Chapter 3
Sustainable and Together: Between Ecology, Health and Governance

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Abstract This chapter examines the effects of biodiversity loss, which have dramatically highlighted how humanity is constantly dependent on ecosystem services even though the majority of the world's population doesn't even know what they are. This dependence is particularly evident in urban ecosystems, which are often characterized by a deficient and inefficient ecological network that is unable to provide sufficient services. We need to bring nature back to the cities to increase social well-being, to provide services to citizens and to ensure a greater resilience of cities, especially in this period in which the negative feedback of climate change is dramatically emerging. The statement "More nature in the cities" also means contributing to the conservation of biodiversity, which should become a primary objective in urban areas. Instead, very often it sounds like an empty slogan or an environmental policy issue restricted to protected natural areas only.

While the main goal is one, the solutions may be multiple and must necessarily be shared by involving city administrators, citizens and the scientific community. The skills of the scientific community will need to be different but complementary to propose a consistent pattern of multidisciplinary nature-based solutions. Accordingly, the specific contribution provided by each discipline should fit in with those provided by the other disciplines and be designed to maximize the effectiveness of the results. One of the most suitable solutions adopted by designers to counter the harmful effects of global warming is nature based and is known as "Green Infrastructure". The design of various types of green infrastructures is the basis of all sustainable development policies, both at the national and EU community level. If we are talking about green infrastructures, such as urban forests, rain gardens and green roofs, it is evident that they share a common element, namely the use of plants, species and/or plant communities. However, an essential rule should be followed, namely that the plant material used in green infrastructure projects would be better if it were of local origin and preferably consistent with the landscape and biogeographical context of the project sites. In addition to avoiding problems of genetic pollution

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for the natural ecosystems surrounding the cities, this a priori choice would be ecologically sustainable and respectful of the identity of the places.

Plants are a great resource to heal the wounds that we ourselves are inflicting on our quality of life in cities, but they have their own identity card and, like all medicines that treat diseases, they have their own leaflet which cannot be ignored.

Keywords Biodiversity · Green infrastructures · Ecosystem services · Landscape

3.1 Once upon a Time, There Was Ecology

The last book published by Valerio Giacomini (1914–1981), who is among the greatest Italian and European scientific personalities, the father of Nature Conservation Management in Italy, a promoter of the Intergovernmental Program "Man and Biosphere" (MaB) and one of its most brilliant scientific animators and one of the first academics to make the scientific world aware of the importance of Natural Capital, is entitled: "Ecology because..." ("*Perché l'ecologia*" – Giacomini 1980). Thanks to his interdisciplinary culture, the author provides many fitting "ecological case studies" that he explained by associating scientific accuracy with philosophical and humanistic concepts. Although Giacomini provided answers on why ecological thought should prevail in governing our actions, especially when we are called upon to manage the environment, his explanations do not appear to have had much of an impact on subsequent generations. To be more responsive to current needs, it might have made more sense to entitle the book: "Why Ecology?" (*Perché l'ecologia?*) considering the behavior of the industrialized countries' governments (and public opinion itself), the competition to achieve the highest percentage increase in GDP, the denialism surrounding global warming forcefully supported by newspapers (in most cases owned by businessmen or multinationals), some doubts arise. When asking policymakers or people living in cities or isolated villages whether it is correct to follow the principles of ecology and give up gaining immediate wealth for individual countries through the intensive exploitation of natural resources so as to benefit humanity as a whole, the answer would certainly not be univocal. Or rather, it might be univocal and affirmative in words (which the wind blows away), whereas in facts based on concrete actions, it is clear that the ecological vision of the world remains a controversial topic, with the number of detractors equal to, if not higher than, that of the supporters. "Why ecology?" could be a perfect slogan for the COP28 summit, being held in Dubai in the United Arab Emirates (which is one of the leading producers of oil and greenhouse gas emitters), where organizers stated that there is no scientific evidence suggesting that fossil fuels need to be abandoned to achieve the objective of tackling the increase in global temperatures. This statement was made at a time in which the Global Tipping Points Report, a study carried out by the University of Exeter's Global Systems Institute, which coordinated 200 researchers affiliated with 90 research institutions in 26 countries, informs us that we are closer than we have ever been to satisfying 5 of the 25 established climate tipping points that are being monitored: the melting of glaciers in Greenland, in West Antarctica and of the permafrost covering large areas of the planet, the death of coral reefs in warm waters and the collapse of an ocean current in the North Atlantic. That is, the level beyond which a change, which is in this case due to global warming, becomes unstoppable and uncontrollable. Literally, a point of no return.

Ecology is an uncomfortable word that pinches the conscience and should, in some circumstances, either not be mentioned or be mentioned as an empty sounding board.

One of us (Di Pietro 2014), in the preface of an essay on the role of plant ecology in Architecture, started this way to introduce the "multitasking" and "controversial" meaning of ecology "*In the middle of the twentieth century, little was known about ecology. In the Seventies, either due to the activist campaigns on the alarming problem of pollution, or to address a real sense of guilt creeping into public opinion, the term "ecology" rose to the fore. In the nineties, ecology was the watchword for acquiring respectability, in all venues, institutional and otherwise, in all social and cultural gatherings, and in the countless political debates. It was enough to pronounce the term "ecological" in a discussion or in an electoral meeting to automatically pass onto the side of the "goodies". Today we hardly hear about "ecology" anymore because it is no longer a trend, having been replaced by terms that are at least apparently less binding but more engaging and captivating, such as "biodiversity conservation", "green economy", "environmental quality"*.

On the other hand, the history of ecological sciences is dramatically characterized by the awareness of lost things. Alexander Von Humboldt, observing the South American plains at the end of the eighteenth century, was the first to highlight how man was disrupting the *Naturgemälde* (Wulf 2015). Von Humboldt suggested that "there is a chain of affinity binding together all nature" and that the intimate connections that characterized natural environments were at risk. This happened several years before Haeckel invented the word "ecology" in 1866 and founded the science that investigates the relationships between the physical environment and living matter together with the connections (spatial, functional, temporal) that occur within the latter. These are "the connections of nature", the functioning of our οίκος (Levit and Hossfeld 2019). An οίκος (home) that, at the end of the nineteenth century, had its foundations undermined and was going up in flames. Thirty years after the definition of ecology, in 1896, Arrhenius laid the foundations of modern climatology (Rodhe et al. 1997), a science born to outline the impact of man on nature. Arrhenius was the first to prove that carbon dioxide introduced into the atmosphere by industrialization would accumulate over time, causing a rise in temperatures. In 1962, Rachel Carson proved the effect of pesticides on the biodiversity of birds (Carson 1962). In 1972, the "Club of Rome" highlighted the limits and risks in the growth of the world population (Meadows et al. 1972). Apparently, everything was already clear, everything was written and demonstrated many years before the birth and spread of the word "biodiversity", in 1986. This word was coined to define the diversity of nature and to remind humanity that such diversity was precisely what we were rapidly losing. One year later, the concept of "sustainable development" was defined by the Brundtland Commission. The definition was born to call for a change in economic development to meet the needs of future generations without leading to a depletion of environmental resources. The history of the last 35 years, unfortunately, has shown that inserting “sustainable” in front of the word “development” has not brought the desired results. The development was unsustainable in 1987 as it still is today.

In 1992, the “United Nations Conference on Environment and Development” was held in Rio de Janeiro and, considering the impact of the event, there were all the conditions for it to represent a turning point in the establishment of global awareness on the value of biodiversity and on the implementation of effective policies for its protection. Europe tackled the problem of biodiversity loss by ratifying the Habitat Directive 92/43/CEE. In the package of measures and rules constituting the core of the Habitat Directive, for the first time, attention was shifted to the management of ecosystems rather than to their conservation tout-court. In fact, the Habitat Directive put forward the innovative concept that some anthropic activities could even serve as bulwarks to face the loss of biodiversity, especially in the so-called semi-natural environments. Unfortunately, despite these interesting and innovative environmental policies, the loss of biodiversity did not slow down.

In 1997, the concept of Ecosystem Services was born. Once again, a branch of ecology arose to define what we were losing. In their scientific work that represented a new milestone in nature conservation, Costanza et al. (1997) showed that the loss of biodiversity, in terms of species and ecosystems, would lead to the loss of numerous functions that the ecosystems themselves performed and that could be easily quantified as services for humanity. Since then, thousands of scientific papers have been published on this topic (Turner et al. 2007), and ecosystem services have become the backbone of European strategies for the safeguard of biodiversity (Maes et al. 2020). The introduction of the concept of ecosystem service which evaluated not only qualitatively but also quantitatively the useful contribution of plant communities at different scales (from the oak forest stands to be planted in the surroundings of great cities to the micro-garrigues rich in *Sedum* sp.pl. and therophytes used for green roofs) represented a further leap towards a more functional and, in some ways, “productive” view of the environment. It became clear that a vigorous biodiversity was required to counteract climate change, to feed a growing population and to maintain a sustainable socio-economic fabric which at the same time ensures a high quality of life. Taking this for granted, the first action to be taken was (and still is) that of reversing the current, and unfortunately excessively fast, trend in biodiversity loss.

The MAES (Mapping and Assessment of Ecosystems and their Services) project, completed within the framework of the European Strategy for Biodiversity for 2020, has defined and evaluated the state of European ecosystems (Maes et al. 2020). Urban ecosystems are growing. Although not completely devoid of biodiversity, urban environments (especially large cities) have seen a drastic decrease in green spaces. Thus, the enhancement of nature in cities has become a priority. One of the strategies hypothesized by ecologists, who promptly suggested it to city administrations, was that of reconnecting urban spaces to the surrounding natural areas in order to reduce habitat fragmentation, the latter phenomenon being one of the leading causes of biodiversity loss at both the global and local scale. Unfortunately

(. . .for whom?), this goal could only be effectively achieved by moving in a diametrically opposite direction to how productive society is currently moving, namely by preserving the natural ecosystems that survived the expansion of artificial surfaces, restoring the most severely compromised natural spaces and planning different types of green infrastructures at different scales. However, while the objective is clear and the strategies may share similar bases in different countries, the methodologies (technical or scientific) to be used cannot be generalized. In other words, while there is one globally recognized problem, the solutions may be numerous but inevitably need to be found locally. Let's take the example of urban forests, the most popular solution proposed to tackle the heat island effect in cities. Every urban forest is a living and dynamic system bound by the rules of the evolution path and by the limits imposed by biogeographic maps. Therefore, if the suggested solution is "planting trees", then we must consider that there are countless connections that have developed in natural ecosystems and that have been perfected (phenotypically and genotypically) over hundreds of thousands of years. The genetic variability of an individual (or a population) is a resource that allows the resilience of species and ecosystems and should be primarily considered when plants are going to be used in green infrastructure. To sum up, each place will have its most suitable tree choice (or association of trees in the form of a wood stand) which will be different from the most suitable tree choices in other places, these "other places" presumably being characterized by different ecological, climatic and biogeographical conditions. In short, "the right tree for the right place".

3.2 The Wealth of Biodiversity

Biodiversity is a multidimensional concept. The simplest way of understanding it, which will be clear to everyone, is to count the number of species[1]: a biodiverse ecosystem tends to host many species. For instance, a patch of 10 km^2 in an intertropical rainforest can contain more than 2000 plant species. Not all the ecosystems in the whole Biosphere are characterized by such high plant biodiversity. However, the specific richness of an ecosystem is not the only parameter to consider when assessing its importance. In fact, there are many poor-in-species ecosystems (e.g., those developed in environmental conditions in which one or more limiting factors act, such as the salty steppes of coastal areas – Fig. 3.1), among the rarest and most vulnerable ecosystems in the world, in which a microclimatic change or a slight increase in anthropic pressure could lead to their local extinction.

[1] There are many methods for counting species and therefore assessing the biodiversity of an ecosystem. Many indices have been developed and even the simple "number" of species is a complicated and multidimensional concept. The scientific literature on the subject is vast, and the works we cite (Moreno et al. 2018; Tuomisto 2010) are but a few examples.

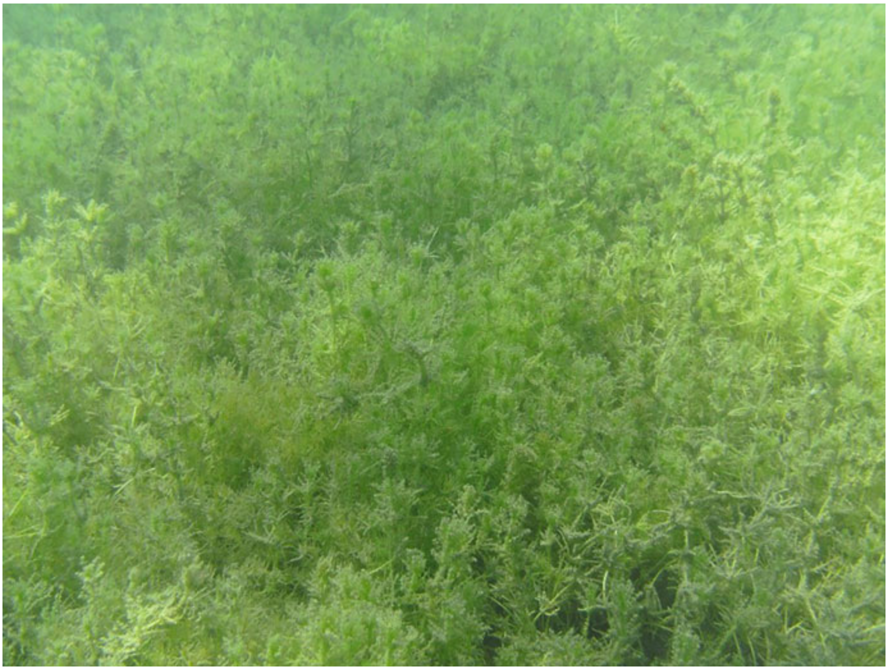

Fig. 3.1 A submersed meadow of Chara aculeolata. Stonewort's meadows are an example of poor-in-species ecosystems, which are threatened worldwide

The spatial arrangements of a high number of poor-in-species communities related to the sharp change in micro-climatic and micro-topographic conditions are the most typical form of γ biodiversity (number of ecosystems per unit area). In the field referred to as "Vegetation Science", γ biodiversity assumes greater value when it is composed of a highly diverse pattern of potential plant communities (high potential heterogeneity), which means that the plant landscape is composed of a high number of "climax" (potential natural vegetation) communities. Very often, especially in environments that have interacted significantly with the presence of humans, an apparently high "actual" heterogeneity of the landscape does not correspond to an equally high "potential" heterogeneity. From a bird's-eye view, the Po river valley, in northern Italy, currently looks like an intricate puzzle of intensively cultivated fields with various crops for dozens of square kilometers. In terms of potential heterogeneity, however, it refers to just a single type of potential natural vegetation, i.e., the alluvial forest of *Quercus robur, Q. petraea, Carpinus betulus* and *Ulmus minor* (Blasi 2010). By contrast, by following a linear spatial transect of only 100 m crossing a dunal environment from the shoreline to the back of the dune, a spatial succession composed of different "permanent" plant communities can be observed, each of which is dominated by a single species (*Cakile maritima, Elymus farctus, Ammophyla australis, Crucianella maritima, Juniperus macrocarpa,* etc....) and each of which acts as a single type of potential natural vegetation (Géhu et al. 1984).

Examples of the importance of poor-in-species ecosystems can obviously also involve the fauna and be read from the point of view of the entire food web. The ecosystem that allows salmon reproduction is very poor in species: a stream with some bare rocks. However, salmon belong to a keystone species that is needed by many other animals and ecosystems (Reimchen 2000).[2] Without Pacific salmon, wolves, bears and scavenging birds do not have enough food (Willson and Halupka 1995). The local extinction of salmon affects the forest ecosystems close to the rivers where the salmon spawn, which means they eventually collapse. Thus, the ecosystem diversity that allows salmon to survive is crucial. Accordingly, to protect the upper stream, near the source, where salmon mate, all the ecosystems of the river are important, even if they appear to be poor in species. Many other examples exist that highlight the pivotal role of keystone species and ecosystems, such as the mangrove forests that protect the tropical seacoasts (Kelleway et al. 2017) or the previously mentioned dune vegetation communities dominated by *Ammophila australis*, which are so important to the functionality of dune ecosystems (Feagin et al. 2015).

The variability between different species becomes clear when we analyze animals, whereas the genetic variability within species is immediately evident when we observe the multiform phenotypic expressions manifested by the species (*Homo sapiens*). Instead, phenotypic and genotypic variability (especially infrageneric variability) tends to be somewhat ignored when it comes to plants. Our yardstick, which is calibrated to identify only macroscopic differences, might lead us to conclude that all the birches or deciduous oaks of the world must belong to the same species. Taking birch as an example, we might think that the disappearance of birch from the slopes of Mount Etna in Sicily would not be a great loss since birch (*Betula pendula* L.) is probably the most widespread deciduous tree species in central and northern Europe (Euro+Med 2006). It would actually be a painful loss regardless (at least for the two authors of this chapter), but it would be an even more painful loss if we consider that the Etna birch populations do not belong to the species *B. pendula* found throughout Eurasia, but to a taxonomically separate species, *Betula etnensis* Rafin, whose occurrence in the world is exclusive to Mount Etna. It is for this reason that observing *Betula etnensis* in its natural ecosystem immediately and unequivocally places us on the geographical map and allows the Etna landscape to be immediately identified and circumscribed with respect to the landscape of the rest of Sicily and of any other place in the Italian peninsula. In addition to the multiform aspects of anthropic interactions between human activities and natural ecosystems, there are millions of other cases in which biotic interactions between living organisms lead to significant (but sometimes invisible) modifications in the environment. These may appear less spectacular than those that include man among the modifying agents, and yet they are extremely significant for both ecosystems and the landscape. We should perhaps finally realize that, whether we're talking about *Homo sapiens* and *Betula etnensis* or about *Ailuropoda melanoleuca* (giant panda), *Canis lupus* (wolf), *Lumbricus terrestris*

[2] salmon: a keystone species (https://pacificwild.org/salmon-a-keystone-species).

(earthworm) or *Latrodectus mactans* (black widow), they all have the same value in taxonomic terms (each of them counts for one single species). In broad terms, the extinction of any of the aforementioned species would have the same negative impact on the computation of the overall alpha-biodiversity of our planet and should cause us the same displeasure, regardless of their external appearance. We are aware that the above comparison may sound quite trivial, especially if we look at it from the perspective of mankind. However, the combination of the "equal specific dignity" with what was said a few lines above about the importance of the Etna birch allows us to introduce the concept of biogeographic identity of plant species and communities, which is in turn strictly related to those of landscape identity. Biodiversity is important because the higher the number of species, the more functions ecosystems perform (Tilman et al. 2014). For example, a meadow with a high number of species has a high aboveground biomass (Spehn et al. 2000). That means it produces taller hay for livestock than a meadow characterized by a lower number of species, capturing and storing more carbon dioxide and allowing the survival of more bees. Thus, the higher the biodiversity, the greater the number of ecosystem services available. Nevertheless, there are normally very few species in our cities, in public parks and gardens as well as in private backyards. Biodiversity is normally made up of a much smaller number of species than the environment could naturally host, and it very often contains introduced species (alien) or obviously artificial associations of a few species. Biodiverse meadows are decreasing and butterflies are disappearing, as are bees. In order to change the approach in the design of green areas and go beyond the garden, knowledge of the "concept of biodiversity" is required, as is an awareness of what biodiversity is currently under threat. Biodiversity is rapidly collapsing, and it is exclusively because of us. This is the biggest global problem we are facing, a problem that is even more alarming than climate change, to which it is in any case closely connected. Indeed, lots of the scientific evidence and figures on the biodiversity loss highlighted by IPBES[3] are more bewildering than the alarming numbers related to the negative effects of climate change. The number of insects, the most species-rich group of living beings, is collapsing worldwide (Sánchez-Bayo and Wyckhuys 2019). In Europe, there has been a 76% loss in insect biomass (Van Klink et al. 2020). Even if insects may disgust us a little (and once again. . .the authors of this paper do not think so), "we will miss them" (Kolbert 2020). It is well known that insects and plants have co-evolved, and many Angiosperms (plants producing flowers) need pollinating insects. Thus, the 50% reduction in butterflies (pollinating insects) will generate a cascade effect on the efficiency of pollination on flowering plants, the results of which can easily be deduced in terms of seed and fruit production and as intensity and abundance of the subsequent phenological cycles. This is due to the fact that flowering plants are the reason why biodiversity is so abundant on our planet (Benton et al. 2022).

[3] Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services: https://www.ipbes.net/

Recent studies on the Earth biomass have outlined something shocking. The extinction rate of mammals, birds and fish has skyrocketed exponentially over the last 100 years, and the mass of all mammals and wild birds, from mice to whales, from hummingbirds to condors, combined currently accounts for only 0.38% of the planet's total biomass, while humans account for 2.5% and farmed animals for 4%. On Earth there are now more chickens on farms than birds in the wild, in a ratio of about 100 to 1. We have disrupted biodiversity, and this is a huge problem because (and we apologize for underlining the following concept so frequently) biodiversity is essential to our life.

3.3 Ecosystem Services in a Changing World

Biodiversity provides us with ecosystem services, which are the benefits that human beings get from nature. It is important to note the slight difference between ecological functions and ecosystem services. We will try to explain it with an example. Through a series of complex anabolic chemical reactions known as photosynthesis, plants produce sugar from carbon dioxide and water. The byproduct of this reaction is oxygen. All the oxygen that we and all other animals breathe in every second of our lives is made available to us free of charge. Thanks to plants, the level of carbon dioxide in the atmosphere of planet Earth is lower than that in the atmosphere of Venus, a planet that is similar to Earth insofar as it is of a similar size and has a similar position to ours in the solar system. The greenhouse effect present on Earth, which causes us so much concern, has nothing to do with the extreme greenhouse gas effect on Venus, which is incompatible with life itself. Obviously, plants perform photosynthesis not to please us but to fulfil a function designed to produce glucose for the plants' own nutriment. However, if we look at the amount of carbon dioxide that plants remove from the atmosphere thanks to the activity of an urban forest and we compare and economically quantify it with a job (duty) aimed at reducing the rising temperature, we are assessing an ecosystem service. Thus, once the function (plants produce fruit to spread seeds) is viewed as a service for us as human beings (we collect, sell and eat fruits), we move from the concept of ecosystem functions to that of ecosystem services (ES). Having ascertained that ecosystem services exist and are given to us on a plate, let us ask ourselves which places on Earth need these services most.

The MAES project mapped and assessed, between 2010 and 2020, the European ecosystems and the services they provide within the framework of the European Strategy for Biodiversity. Among the various European ecosystems considered, MAES identified and more thoroughly analyzed one in particular, which could only marginally be classified as a natural origin ecosystem: the urban ecosystem. In this case, we should take a small step back and move from the scientific concept of "ecosystem" to the more popular one of "environment". The environment, using basic terminology, is "everything that is around or that surrounds something". Normally our ego leads us to formulate the concept of "environment" according to an anthropocentric vision: the object of the environment is the human being. However, it is not easy to establish what habitat provides the ideal conditions for the existence of humans, or, using a slightly more scientific terminology, the habitat in which both the autoecological and the synecological optimum coexist for the species *Homo sapiens*. It is very likely precisely that mass of inert materials that are artificially modeled, sometimes with skill and intelligence, other times somewhat illogically (. . .except the logic linked to business and short-term profitability), and very often assembled with no ecological and landscaping foresight. In short, we are just saying that the beautiful place that goes by the name of "urban environment" is probably the one with which human beings are most frequently associated. In this unnatural inert material–human being combination, the maximum population density and the maximum phenotypic and genotypic diversity for our species (*Homo sapiens*) are found at present. The curious thing is that cities, which are arid and life-impermeable, at times unbreathable, environments, are for many of us indispensable if we consider that at least 50% of the world's population lives in cities and about 10% of it lives in the largest metropolises. Despite accounting for a negligible percentage of the Earth's surface, the urban environment is among the most familiar to man, certainly among the most easily identifiable and at the same time among the most investigated in scientific terms. This environment is actually expected to become the only one possible for a significant proportion of young future generations, given that migration from the countryside to the city is estimated at around 60 million people a year, and that some recent projections predict that by 2050, over 80% of the world's population will live permanently in large cities.

Despite the different origins and the evident different physiognomy and outer color between the urban ecosystems and the more natural ones, we can find similar ecological dynamics in both cities and natural environments, albeit with some exceptions.

Urban ecosystems, like the natural ones, are characterized by a well identifiable core area, which in the case at issue is the center of the city. Associated with the core area there is a commuting zone, which in most cases is far larger than the core area, where most of the population that reaches the core area every day to work lives. Forming an external belt, concentric to both the core area and the commuting zone, and with an extremely variable radius, there is the so-called functional area, which is the portion of the territory providing the resources on which both the core area and the commuting zone depend. It is therefore clear that, in ecosystem terms, both the city core area and the commuting zone will act as the main users of ecosystem services, whereas the functional zone will represent their producing source. In recent years, there has been a lot of focus on how to improve the quality of life in cities. In fact, the design and implementation of green infrastructure (such as urban forests, green roofs, rain gardens) is almost always dedicated to core areas or commuting zones. Although there is absolutely nothing wrong with that, the well-being of natural areas outside cities should be managed and safeguarded with the same level of attention. Indeed, the proper functioning of cities, or their ability to resist and to develop resilience to global changes, will depend precisely on the resources created and put into circulation by functional areas. Let's take the example of the resource “water”. The water a city (core area) needs comes from sources (functional zones) often located a long distance from the city core. Water consumption is growing worldwide, with European cities being no exception. Every year cities need an ever-increasing quantity of water, both to carry out production activities and for daily domestic needs. Water supplies are in danger, not only because of overexploitation but also owing to climate change. Accordingly, the water supplies of a city can be ensured only by protecting the well-being of the natural environments that make up the functional zones (e.g., forests, shrubland, grasslands, mires, marshes, rivers, etc.), thereby allowing the water tables to recharge with water. Planning must therefore go beyond the boundaries of the core of the city and ensure the ecological connection between the city and the surrounding natural ecosystems by protecting them.

3.4 Global Problems, Local Solutions

The urban ecosystem is the most widespread in Europe, as highlighted by the EU ecosystem assessment (Maes et al. 2021), and it is the only ecosystem that is constantly growing. Although there is some good news, such as the improvement in bathing water quality and the reduction in emissions of air pollutants, many other problems persist: an uncontrolled invasion of alien species; +11.3% share of dispersed settlements in peri-urban areas; −4.4% vegetation loss inside urban green space of core cities; and − 6.4% vegetation loss inside urban green spaces in the commuting zone. In a decade (2010–2020) in which the population and the governments of the countries started to become seriously aware of the importance of biodiversity for ecosystem services and the need to restore ecosystem services, we witnessed a continual loss of nature in our cities, in which existing green infrastructures were dismantled as opposed to new ones being created. In fact, we continue to artificialize considerable portions of European territory, threatening biodiversity, and therefore threatening ourselves and our survival.

Urbanized areas share common problems, i.e., poor air quality, high levels of noise pollution, limited capacity to tolerate flooding events (and increased risk of flooding due to the high share of impermeable surfaces), to cope with the urban heat island effect and, finally, an excessively modest contact with “natural” environments and green spaces. We need to increase our effort to defend biodiversity, and one way to start this defense action is by “bringing nature back into our lives”.[4] Since 72% of the European population currently lives in urban areas, “bringing nature back into our lives” means bringing it back into our cities.

[4]The motto of EU 2030 Biodiversity strategy. Document 52020DC0380. Communication from the commission to the European parliament, the council, the European economic and social committee and the committee of the regions EU Biodiversity Strategy for 2030 Bringing nature back into our lives. COM/2020/380 final. link

The Natura 2000 network is the backbone of the European green infrastructure[5] and the biggest network of protected areas in the world. The aim of the network is to ensure the long-term survival of Europe's most valuable and threatened species and habitats, listed under both the Birds Directive and the Habitats Directive. Reconnecting cities to the Natura 2000 network is one of the main objectives of the European community and the task set for the EU governments in the next 20 years. At present, the Natura 2000 network protects 18% of the European territory, but the goal is to reach 30% by 2030 and the challenge is precisely to achieve this increment by strengthening this network in our cities and improving urban naturalness. How can that be done? The most immediate solution would to recover marginal areas and restore natural ecosystems where they were once present. However, there are also other hybrid solutions, such as green roofs and city parks devoted to biodiversity and not just to the enjoyment of the citizen, which will, even if they do not enhance the Natura 2000 network, certainly contribute to a greater efficiency of the local or regional ecological network.

3.5 Flora, Vegetation and Landscape Identity

To conclude this dissertation, let's take a small step back and return to a concept we have already mentioned in the previous pages. The problems are common, just as the solutions are very often common, but the application of these solutions cannot follow the same pattern because each of the places in which these solutions need to be applied has its own identity.

In order to address climate change and to halt biodiversity loss, a huge global effort will be needed over the next 20 years. Unfortunately, we will not be able to limit ourselves to conserving the most beautiful and precious natural communities that are still present, but we will be called upon to restore entire ecosystems. For example, ecosystems that ensure high resilience and protection from rising water levels will need to be restored on the coasts. Freshwater ecosystems, the most at risk globally, will have to be thoroughly restored because floods and droughts are two sides of the same coin (climate change) that make vast territories of entire countries fragile. Recreating the pattern of permanent micro-communities that characterizes coastal dunes, restoring the ecological balance in a river and setting up urban forests are three examples that require joint planning by a range of experts in different professions. In Italy, the native vascular flora consists of 8237 species. The total number of plant species (native and alien species) consists of 9897 taxa, belonging to 1547 genera and 198 families (Bartolucci et al. 2018). The past paleoclimatic and paleogeographic changes and the current very diversified bioclimatic, lithological and orographic pattern of the Italian peninsula allow the development of hundreds of different habitats and ecosystems. Each ecosystem has its own features. Thus, when

[5] Link to the European website about the green infrastructures.

we plan to create a new green infrastructure in a city or we decide to restore a green infrastructure that has lost its original degree of biodiversity, we must carefully plan our interventions. In the design of urban forests, the same association of tree species, scrub species and herb species cannot be used in Milan, Rome and Palermo. The urban forest (which is a common solution to a common problem) in Rome will have its own specific composition which will correspond to what is already present in the natural forest ecosystems present in the city center of Rome or in its countryside.

Therefore, the synergy between botanists and architects is fundamental and essential to combine the ecological characteristics of a plant community with the concept of landscape identity and the identification of places. In fact, vegetation is not distributed randomly, and different species that have similar ecological needs are associated according to ecological rules (Braun-Blanquet 1964). Species and communities derive from an evolutionary path lasting millions of years, a path characterized by biogeographical and climatic barriers that today are reflected in the current geographical distribution of the species. It is precisely this background that provides the landscape with an identity card, a millenary identity that could be erased by reckless planning choices.

It is very often the lack of attention paid to the microscopic and sometimes invisible interrelationships that are established between various forms of living matter within a territory that results in the need to address difficult macroscopic environmental problems. “An action here and now produces an effect there and then” reads the first law of Landscape Ecology (Forman and Godron 1986). Nothing is truer. This is the case of the thoughtless use of alien species in environmental design projects of urban parks, or in a simple botanical arrangement of a public (or private) garden. Indeed, the planting of species, greening of flowerbeds and reforestation actions in urban or suburban areas are often carried out without thinking in the slightest of the consequences that the introduction of an alien species could bring to the surrounding natural areas. Only rarely is the degree of invasiveness of an alien species taken into account in the design stages in setting up parks and gardens and very often, dazzled by an assortment of exotic scents and colors, one is unaware of how harmful the negative implications of a “local” negligence of this kind might be on a larger scale. For this reason, a greater degree of integration between landscape architects, taxonomists, phytosociologists, ecologists and other scientific figures would be desirable both in environmental design and in planning. Unfortunately, this virtuous mixture of scientific expertise is often absent, which means that from the very first stages of a landscape plan, in which the use of plants should assume a leading role, some fundamental aspects of the “instructions for use” are missing, and nefarious biotic interactions between species may occur. It is no coincidence that the native *Calamagrostis arenaria* and *Elymus farctus* communities in the dune ecosystem are rapidly and aggressively being replaced in the Mediterranean coastal landscape by the colorful and luxuriant communities of the succulent South African *Carpobrotus acinaciformis* or *C. edulis* as a consequence of the latter’s inconsiderate use in cottages, villas and beach resorts. Nor we can ignore the regression of *Pistacia lentiscus, Myrtus communis, Phillyrea latifolia, Arbutus unedo, Calicotome villosa* and many other native taxa in the native Mediterranean

Fig. 3.2 Colonization of the back-dune of the coast of Taranto (Puglia region southeastern Italy) by the hottentot-fig (*Carpobrotus acinaciformis*), an alien South African species that is about to surround a nucleus of large-fruited juniper (*Juniperus macrocarpa*)

maquis biome in various European Mediterranean countries owing to the invasion of some American prickly pear cactuses (e.g., *Opuntia Ficus-indica*) (Fig. 3.2).

The surviving lowland oak woods with *Quercus robur* and *Carpinus betulus*, reduced to the margins of the valley floors of the peri-urban environment of the city of Rome, offer only weak resistance to the attack of the black locust tree (*Robinia pseudoacacia*) or paradise tree (*Ailanthus altissima*) and of all those competitive non-native species with a very high invasive capacity that find their best allies for complete success precisely in the disturbance and degradation. The overall picture is dark. We are already very late in reaching a full awareness of the danger, and unfortunately, the administrations that govern us do not appear to be adopting any preventive measures to tackle the problem.

This progressive invasion of alien species doesn't resemble a coup, nor is it loud. It is a silent advancing tide. The only perceivable echo is that of the identifying characteristics of the places that inexorably evaporate into thin air.

The number of non-native species is growing drastically in the sites that are affected most by man, such as urban, industrial and agricultural areas, because such species are favored by the high degree of anthropic disturbance and by the greater contribution of propagules (Di Castri et al. 1990; Pyšek 1998). Biological invasions, i.e., the uncontrolled spread of species transported by man beyond their natural dispersion limits, are considered one of the main components of global changes and cause enormous damage, including those inflicted upon crops due to weed species, those inflicted upon people's health by pathogens, allergenic species, parasites, etc., and those inflicted upon ecosystem services due to changes in their functionality. According to the United Nations Development Program (UNDP), the invasions of alien species are the second biggest cause of the loss of biodiversity in the world after the direct destruction of habitats.

Plant species have a name and a surname which is linked to hundreds of thousands of years of evolution, of migrations across lands now covered by seas, of settling in glacial shelters, of separations due to the emergence of mountain ranges and much more. For this reason, the presence of a species in its area of origin has an infinite value, and being able to identify it in its natural environment comforts us and immediately positions us in space and time.

Flora and vegetation as an oasis of memory… precious treasures.

3.6 Conclusive Remarks

Designing a green infrastructure, even if it is merely a flower bed, a green roof or a rain garden, must start from the knowledge of local biodiversity. To get an idea, we can refer to the technical annexes of the recent urban reforestation call promoted by the Italian Minister for Ecological Transition. The Urban Reforestation program aims to plant 6,600,000 trees and shrubs according to the principle of using "the right tree in the right place". The call provides information on the characteristics of the vegetation and therefore of the local ecosystems. The experts called upon to carry out reforestation are expected to conduct preliminary studies regarding the potential natural vegetation of the sites and the different stages of the Vegetation Series. Indeed, the different metropolitan areas have different vegetation series. Therefore, for each city (and in different areas within the same city), there are different "lists" of useful trees (Fig. 4). This advanced concept, which considers the neutral model adopted by nature (potential vegetation) as the most ecologically and economically advantageous example from which to take inspiration, is still partially unclear, but we must keep it in mind. It is not a habit; it is not an unnecessary complication. It is the starting point for successful green infrastructure planning (Fig. 3.3).

On the other hand, we have long since reached a point of no return with the environmental issue. It is a real social emergency for modern society, and dealing with this emergency has become a duty and an obligation for every single citizen. As decreed by the European Community to all national governments, in order to plan the sustainable management of resources on a global scale, it is first necessary to plan and implement multidisciplinary interventions on actions on a local scale. It is therefore desirable that future environmental restoration and recovery interventions, as well as all landscape plans and master plans, that significantly affect landscape

Fig. 3.3 Wheat field mixed with poppies (*Papaver rhoeas*) on the outskirts of Rome with a specimen of cork oak (*Quercus suber*) in the center of the photo, a solitary bulwark bearing witness to the "neutral model", in this case, the *Quercus suber* evergreen thermophilous forest, i.e., the potential vegetation of that area if there hadn't been any crops

management, be the result of the interaction between different disciplines (ecological, humanistic, technical-scientific, architectural). Each of these skills will be the bearer of its own interpretation, which should remain complementary in its analysis but needs to provide results that can be exported and prove useful to other disciplines while gathering innovative ideas and application possibilities from the latter. The systemic concept of "landscape" itself frames it, albeit not intuitively on an exclusively aesthetic-perceptive basis but as a "set of interacting elements" within which several disciplinary components combine to characterize its profile.

Environmental design in the field of architecture arises precisely from the awareness of the multidimensional "surrounding reality", from the need to relate architectural aesthetics to the environmental matrix, so as to avoid reducing it to a mere visual experience.

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