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MULTIDISCIPLINARY APPROACHES TO LANDSCAPE DESIGN

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ABSTRACT
The European strategy to meet the sustainable development objectives which were put in place by the European Green Deal and the 'European Taxonomy' has created a need for the greening of our cities, intending to improve equity in terms of access, distribution, and the quality of green areas, as well as the promotion of human well-being and social justice, while also including species other than humans. The implementation of Nature-based Solutions, however, such as Blue and Green Infrastructure, can only be accomplished through the adoption of multidisciplinary approaches. It is, therefore, imperative that future landscapers are equipped with the ability to relate to and collaborate with other specialists and colleagues from other disciplines. With this objective, this paper presents two research activities which investigate two different teaching methodologies, within both public and private green spaces: the Ecological Driven Design (EDD) and the Green Experience Laboratory (GE-Lab).

KEYWORDS
landscape architecture, urban biodiversity, habitat, ecological landscape design, design for nature

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The recent European Strategy to meet the UN's Sustainable Development Goals (UN, 2015), along with the publication of the European Green Deal (European Commission, 2019) and the recent European Taxonomy for Sustainable Activities (EU Technical Expert Group on Sustainable Finance, 2020; Lucarelli et alii, 2020) has led to the greening of cities, to improve equity in terms of access, distribution, and the quality of green areas, as well as the promotion of human well-being and social justice, while also including species other than humans. However, the implementation of so-called Nature-based Solutions (Eggermont et alii, 2015) such as Blue and Green Infrastructure, can only be accomplished through the adoption of multidisciplinary approaches, which expand upon the available knowledge surrounding the ecology of a given urban green space (Lepczyk et alii, 2017). This allows practitioners to better support and manage urban biodiversity (Aronson et alii, 2017) and to develop a more widespread acceptance of the peculiar aesthetics of urban wilderness (Ignatieva, 2017; Nassauer, 1995).

The consideration of ecological principles, i.e., the natural processes and the relationships among them, is fundamental to the implementation of sustainable landscape design. An awareness of this has given rise to the Ecological Landscape Design movement, which is a holistic design approach based on landscape ecology, to maintain landscape integrity, while also strengthening the natural and cultural spirit of the area (Çelik, 2013; Makhzoumi, 2000; Makhzoumi and Pungetti, 1999).

This paper presents two multidisciplinary teaching methodologies and case studies, related to both public and private green spaces, with both a group of students enrolled in the Natural Resources Sciences Bachelor's degree program at the Zurich University of Applied Sciences (ZHAW) and another enrolled in the Territory, Environment and Landscape Protection Master's degree program at the University of Catania. The two methodologies investigated were the Ecological Driven Design (EDD) method and the Green Experience Laboratory (GE-Lab) method. The aim in both cases was to provide future landscapers with transferable skills that allow them to work in multidisciplinary groups, by providing them with a replicable method for approaching design projects in an ecosystemic way.

Ecological Driven Design (EDD) for natural and environmental sciences students | Across Europe, the recent collaboration between landscapers, designers and biologists has resulted in the development of methods such as Animal Aided Design – AAD (Weisser and Hauck, 2017) and other experimental approaches based on multidisciplinary collaborations (Whitelaw, Hwang and Le Roux, 2021), all of which have the aim of creating inclusive cities, which are also designed with wildlife in mind (Apfelbeck et alii, 2020), i.e., urban habitats where biodiversity can be promoted by stimulating citizens' involvement (Garrard et alii, 2017). Similarly, a European project called Ecolopes (Canepa et alii, 2022) and an international Switzerland-France collaboration titled DeMo (Catalano et alii, 2021), aimed to develop a methodology for creating inclusive and regenerative building envelopes from an ecosystem perspective, by em-

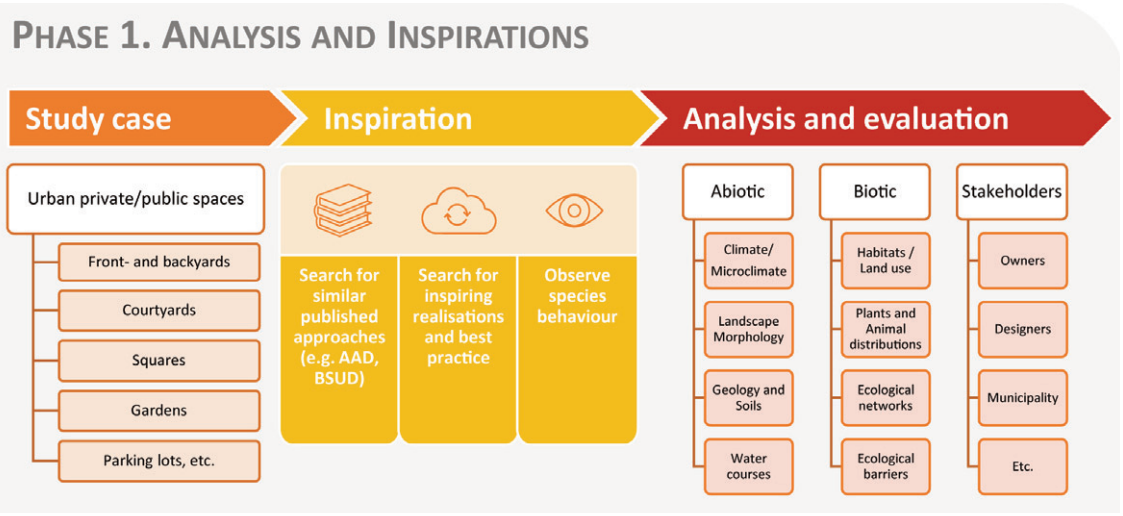

Fig. 1 | Methodological diagram, phase 1 of the EDD method (credit: C. Catalano, 2022).

ploying a multidisciplinary, computational and reproducible design approach. This line of research and application abandons the classic anthropocentric design vision, which aims to satisfy the comfort and well-being of humans, in favour of a multi-species approach.

In Switzerland, the federal biodiversity strategy explicitly addresses urban areas and considers settlements to be an essential factor in the preservation of the species deprived of their natural habitat (FOEN, 2012). The EDD, which is investigated in this study, fits the abovementioned international context and adheres to the guidelines set by the Swiss national strategy. It aims to provide natural sciences students with a reproducible design method, which has the goal of increasing the biodiversity of certain urban habitats, such as private gardens and courtyards. The hypothesis behind this methodology is that small but connected interventions which are made at an urban scale can be implemented at a territorial scale to support the urban ecological network, as it does with green roofs and walls (Braaker et alii, 2014). The EDD consists of three main phases[1]: 1) spatial analysis, ecological assessment of the site and stakeholder analysis; 2) the selection of animal species guiding the design intervention; 3) the planning and design of interventions. In addition to visual materials, students are asked to compose a text related to the project, which is structured like a scientific text, i.e., including an introduction, materials and methods, results and discussion, and conclusion sections.

Step 1: Analysis and Inspirations | The analytical phase is preceded by a literature review, which is accomplished by conducting a keyword search on Google Scholar

and Web of Science. The literature which is gathered here will ultimately be utilized in the introduction of the final paper (Fig. 1). By consulting 'peer-reviewed' publications, students should be able to contextualize the objectives of the project in a manner consistent with the solutions and strategies in support of biodiversity (such as nature-based solutions, or biodiversity action plans) implemented in Switzerland and other European countries. They also search for projects that are similar to their case study, and which shall inspire the design of the interventions. These best practices contribute to the content of an 'inspiration journal', which the students prepare along with their final paper.

Following their literature review, the students complete a spatial analysis, which focuses on the analysis of the abiotic (e.g., climate, geology) and biotic (e.g., habitat, data on species presence) components, to identify ecological corridors and barriers. In particular, the ecological assessment of the site is made according to the checklist developed by the urban ecologist S. Ineichen[2], which allows for the qualitative evaluation of both the entire area of intervention and the individual structures characterizing it. The parameters used for the overall evaluation are the degree of imperviousness, ecological connectivity, and the presence of undisturbed areas. In the case of small structures, the parameters used are the floristic diversity, the origin of the plant species

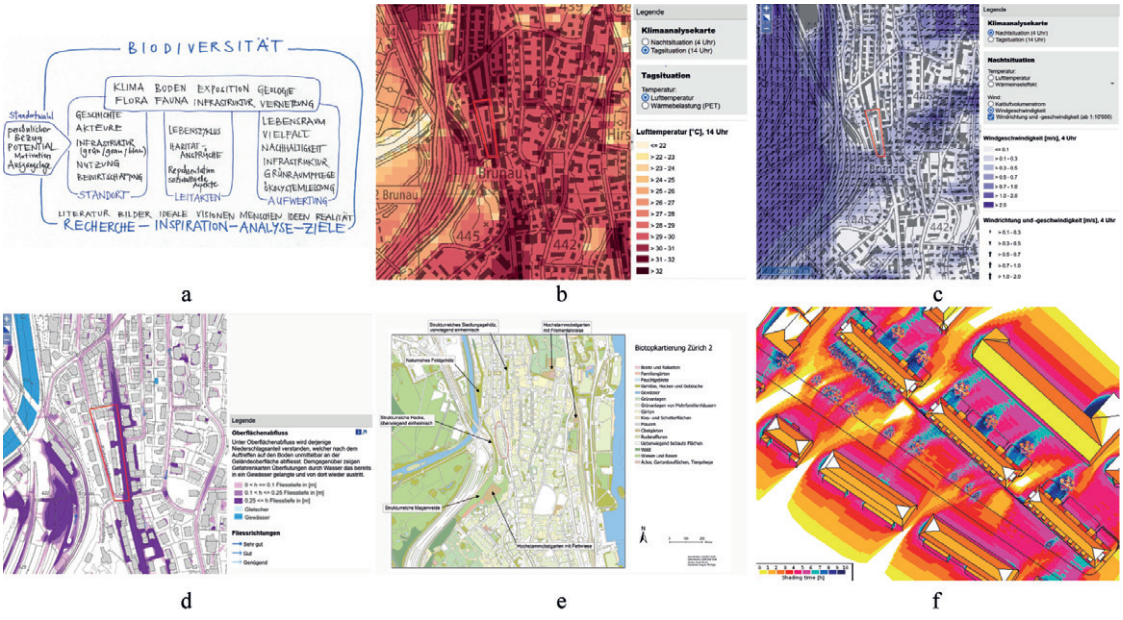

Fig. 2 | The study case; a) customized diagram of the EDD method; b) thematic maps of temperature, c) wind intensity, d) surface runoff and e) urban biotopes; and f) shadow analysis (20th of June) of the area of intervention (credit: R. Flückiger, 2021).

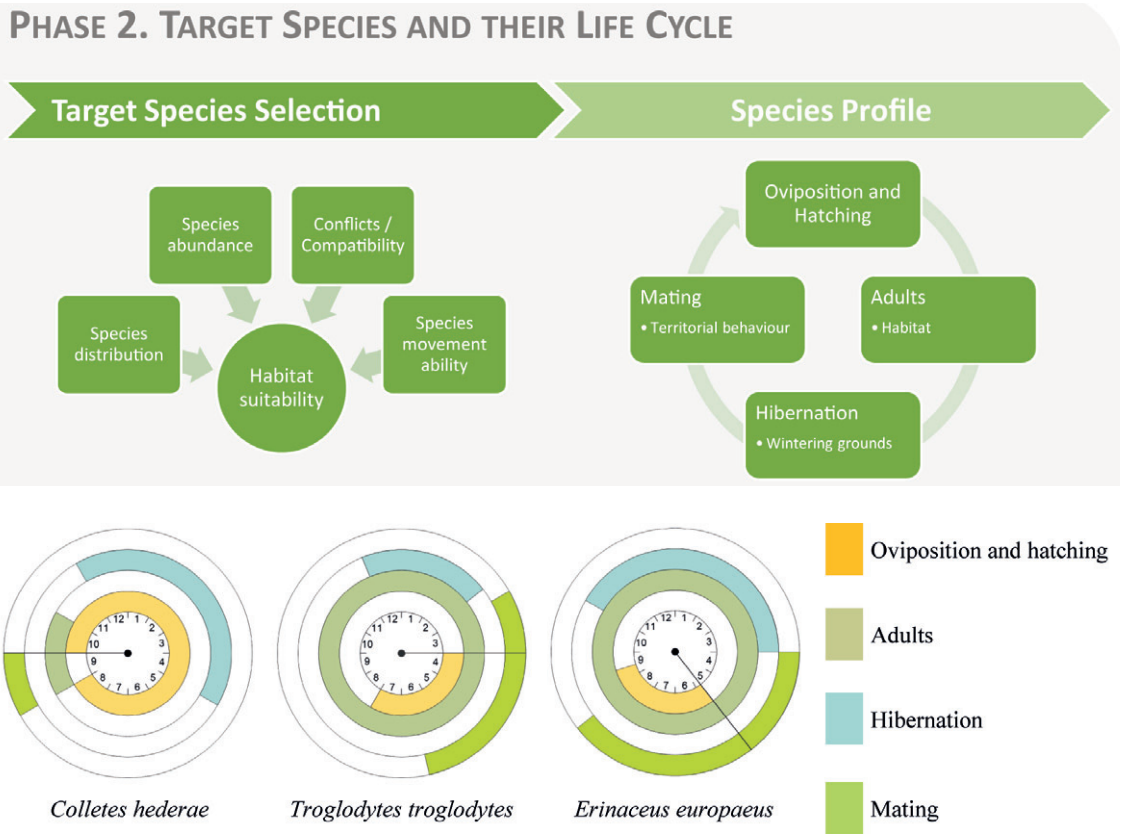

Fig. 3 | Methodological diagram, phase 2 of the EDD method (credit: C. Catalano, 2022).

Fig. 4 | One-year life cycle of the ivy collet 'Colletes hederae', the common wren 'Troglodytes troglodytes' and the common hedgehog 'Erinaceus europaeus' (credit: R. Flückiger, 2021).

(presence of native or exotic plants, in any case consistent with the place), the age of the individuals, and the type of maintenance (sustainable or not). Students are asked to synthesize the information they have collected, customize their proposed method (EDD) to make it their own (Fig. 2a), and present everything in an easy-to-understand, visual style. The spatial analysis at both the territorial and urban scale is carried out on GIS-browsers at different levels of in-depth analysis (municipality, canton, federation), and represented through thematic maps (Fig. 2b-e). On a smaller scale (varying according to the object of study) a shadow analysis is carried out so that specific interventions can be optimally positioned, that is, in relation to the needs of the selected plant species (Fig. 2f).

Step 2: Animal species selection and their Life Cycle | A crucial part of this method

is the selection of some animal species (characteristic of certain surrounding habitats), which is based on the spatial analysis of the site and is, therefore, site-specific (Fig. 3). The specific needs which are identified for species throughout their life cycle (Fig. 4) are based on reliable sources (federal wildlife monitoring sites, lessons from other courses) and summarized in so-called 'species profiles', according to the Animal Aided Design method (Weisser and Hauck, 2017). Students are allowed to choose a maximum of three species, which are limited to those included in the complementary modules in their study program among amphibians, reptiles, birds, beetles, bees and bats. An exception is the common (or European) hedgehog 'Erinaceus europaeus', which may be selected because it is already included in several urban biodiversity conservation programs in Switzerland.

The students must define and explain the criteria for choosing species individually, but among the conditions set, the selected species must already be present in the study area based on federal distribution maps (provided by the Swiss Wildlife Protection and Information Centres) or observations recorded by the Global Information Biodiversity Facility (GIBF, an international network aimed at providing free data on all types of life globally). The final choice of the three species is influenced by the stakeholders involved and the conflicts/compatibility among species (including humans).

Step 3: Conceptualization and Design | The design of the individual interventions to support the local biodiversity is the result of the ecological analysis, stakeholder involvement, and the needs of the selected animal species (Fig. 5). In the case study which was utilized by the student R. Flückiger[3] (Fig. 6), for example, the choice of the

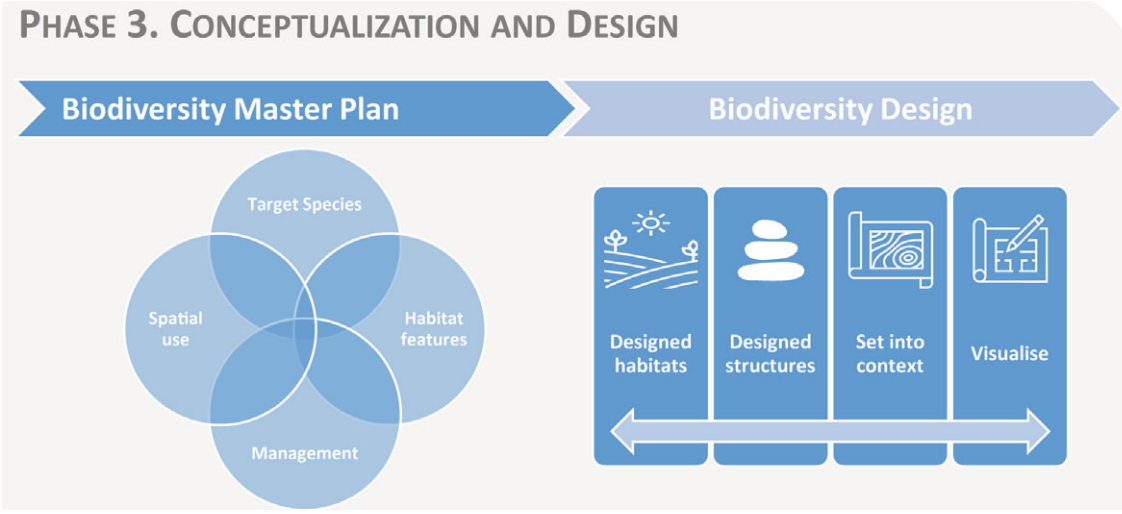

Fig. 5 | Methodological diagram, phase 3 of the EDD method (credit: C. Catalano, 2022).

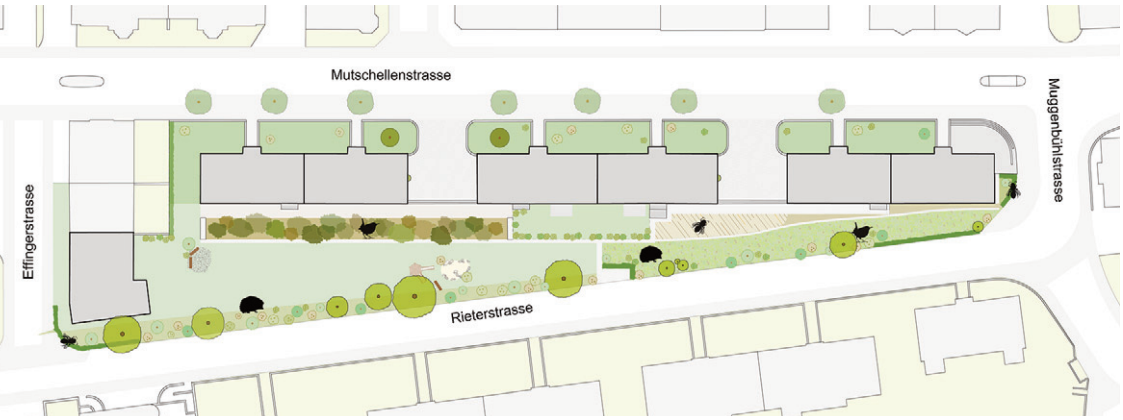

Fig. 6 | Contextualization of the interventions at the site (credit: R. Flückiger, 2021).

ivy bee (also suggested by the presence of several ivy hedges on site which represent the main source of nectar and pollen for this species), brings as a consequence the need to create one or more sunny ruderal areas with a sandy substrate and small annual plants necessary for nesting. Conversely, in targeted interventions which support wren instead, the cherry laurel hedge should be replaced by a mixed one with dogwood, barberry and blackthorn. In the same way, the common hedgehog is linked to structurally rich and dense margin vegetation, but without barriers. In this specific case, the area adjacent to the road (Rieterstrasse in Zurich) should therefore be planted with a herbaceous border supplemented with native woody plants such as dogwood, rowan and wild roses. In addition, the dead leaves and pruning piles, which must therefore be left on site, would serve as a shelter for hedgehogs, a foraging site for the wren which feeds on insects, caterpillars, worms and small spiders, and also a source of nesting material.

Green Experience Laboratory (GE-Lab) applied research and approach to the urban landscape for landscape agronomists: design experiences in the historic centre | The Laboratory has two integrated modules: Landscape Design and Redevelopment and Restoration of Degraded Areas to Green. The work focused on public spaces, and on how to deal with a multidisciplinary approach to an ecological transition in a strongly consolidated and historicized urban environment, while following the indications of the Italian National Recovery and Resilience Plan (PNRR). The work was conducted with the Landscape Architecture discipline and the agricultural Horticulture and Floriculture disciplines, and consists of three main phases: 1) spatial analysis, with the definition of guidelines for the synchronic and diachronic analysis of places and the study of existing landscape and urban planning; 2) synthesis and definition of judgments on critical issues and potential; 3) the planning and design of green rede-

velopment interventions of the places to be converted into public spaces. In addition to the visual materials, students are asked to create a multimedia presentation related to the project, structured according to an introduction, materials and methods, results and discussion, and a conclusion section.

The case study which was used revolved around the historic centre of the city of Catania, Sicily. If history represents the sense of belonging to something that has existed since before us, in forgotten but historicized places, the designer – through the experience of being in those spaces, where the present is interwoven with the past, and the signs of history are interspersed with the most recent contemporaneity – can try to transfer his or her feelings to the citizens who live in those places (Leonardi, 2021). The work in this case focuses on the ability to make citizens reflect on where they live, thus restoring lost, fragmented, or forgotten places within their consciousnesses.

The design research of recent years (Pica Ciamarra, 2018) has attempted to demonstrate how space, remarkably versatile with respect to meeting the varying needs of its inhabitants, can be considered essentially a place of relationships. The designer must therefore be able to trigger processes of participation, together with associations or dedicated bodies, which inform citizens and administrations of the potential of public spaces, local cultural and landscape heritage, and a sense of identity. From this perspective, with the help of ICT, the city could become increasingly smarter, and find an innovative new way to communicate its artistic, cultural and landscape heritage. It could also become increasingly greener, by reintegrating architecture and nature in the redevelopment of abandoned landscapes.

In compliance with the principles of the Charter of Public Space in Rome (Biennale of Public Space, 2013) and the subsequent proposals promoted by INU – National Institute of Urban Planning and UN-Habitat (2016) – United Nations Program for Human Settlements in the creation of a Global Toolkit on Public Space, in particular, the course worked on the green aspects of the redevelopment of the open spaces around the abandoned Vittorio Emanuele Hospital Complex in the 'Quartiere Antico Corso' in the historic centre of Catania. The Hospital Complex is located adjacent to the former Benedictine Monastery of San Nicolò La Rena, which was redeveloped by the architect Giancarlo De Carlo and is a UNESCO Heritage site. It extends over the area of the former Benedictine Flora. It will be reconfigured to become the third green lung of the historic urban centre, after Villa Bellini and Villa Pacini.

According to the forecasts made by the Detail Study L.R. 13/2015, the area is subject to urban restructuring, with the conversion of the Ancient San Marco Pavilion into the Museum of Etna and Sicilian Identity, and the demolition of some particularly degraded hospital pavilions, so that the currently existing garden can be expanded, and an urban park can be created for the neighbourhood. From these premises comes the action research aimed at enhancing biodiversity and recovering a sense of memory of the places. After a careful analysis of the area which, in addition to hosting the remains of the 'Ex Flora Benedectina', is strongly characterized by the permanence of

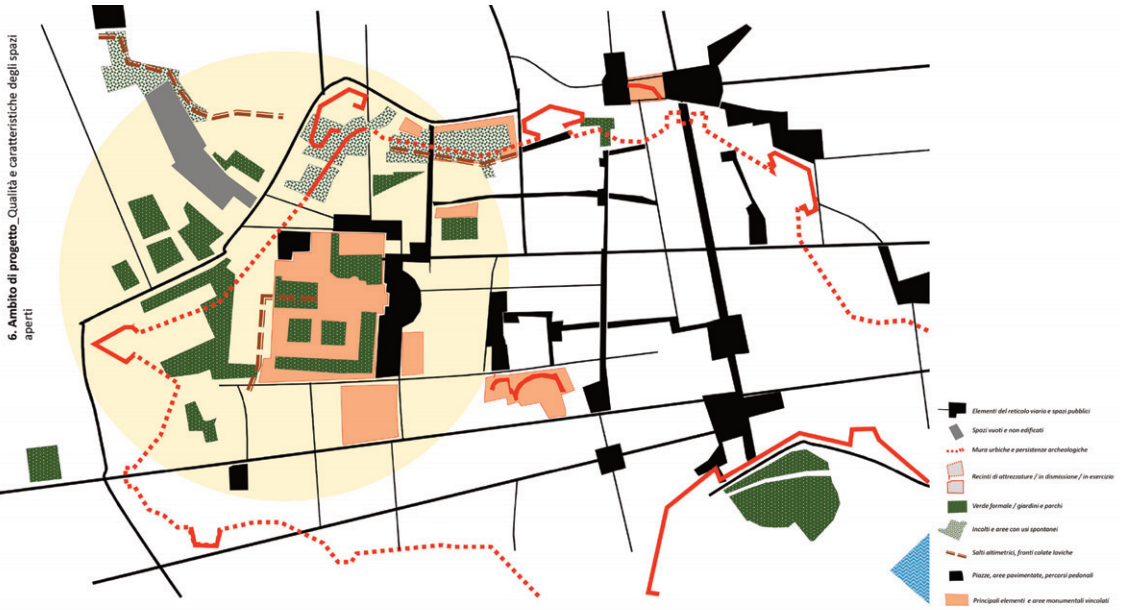

Fig. 7 | 'Quartiere Antico Corso' in the historic centre of Catania: the system of the walls of Charles V, the archaeological remains, the remains of the lava flow that swept over Catania in 1669, the green system, the Baroque monumentality UNESCO Heritage of the urban reconstruction after the 1693 earthquake (credit: M. Leonardi, 2021).

the historic walls of Charles V that surrounded the city of Catania, and by the persistence of the lava flow from 1669 still resurfacing, it was decided to focus on themes that aim to enhance the history of the area, and to select Nature-based Solutions that promote biodiversity in urban areas by carefully choosing which plant species are introduced. The phases of the action-research are as follows.

Step 1: Analysis | The analytical phase is preceded by bibliographic and cartographic research at libraries and in historical archives. The above material and landscape and urban planning existing documents are given to the students. Inspections are then organized on the project area, during which students are supported by a team of teachers with multidisciplinary skills able to guide them through the recognition of existing fauna and flora species, and the organization and composition of the spaces. In collaboration with the disciplines of Ecology and Landscape Analysis, students learn how to use a GIS Browser able to analyze and define the state of affairs with thematic maps of the different landscape components. Through the help of CAD software, they learn how to reconstruct the state of the places, starting from the existing cartography. Bodies or associations dedicated to urban participatory enhancement are also involved during the inspections, to represent the needs of local stakeholders.

Projects and realizations applied to similar case studies that can be a support for the work are also presented by teachers or experts, and students are invited to deepen their knowledge of those they perceive to be closer to their ideas for transforming the places. The ecological assessment of the site is carried out in collaboration with the teacher of the of Landscape Ecology course, a module integrated with Landscape Analysis, within the Ecology and Landscape Analysis course.

Step 2: Synthesis | After having conducted, with the help of specialists and through the existing thematic literature, an in-depth analysis of the existing plant and faunal species, and the botanical species present in the Benedictine Flora (Pagnano, 1984), and after having focused on the study of the historical plans of the city of Catania and in particular of the 'Quartiere Antico Corso' and the Benedictine Flora published in the literature (Amico 1757-60; Leanti, 1761; Hittorff and Zanth, 1835; Dato, 1983; Pagnano, 1984; Cusa Gentile, 1994; Atripaldi and Costa, 2008), at libraries, or in historical archives[4], the students are ready to synthesize what they have learned. This is accomplished by making judgments on the critical issues and the potential of the places with a SWOT analysis. This analysis presents hypothetical thematic gardens that in some way can reconstitute the spirit of the place, even though it has a contemporary look, and even though the public space will be reconfigured to provide its citizens with a new urban park. The thematic gardens which are designed also assume an educational and didactic function for visitors, as they are assisted by ICT technologies

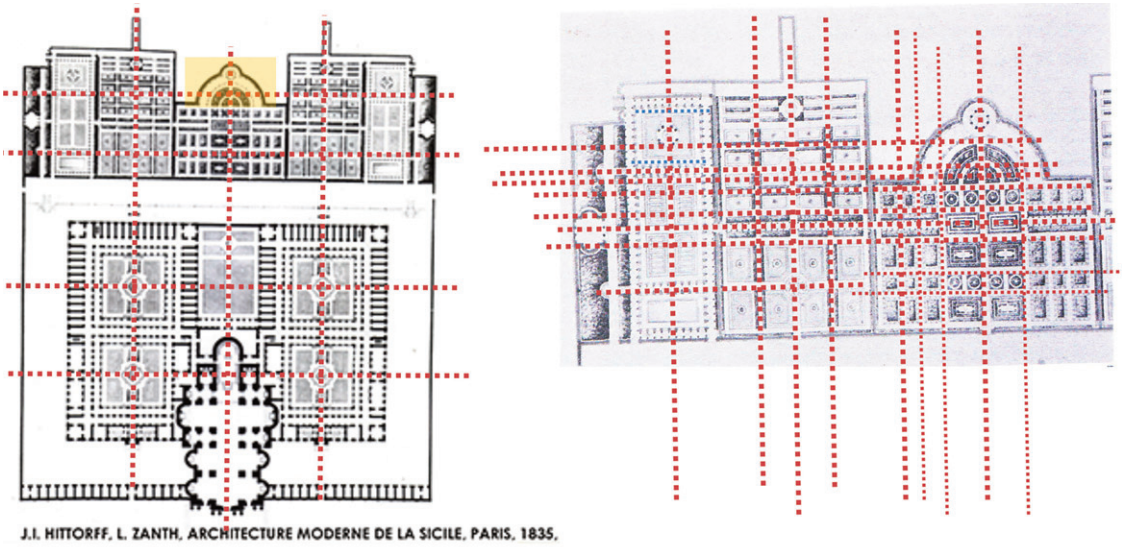

Fig. 8 | The Benedictine Monastery of San Nicolò La Rena and its Flora: the system of axes (source: Hittorff and Zanth, 1835).

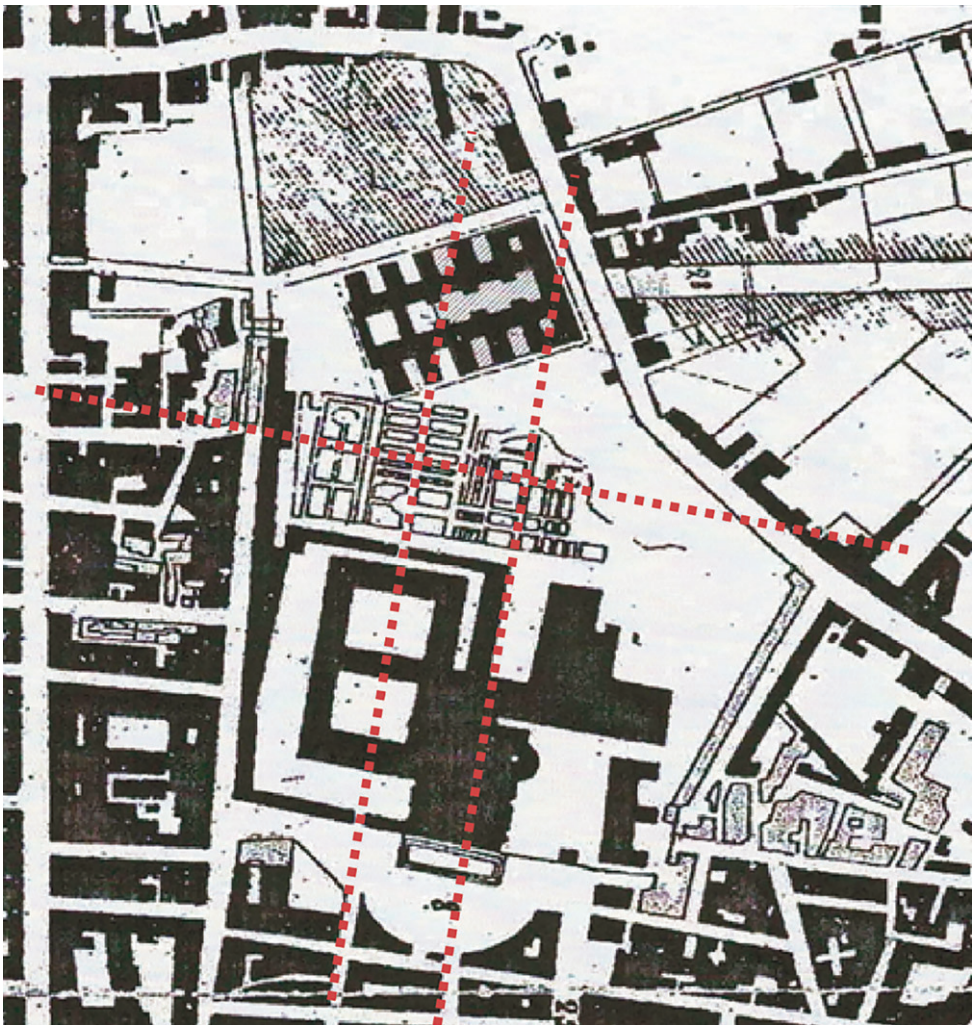

Fig. 9 | The Benedictine Monastery of San Nicolò La Rena, its Flora and the San Marco Hospital Pavilion: Master Plan of Renovation and Expansion of the City of Catania proposed by Eng. Gentile 'Ufficio d'Arte Comunale', year MDCCCLXXXVII and the system of axes (source: Cusa Gentile, 1994).

that in some way reconstruct the history of the places, describe the botanical species present, and the animal biodiversity that follows (Figg. 7-11). A fundamental aspect of the multidisciplinary comparison is identifying which plant species can be used to help recover the degraded spaces, based on the spatial analysis of the site and the specific potential of the context. From this choice, a spontaneous faunal repopulation follows that can still be compatible with the public use of the spaces. Students must define and explain the criteria for choosing species with special cards and schedules.

Step 3: Design | The result of the analysis and synthesis phases is the planning and design of the green redevelopment of the places to be converted into public spaces. The project is addressed and controlled in its multiscale components from the initial masterplan up to the definition of the construction details of the urban elements. For example, Figures 10 and 11 represent a part of the project developed by the students A. Iozzia, and G. Stracquadanio. In the spirit of recreating a park in harmony with its historical context, where the usability of the inhabitants and tourists is always made possible, and taking into account the accessibility conditions defined by studying the results of the Biennale of Public Space and UnHabitat, and by introducing different recreational, environmental and cultural functions, the area, also connected with the Benedictine Monastery through the Battaglia bridge, is designed with overlapping layers, which logically relate to one another.

The first layer represents the partition of the pathways, based on a diachronic analysis of the axes of the Benedictine Flora (axes of the Monastery, the Battaglia Bridge and the historic Garden of the Benedictine Flora: main project pathways parallel to the Novice Garden). The second consists of a cycle and pedestrian pathway which encloses a multifunctional surface. The third layer is contained within this pathway and is based on circular modules. The park is characterized by several discrete areas: recreation (cycle-pedestrian track, sports, playgrounds), refreshment (equipped with rest ar-

Fig. 10 | The design of the green system in Catania, Project 'The gardens of OVE – Vittorio Emanuele Hospital' in 'Quartiere Antico Corso' (credit: A. Iozzia and G. Stracquadanio, 2021).

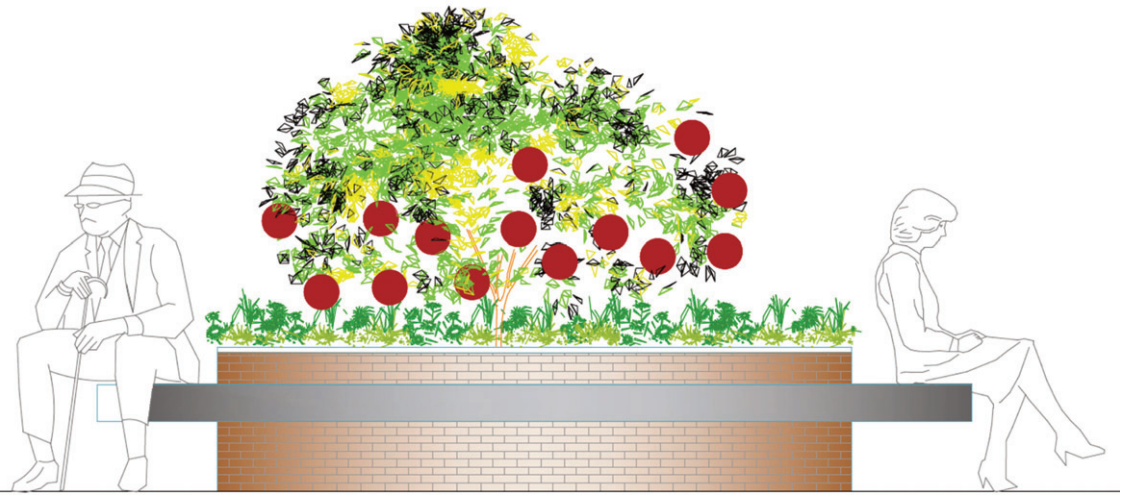

Fig. 11 | Detail of a flowerbed-bench ('Punica granatum') in Catania, Project 'The gardens of OVE – Vittorio Emanuele Hospital' in 'Quartiere Antico Corso' (credit: A. Iozzia and G. Stracquadanio, 2021).

eas), educational (info-point, green areas), and thematic gardens (Gardens of perception, Rock Garden, Evergreen Garden). The choice of the botanical species of the project was made based on the climatic and soil conditions (in which the students operated), and the maintainability, considering the limited public financial resources as well as the ability of the selected species to contribute to animal biodiversity.

Concluding remarks | The case studies shown here respond to the need to direct students towards the ecological transition that is taking place on a European scale, which supports biological diversity in the urban environment. Simultaneously, this demonstrates how the dialogue between different professionals and their related skill sets is not only feasible but also necessary to the success of the different design phases. The common purpose of the workshops is in fact to create spaces that increase biodiversity and social well-being (Un-Habitat, 2022). It, therefore, seems clear that it is necessary to further integrate the curricula of the natural sciences and landscape architecture so that new professionals can be trained to work in multidisciplinary groups. This would therefore increase the spectrum of skills in the field of landscape architecture, by starting from an ecological understanding of the landscape. The studies and applied methodological research start from the common idea of a multidisciplinary approach to landscape design, although they differ in the choice of existing case studies. The EDD method has been applied to green areas adjacent to condominiums or private neighbourhoods, while the GE-Lab focuses on the redevelopment of pieces of land and public spaces in highly historicized environments.

In summary, in the case of the EDD, the stakeholders are both the animal and plant species considered through the analysis of the vital critical needs of the animal species, as well as private individuals, municipalities and other professional figures (for example architects and landscape architects). All the interventions are related to each other in an ecosystem vision that generates benefits and opportunities both for users and for local flora and fauna, converging with the above-mentioned approaches on a European scale.

Among the limitations identified, there was the difficulty to incorporate the ecological needs of the animal species and habitats into the landscape project along with the expectations of the owners, which were not necessarily focused on protecting biodiversity, and who were possibly afraid of the costs that such interventions could cause (nature-city conflict); the difficulty of finding ecological data that is accessible and available at the municipal level in high resolution; the difficulty for students to translate ecological knowledge and data in a conceptual, spatial and functional way. These limitations and criticalities are consistent with the results obtained in the survey addressed to students and professionals in the field of architecture and construction published by Catalano and Balducci (2022).

On a theoretical level, the various methodological phases have been described in detail to make them applicable in other contexts and similar case studies. The study cases presented here can be implemented at the same time, improving through previous experiences and new objectives in an iterative and non-linear feedback-loop or 'design thinking' system. The GE-Lab laboratory experience has been applied to abandoned open spaces in highly consolidated historic centres for their conversion into public places and the enhancement of biodiversity. We tried to follow a model of approach to the project that, along with its multidisciplinary component, can be replicable. Also, in this case, the interventions are managed with an ecosystem vision that generates benefits and opportunities for both the users and the local flora and fauna. Among the critical issues and limitations encountered, communicating with public bodies and stakeholders also led to some difficulty. In this regard, collaboration with urban sociologists should certainly be encouraged. The methodology attempts to apply the principles derived from the international UnHabitat experiments, reconciling them with the PNRR and the ideologies supported by Pica Ciamarra, and it tries to emphasize their multidisciplinary contributions. The work, which has been verified in small urban areas, should, however, be experimented with at both the urban level, with the creation of ecological corridors connecting parks and public gardens, and at the territorial level.

The results of these pilot projects suggest the possibility of applying the methods in other contexts in a synergistic way. The Mediterranean environment lends itself as a biodiversity hotspot, both from the point of view of multi-layered cultural landscapes and from the ecological and naturalistic point of view. This is consistent with the strategy envisaged in the Italian National Recovery and Resilience Plan (PNRR).

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Notes

1) For more information see: Catalano, C., Jüstrich, S. and Baumann, N. (2021), *Praxisauftrag UÖ2 2021 – Vom Lebensraum zum Ökosystem – Design [Practical assignment UÖ2 2021 – From habitat to ecosystem design]*, Students' class material of the Course 'Urban Ecosystem – Fundamentals 2', BSc degree in Natural Resource Sciences, Zurich University of Applied Science. [Online] Available at: moodle.zhaw.ch/mod/resource/view.php?id=155683 [Accessed 17 June 2022].

2) For more information see: Ineichen, S. (2020), *Naturnahe Grünräume- eine Checkliste für Grünflächen, Wohnumfeld, Garten und Parks [Natural green spaces – A checklist for green spaces, living environments, gardens and parks]*, Students' class material of the Course 'Urban Ecosystem – Fundamentals 2', BSc degree in Natural Resource Sciences, Zurich University of Applied Science. [Online] Available at: moodle.zhaw.ch/pluginfile.php/202680/mod_folder/content/0/U%C3%962_L_2020_Naturnahe-Gr%C3%BCnr%C3%A4ume-eine-Checkliste_Ineichen.pdf?forcedownload=1 [Accessed 17 June 2022].

3) For more information see: Flückiger, R. (2021), *Lebendige Inseln in der Stadtlandschaft – Aufwertungsmassnahmen für die Siedlung Mutschellenstrasse | Living islands in the urban landscape – Upgrading measures for the Mutschellenstrasse settlement*, unpublished work, Course 'Urban Ecosystem – Fundamentals 2', BSc Degree in Natural Resource Sciences, Zurich University of Applied Science.

4) For more information see: Orlando, F. (1761), *Veduta della città di Catania* (source: Archivio Storico del Museo della Fabbrica del Monastero dei Benedettini, Catania); Ittar, S. (1832), *Topographic plan of the city of Catania, Paris ca., engraving on copper, cm 78,5×53,4* (source: Biblioteche Riunite Civica e Ursino Recupero di Catania).

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Fig. 12 | 'Chamaenerion angustifolium' (L.) Scop. and visiting bumblebee, biodiverse green roof of the Europaallee 21, construction area C, Zurich (credit: C. Catalano, 2014).