentiation, flowering and fruiting), and the *ecophysiological* characteristics in terms of environmental for the and development of the species.

Environmental measures: in the context of negative environmental effects –sometimes unavoidable– that are inherent to social construction, by projects or civil works, of intensive human dwellings, landscape practices consider and offer environmental mitigation measures. Thus, landscaping intervention considers measures for environmental avoidance, minimization and compensation.

Table 13. Environmental measures

Avoidance	Avoiding, saving. Measures undertaken during the process of characterization, localization and inventory, assessment, advancing hypothesis of intervention, developing projects. Safeguards resources and areas and prevents adverse functions deriving from uses and purposes programme.
Mitigation	Measures that reduce or minimise in future activities of the programme. · Measures undertaken during the development of projects that assess future intensive activities of the program and its spatial distribution of uses to reduce adverse impact. · Measures undertaken during the implementation of projects that comprise technology and available engineering operating procedures that reduce impact on the intervened resources.
Compensation	Offset, reparation. Measures undertaken during the hypothesis of intervention and project. It offsets -as extreme measure- and environmentally compensate the loss of any resource or part of an area with infrastructure or support functions that reduce an inevitable impact.

Management plan for green covers

GREEN COVERS found in facilities, phenological areas and forest cores constitute the units of assessment, project or re-project and management of urban landscape sites. Diversity and persistence of plant population, considered in terms of ecological structure and functions, may be guided by means of a management plan, according to the following criteria:

- multistratified green covers, for landscape diversity and structure of tree canopies;
- multiaged green covers, to guarantee seedling recruitment, succession and persistence of the dynamic resource in continuous substitution;
- multiphenological green covers, to guarantee comfort, variety of seasonal landscapes, and biological diversity of low herbaceous covers, lianas, shrubs and basal covers;
- multi-specific green covers, for better vegetation health, compositional diversity and botanical diversity aimed at landscaping, cultural, educational, environmental and recreational purposes;
- multifunctional green covers, to fulfil different functions in the space and lapse of time of a service programme.

As regards plant types variables, they derived from main morphological and phenological characteristics of plants, which facilitates selection of those species that fulfil ecological requirements of the landscape and those of the need program for the site.

Selection of species

The process for selection of plant species may be summarized in the following phases.

Eco-spatial variables: scale and programming, geometry of the polygonal and its networks, modulation or visual systems, building the project on the basis of local ecological components and factors.

Structural species: provide the scale and the bioclimatic quality; subordinate species and visual accents.

- Scale → magnitude, height and diameter of mature species.
- Bioclimatic → foliar vegetative phenological proportion between deciduous and evergreen in each season
- Programmed functions → species-specific plant architecture or silhouette.

Landscape expression: visual translation in terms of dominance, subordination and accent.

- Dominant plant structure and subordinate phenological proportion for stability and seasonal changes.
- Leaf textures: foliage, size, texture and colour, foliar density, texture, glossiness or dullness of leaves.
- Ephemeral or persistent accent: colour of leaves, flowers or fruits, profusion, duration, fragrance. Flowering and fruiting, colour, profusion and duration. Rhytidome and bark, colour and texture, stiffness and elasticity of branches, bare shaft or basal cover of the specimen.
- Species-specific characteristic or distinctiveness: annual stability, seasonal or episodic changes

- Crop requirements and management: crop-specific requirements or ease of cultivation, health or vulnerability, invasive or non-invasive species.
- Environments according to solar radiation: 1. full sunlight in ground without trees or wall facing afternoon sun. 2. part shade under deciduous or wall facing morning sun. 3. shade under evergreen or wall without sunlight.
- Selection of plant species available at nurseries.

Graphic Process

Creating thematic graphic maps to scale with measurements of existing green covers and different types of soils, such as absorbent soil with herbaceous covers or absorbent soil without herbaceous cover and undergoing erosion, impervious paved surfaces and half-impervious surfaces with loose materials. Bodies of water and watercourses are measured, and also water vegetation and land trees, shrubs and herbaceous vegetation. Morphology mapping of barren and vegetated areas are elaborated using satellite images.
Field data collection with inventory map including numbering of specimens and sheet. Individual plant specimens are evaluated according to public safety and environmental landscaping value parameters.

The typological maps are:

- Typological and phenological maps: plant specimens are recorded in an inventory in a map at scale, indicating individual location in the green cover, and a theoretical circle is used to represent the typological size of a species-specific mature mean crown in the urban space and region, which

shows the foliage habit. White colour is used to represent deciduous species and grey, for evergreen and semi-evergreen. Surface and percentages.

- Morphological map of barren and vegetated areas: measurements are taken on the satellite image according to the patches of different covers: forested, shrubs, herbaceous beds and grass covers.
- Infiltration maps: relative surfaces and soil health are measured: pervious with herbaceous cover, pervious without herbaceous cover and undergoing erosion, impervious or semi-pervious hard soils with inert materials according to stormwater infiltration: pervious or impervious ground or paved surfaces as environmental function. Surfaces and percentages.
- Erosion and paved surfaces map: erosion and hard paved soils. Surfaces and percentages.
- Risk map: public risk map according to tree specimens: red for alert, orange for caution warning, yellow for caution and striped grey for good sanitary conditions. Surfaces and percentages.

Table 14. Outline for vegetation covers and strata mapping on different types of floors

Covers m²	1st and 2nd	3rd	4th and 5th	6th
Type of soil m²	Upper stratum	Mid stratum	Lower stratum	Stratum in planes
	Uppermost tree canopy, palms, big bamboos, scandent and epiphytes.	Mid layer: second canopy. Shrubs, woody shrub and low bamboos.	Lower stratum: third canopy. Shrubs, low shrubs, high herbaceous.	Grass and creepers. Very low herbaceous plants. Aquatics.
Impervious	Expression in plant by cover patches and its percentages and surfaces			
Semipermeable				
Pervious				
Body of water				

Landscaping engineering and management: engineering and management of green covers comprise the following variables: longevity and relative and specific cycles in vegetation → consolidation of different covers and their autogenia → predicted succession and unexpected spontaneous changes → incorporation of species or replacement of typologies during monitoring of plant trajectories.
Successive changes in the site, as the basis for the management plan, are devised according to the following components and functions:

- Structure: biotic components are the different perennial plants and plants selected to be implanted and the microbiological spontaneous or inoculated activity. Abiotic components are climate elements and factors, micro-environmental factors, and material from edaphic amendments.
- Functions: interactions between selected plant species as main components, which have different interacting habits: synergism, antagonism, rhizosphere symbiosis, etc.
- Inputs: contributions that influence the system functioning: water, solar energy and photosynthesis, chemical fertility of the soil due to added mulch or fertilizers, etc.
- Outputs: remnants, products or parts of the system that go out: respiration, and microbiological activity in substrates, water, rate of leachate, pruning, etc.
- Limits: the system is limited as primary entrance by rainfall, runoffs produced by vegetated elevations or bodies of waters.
- Biodiversity: biodiversity α is the biological diversity of the site, while biodiversity β refers to the regional context in a wider scale.
- Tensions and subsidy: landscaping projects are based on these two terms. A tension is the presence of a factor that constrains or imposes a tension on the expression of the vegetation in a given site or the need for energetic subsidies to improve a defective factor or component. For instance, irrigation during dry seasons, fertilizers, mulch and agricultural chemicals frequently required, human work on preservation tasks, fossil fuel´or electricity used for machinery, etc.
- Sustainability: an equation between tensions and subsidies will indicate costs and levels of autonomy in the projected system. An adequate adjustment should start with topographic

> inventory, identifying the characteristics and distribution of soil types, substrates and slopes, the level of erosion risk, and the need to systematize protective contour lines, programming –in space and time– uses that do not have negative impact on green covers or the abiotic support. Thus, sustainability in a landscaping site is the level of self-sufficiency, permanence, stability and change in space and time together with the capacity to provide continuous and quality services.

To sum up, a project, its programming and management plan require monitoring objectives, adjustments and imponderable items. This follow-up is the tool to understand change, either to verify an expected result or to weigh the unexpected. The unexpected leads to the revision of criteria used for vegetation strategies and to reconsider autogenic change in vegetation as well as the impact of human-induced changes due to social use or the sprawling urban dynamics, which may derive from spontaneous variation in social use or from urban projects or policies about the urban role of the site. In any case, if there is degradation, uncertainty inherent to functioning of novel biological structures, source of discovery and new opportunities, is desirable.

LANDSCAPING

Curatorship of habitat

Nowadays, expression of landscape involves overcoming the culture-nature dichotomy. It is about a type of landscaping that synthesizes the biological elements and the artistic expression, and fulfills an educational function: communicating values for a real ecological awareness, which is not a slogan but a friendlier cultural attitude to nature in the city. The experience of the botanical gardens, which accompanied the emergence and development of landscaping during modernity, should today be applied to renewed popular projects for the city. Since landscape is conceived as a new way to access artistic expressions, we refer to curatorship of the habitat: a mediation between nature and people.

Expression of landscape

A PROPOSAL that synthesizes the objectives of present landscape design consists in deploying –in public space– the new global functions of botanical gardens, creating a different culture for nature.

We do ecology as we cultivate, and waste can be transformed into artistic expressions. In this way, diversity in nature is exhibited and the multiplicity of individual and collective imagineries is represented.

The landscape of culture is a social construct in which human purposes as well as biological and physical processes of nature come into play. New functions of current botanical gardens, and its social and educational uses in the city, are part of a new paradigm (Benassi et al., 2001).[10]

The globalized urban culture of this century requires a specific urban educational experience, related to local and global life and ecology. In the context of an undeniable environmental and socio-biological illiteracy, landscape vegetation goes from being *embassy of biology* in the city to being *fellow citizen* in a new collective pedagogy that aims to democratize the discussion on territorial purpoess and ecological knowledge, integrating shared culture. Thus, desacralization of environmental and social problems could open up the possibility of an ecological, democratic and inclusive thinking, to avoid the darkness of any fundamentalism or subdivision that may halt change.

Bernard Lassus (1977) demonstrated that in suburban industrial towns *landscape dwellers* develop in their everyday life and out of

10 Working paper prepared as visiting lecturer at the University of Cadiz, Spain, in the Zoo and Botanical Garden Jerez, Jerez de la Frontera, 2001.

a creative garden culture a folk aesthetics, which in many cases contrasts with the aesthetic principles of modernist housing. This social finding can be recovered to propose spaces and greenways as ideal places to communicate an integrative and pedagogical message, a biological as well as socially and artistically expressive message. As ecosystems where communities live are discovered and observed, transformation by means of plural public awareness about social integration and the irreplaceable value of nature in the city turns into a shared possibility.
From this perspective, we may state that "the conceptual and technical development of the landscaping discipline must be continually re-founded as a landscaping that is environmentally sustainable, socially inclusive, culturally diverse, economically viable, politically legitimate, artistically innovative, legally correct, and scientifically correct" (Carta de La Plata, 2006).[11]

Landscaping presentations and representations

Pedagogical function

The educational function is one of the main aspects of the social function of landscape. It links together the promotion of public and political awareness about the quality of urban landscape projects, the sustainability of natural resources and the establishment of a new relationship between human being and nature.

[11] Carta de La Plata [Charter from La Plata], drafting committee from Argentina: Benassi, Alfredo H., Opel, Rubén, Margarita Alconada. Brazil: Bueno Souza, María Alice de Lourdes, Terra, Carlos. Mexico: Carrillo Rivera, José Joel. La Plata, 10th April 2006, Facultad de Ciencias Agrarias y Forestales de la Universidad de La Plata [School of Agricultural and Forest Sciences, National University of La Plata], 2nd Seminario de Paisaje Sudamericano de Argentina, Brasil, Colombia, Francia, Perú, México y Uruguay.

Educational activity fosters the firm commitment to conveying the concept of landscape and landscaping in the immediate environment, promoting the knowledge of flora, fauna and local ecosystems, its related values of biological diversity, beauty and diversity as well as its current problems.

Scientific function

Research in the field of botany should focus on those species at high risk of extinction in order to learn about their ecology and biology and to create gene banks. From this perspective, studies and research are carried out in different fields such as nutrition, physiology, ecology, reproduction, among others. Different universities and scientific institutions find a great potential in urban green infrastructure as a means of access and availability of species that are sometimes very distant from their original locations. All results of the various investigations are published for the advancement of science and as the basis for nature conservation and protection policies.

Cultural function

Nature as reference, art and collective development as a means, enhance a strong cultural vocation, a growing hunger for knowledge of the world of plants in areas of community participation and social integration. Cultural functions are many and varied. For instance, the promotion of nursery and food production projects of private and public gardens as a source of knowledge for the improvement of the human environment through landscaping and folk gardening. The commercial propagation of threatened or endangered species as an opportunity to increase the number of specimens in conservation and, consequently, the possibility of generating

more creative and original landscapes. Commercial production in private nurseries and botanical gardens as a source of specific knowledge to advise the cultivation and propagation techniques of little-known species. Production of food in schools and community gardens constitutes a way to expand urban green areas and to foster social participation and the importance of cultivation. Urban trees and green spaces planted with fruit trees could also integrate a landscape design program. The recovery of desurfaced soils could be integrated with social and environmental programs. Finally, recycling art workshops – regarded as opportunities of collaboration between artists and teachers working on landscaping expression as a platform for projects, and the recycling of materials and functions through art– illustrate a new stance that considers organic biological processes as part of an "environmental literacy". Waste materials, biological recycling, waste as transferable securities, and open-space art installations, all point to social prominence in a process that can be named: landscape, sustainability, art and city.

A different presentation of nature

Systematic and evolutionary classification of plants constitutes a traditional form of presentation. It bears great educational relevance because it presents different species connected in their evolutionary processes. Within the same plant group we find a great diversity of adaptation strategies, for instance, within the same plant group we find terrestrial, marsh or water plants, epiphytes, parasites, etc. These contrasts, easily noticeable, allow us to understand the complexity and diversity of evolution within a single phylogenetic line.

Presentation of natural environments: This presentation shows,

as far as possible, conditions and natural aspects of different plants and animals specific to a certain habitat. This contributes to understand biotic and abiotic factors and components of an ecosystem in their close and essential relationship. These ecosystems, in which relations within and among them form a complex mosaic, are the basis where a region's natural resources are found.

Presentation of bio-geography: This presentation shows plant groups according to their geographical origin and history of botanical introductions. The collections of these species are intended to represent the main components that make up natural diversity in world regions. People can recognize the origin of species and discover world distribution of life forming the biosphere human beings live in.

Presentation of the plant domestication process: This presentation keeps domestic species and displays the process by which human being has domesticated plant species for subsistence through agriculture, livestock and industry.

Scientific knowledge of the plant world produced the industrialization of agriculture during the Industrial Revolution alongside an increase in the global population, which today amounts to seven billion. These resources have provided plenty of utilities, such as food, transportation, medicine, textiles, construction, furniture. In other words, they have improved the conditions of the human environment. This industrialization also exhibited a twofold economic organization: *colonial cultivation* in raw-material-producing countries and manufacturing in industrial countries.

This presentation allows us to understand that culture and nature are inextricably linked, that culture depends on nature for its survival. At the same time it shows the need for a cultural

change towards conservation of biodiversity on the planet and an open outlook on the urbanization of present globalized society.

Presentation of landscape culturalization: Man-made landscape reveals a historic development that allows us to detect the different forms in which urban and domestic gardens have been developed according to a certain aesthetic characterized by period-specific values and different cultural traditions. When they developed in regions and countries of different cultures and climates, these forms became landscape styles. Threatened or native species can be incorporated as novel plant elements in these formalized places in order to promote its dissemination in public and private gardens.

A haven for conservation of biological diversity

In situ conservation refers to activities developed in the natural environment of endangered plants, whether protected or not spaces. This is to preserve the ecosystem and its processes rather than a particular species. However, certain *flagship species* of which there is greater public awareness are often used to justify the protection of the whole system. This is the most effective way to ensure the survival of endangered species, because in these conditions they can fulfill their natural propagation processes and recolonize areas undergoing regression.

Green spaces and pathways collaborate with *in situ* conservation by creating micro-reserves, which function as representative stations of the regional flora. These areas allow us to keep track and know the dynamics of the species as well as to educate and sensitize local people.

An interesting trend is the involvement of landscape management in in situ conservation projects, often developed

in collaboration with other institutions. These projects include education and awareness campaigns for local people, land acquisition for the creation of reserves, and funding of conservation projects (Chatti et al., 1991).

A regional landscape management makes it possible to promote *in situ* conservation activities of the local flora, which can be carried out in the most biologically diverse areas of influence. *Ex situ* conservation is the traditional conservation method developed in botanical gardens. It reproduces plants outside their natural habitat. The most popular method among botanists has consisted in cultivating and propagating endangered species of flora, and making them available through the *Index Seminum*, which facilitates the exchange of seeds among the international network of botanical gardens. This was established in the eighteenth century and is today protected by the Botanic Garden Conservation International (BGCI). Apart from contributing to conservation of endangered species, this exchange facilitates the introduction of species in regions widely separated from their original places. These species offer landscaping project and intervention a greater diversity and, consequently, greater heterogeneity in urban landscapes. Along with seed collections, botanical gardens can preserve species through gene banks, reserves of pollen, *in vitro* cultures, or meristem, callus and cell reservoirs.

In present times, botanic gardens represent the view that protection of biodiversity and transmission of natural heritage are necessarily linked to education and awareness about this issue. For instance, the botanical garden of Curitiba, in Brazil, functions as recreational urban garden and as gardening school for "homeless children", thus taking on a both pedagogical and social inclusion function.

Final hypothesis: learning to ignore for an ever creative landscape

The more we know about our landscape, the more questions about its quality and potential for change we can ask ourselves. In other words, the more we know, the more we ignore about a subject or a thing. Regarding one's environment a a puzzle opens up the possibility of new creative and experiential horizons.

An expressively novel landscaping integrated into troubleshooting should draw upon curatorship. Curatorship constitutes a possible way to collectively wonder: Which landscapes we want in the city, in the neighborhood and in our houses?

Collective questions include and involve designers and artists from different expressions and disciplines. It is time to offer a place to art curators: *a new guest to a creative picnic in the public space.*

The landscape designer, the artist and the curator: an associated perspective for exhibition design, communication and use of space, color and lighting, including explanations for different audiences.

Public space convenes different members of the world of art and they are invited to tackle public concerns from the stance of landscaping and artistic fields. Also,
an offer of artistic workshops for children, youth, adults and elderly in the context of local biennial.

Far from the "white box" of the contemporary art museum that exhibits works: Can landscaping context accommodate and display works, pieces and installations?

Curatorship would be a possibility for landscaping mediation and for the assemblage of parts as a collective work,

necessary for new "open sky" community settings in the city. Integrating critical thinking with different possible solutions to environmental problems and landscape engineering. Production of outdoor artistic works and installations in the context of environmental rehabilitation constitutes the method for transforming the hostile and exclusionary present. For example, only art and landscaping can turn a garbage dump into a botanical garden, by facing environmental degradation, recycling artistically and producing the novel for new questions. A space for humor and criticism, and a lookout tower for what we ignore. When "no one says or there is nothing to say," *learning to learn is the collective epistemology for urban landscape project.*
Outdoor shows and open sky exhibitions would be integrated to public knowledge into the territory and its contradictions.
No more statues or sculptures in the center of the square, it has been a true anachronism since long ago.
Facilities are temporary. And art is a question or just silence towards a new start first thing tomorrow. Artists and landscape designers try expressive forms in space and time, the design of the pieces and the environment itself; babbling a new dialogue between culture and nature towards an ever new and never conformist landscape.

AFTERWORD

Genes-based landscaping

ALMOST CERTAINLY most of this work belongs to the past because it aims at interpreting a shift in paradigm by theoretical and pragmatic categories from last century. Maybe the main contribution is its conciliatory intention and the criticism itself, that emerged in the search for sustainable tools and processes to face the scale of the problems to be tackled.
A possible path in search of those problems has been outlined. Perhaps, future generations, with a new symbolic capital and ethics, will reach the goal.
However, it may be argued that the ecological power of landscaping lies on its nature as cultural practice based on biological components of the landscape. The word *cultural* was used in its inextricable two-fold meaning: *culture* and *cultivation*. Nothing new: cultivation began in Neolithic, about 10,000 years ago, and it is possible that it may be rooted in climatic change towards milder temperatures, shortage of hunting or yields, or desertification of large regions. It is dreadful to think that only work, technology, water, sunlight, soil, and seeds separate humankind from hunger. Therefore, cultivation was and continues to be the main livelihood strategy and a major cause of humankind survival.
During Modernity, landscaping cultivation in the urban area

constituted a huge transfer of information from nature –plant, animal and microorganism genes– to a territory devastated by the first and second industrial revolutions. In this line, it could be argued that landscaping was ecological from birth, even though it implies an anachronism since the term and concept ecological belongs to 20th century. Three great heroes represent the power of landscaping. Lancelot "Capability" Brown, who in the 18th century perceived the capability of the site (the genius loci), in landscaping, thus anticipating ecology. Then, Edouard André, the great treatise writer, who in the 19th century conferred landscaping the status of discipline. And Roberto Burle-Marx, who in the 20th century discovered that design is landscape seen from the height of skyscrapers in the post-war city and who incorporated the proverbial avant-garde abstract manifestation in Brazil through the subtropical flora; an eco-element of abstract expression that melts the human element into the urban landscape.

It is necessary to understand, following that historical development, that in the present century landscaping faces the challenge of revamping the devastated post-industrial megalopolitan territory. The challenge is reproducing information from cultivated biology into urban ecosystems – about which we still have little knowledge– in such a way that the information in nature makes genes design biomass, matter and energy cycles in a creative invention of post-industrial city. Ecosystems from different origins performing analogous functions in the urban artefact. To attain this, revisiting the concept of cultivation is a must: a renewed alliance with the nature we are part of.

An emerging cultural, social, ecological, and multi-scale landscaping that may lead to unforeseen landscape plans, open

to the unexpected. Continuous change in the megacity, subject to constant interpretation and scientific explanation.
Landscape design that reinforces ecological events; a landscaping based on genes as the key to sustainability; in line with the call for "Sustainable by Design" commended by the International Federation of Landscape Architects (IFLA), which recommends that decision-makers and practitioners work for a sustainable world and sustainable landscapes using wise practice, methods and tools (IFLA, 2009).
Plants interpret environment in a pragmatically analogous ecosystem designed and built in the urban space, which contains the same type of information that represented or reference nature. The reason is that, simple and indisputably, it is nature in its own; surpassing the false dichotomy between natural and artificial as regards all that human beings do and perform. As Morin (2006) asserts, human being is thoroughly biological and thoroughly cultural; human being is and develops in loops: brain-mind-culture and reason-emotion-impulse. Individual-society-species. Any human development means understanding human being as a complexity of all these loops, and mankind as one and diverse entity.
Nothing remains identical to itself across time, in an eternal equilibrium for ever.
A state without change never happens in any hierarchical order of nature, whether biosphere, organism, tissue, cell or gen.
Focusing on these landscaping practices would contribute to environmental good practices of multi- and intercultural relevance. This may facilitate dialogue with other fields related to landscape, all looking forward quality of life in inhabitants and citizenship democracy, as well as environment and natural resources in sustainable works, which would provide a potential

for use autonomy and distribution of biological and economical public resources.
These landscaping designs would collaborate for a better alliance between human purposes and nature trends, a possible landscaping for our mega-scale cities in Latin America, low costs and greater benefits given the enormous potential of vegetation in the urban fabric and the constructive synergy of private and public works. Simultaneous fiscal and private independence that socializes a process, fosters the –not always possible– integration of private activity with social and governmental participation; all working together on the territory. An important driving force if included as part of a collective pedagogy in the context of present-day devastating urban scenarios. To conclude, it is a given historical process that makes landscape comprehensible, its contexts provide the founding fabric. And using social resources to intervene on biological components indicates an ethics. In that *complexus*, landscaping will unfold the regained territories, in which genes devise constant changes. This is why landscaped habitat has a unique purpose: making things be what they are, with greater dignity.

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Botanical city is an essay that reveals the shortcomings and limitations of the historical paradigm in Landscaping –associated to Modernism– in providing answers to environmental and social problems of the contemporary post-industrial megalopolitan territories. It offers a new approach that involves the need of material and symbolic intervention in the cultural landscape.
Faced with the prospect of environmental and social risks, urban greening would be integrated into an environmental strategy aimed at the creative invention of postindustrial city, in an alliance of biology and social construction of landscape. Current trends suggest that 60% of world population will live in urban areas by the year 2030. In that context, and as a conceptual and pragmatic objective, *Botanical city* proposes biocenosis to build the urban artifact. A green skin as biotope that provides continuous mitigation and bioclimatic urban enhancement, energy saving and ponderable environmental services for a higher quality of life in more sustainable cities.
In short, a landscape design contributing to the humanized reconquest of the urban space, regarded as the public space, where integration and social inclusion takes place.

Honorable Cámara de Diputados de la Nación
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UNIVERSIDAD NACIONAL DE LA PLATA

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