Vademecum for sustainable urban green planning

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Index:

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1. Project description

The Viridis Loci (VL) project aims to provide specialised VET training/transfer of skills in the correct management of green areas and parks in municipalities to public technicians and private subjects who are interested in dealing with an advanced professional management of urban nature in three European islands: Sardinia, the Balearic Islands and Madeira. The Czech Republic will contribute to the development of the project as one European country where 'the culture of well managed green areas in cities as providers of ecosystem and social services for the whole community' is deeply rooted, considering the role and the presence of Czech's partner too.

The project partners come from four European countries, Italy, Spain, Portugal and the Czech Republic. The Italian partners are: ANCI Sardegna (project leader), Fito-consult and ATM Consulting; the Spanish partner is FELIB (Federation of municipalities of the Balearic Islands); the Portuguese partner is AREAM (Regional Agency of Energy and Environment of the Autonomous Region of Madeira). The Czech partner is ABA International (a 'non profit' international education association and certification body).

The consortium presented this project for three main reasons:

1) Environmental sustainability and the fight against climate change: it emphasises the role of well-managed green areas/parks within cities and municipalities in general as providers of ecosystem services (benefits that people obtain from nature, e.g.,, climate regulation, CO2 capture, air quality improvement, cultural values, public health and biodiversity conservation).

2) Increase Inclusion. The project will operate in three island contexts in southern Europe, which due to their geography, tend to be isolated and at a permanent economic disadvantage compared to other regions of the continent

3) Overcoming the knowledge gap with the use of ICT technologies to impart a highly technological and innovative working methodology.

The project will operate in three island contexts in southern Europe, which due to their geography, tend to be isolated and at a permanent economic disadvantage compared to other regions of the continent. Islands tend to lag behind in economic terms and innovation processes negatively impact the communities residing on the islands. Unemployment rates in the three islands are high with dramatic peaks among young people and in all cases higher than the respective national averages: Sardinia (18% - youth unemployment around 45%), Balearic Islands (youth unemployment 17% - around 40%) and Madeira (10% - 50.5% youth unemployment).

2. Aims of the document

The "Vademecum for sustainable urban green planning" is a key result within the Viridis Loci project. Indeed, the following document aims at:

- introducing new concepts and skills, targeting the stakeholders active in urban and territorial planning,
- proposing digital solutions capable of quantifying the environmental benefits (namely, ecosystem services) offered by urban vegetation,
- improving awareness among the stakeholders regarding the benefits of urban vegetation and nature-based solutions.

This will lead to a more aware urban planning and maintenance and therefore to an increase of the sustainability of the greenery in urban areas.

The Vademecum is the answer to a growing need among stakeholders and citizens, interested in new, complete and systemic methodologies to evaluate and assess urban vegetation. The document is to be seen as a compass to navigate through novel concepts and as a starting point to learn about latest digital solutions that can be applied at urban level. Nevertheless, for the ones particularly interested in applying the outlined methodologies, it might be useful to further explore relevant literature (see Appendix) and to keep in mind that calibration and validation in specific environments might be needed as well.

Furthermore, the need to propose a Vademecum capable of picturing a new approach to assess, manage and plan urban green vegetation comes from the increasing importance and complexity that today urban green infrastructures cover. Indeed, they improve the quality of life of urban inhabitants and to reach Agenda 2030 goals, including environmental, social and economic sustainability.

Due to this increased importance and to a growing awareness between citizens too, in the last years, many municipal development projects had to take into account the environmental and socio-cultural role of the urban green areas. Often, under the name of "urban regeneration", where however not a tangible improvement of urban environments was granted or quantified, especially for urban vegetation. Indeed, today, there are no accepted frameworks to assess and evaluate the value of the urban natural capital and the ecosystem services provided. Most of the available methodologies are focused on particular components – e.g., soil, trees -, therefore not considering the systemic complexity typical of any ecosystem. Moreover, currently available evaluation frameworks offer qualitative and subjective results, with a possible economic value depending on a limited set of indicators, often derived from other scientific branches and adapted to urban ecosystems.

Therefore, the need for a novel approach, with the characteristic of being systemic and quantitative. At its core, urban vegetation. Urban vegetation – encompassing all trees, shrubs, lawns, and other vegetation in cities –, if adequately managed, can play an important role to ensure a good quality of life and meet the challenges set by Agenda 2030 (2), helping to reach 15 Sustainable Development Goals (3): indeed, in urban environments it can provide several ecosystem services, such as air purification, global climate regulation, temperature regulation, run-off mitigation as well as recreational opportunities, increasing aesthetic values (3). In a few words, urban vegetation can help make cities safer, healthier, wealthier and more attractive, with benefits grouped in social, communal, environmental and economic categories (4). Despite this central role, urban vegetation is not often considered a priority by decision-makers, so budgetary resources are allocated to other areas, which are perceived as more important.

Even worse, most of the time, it is just seen as a cost, even if studies showed that the benefits of urban trees outweigh the costs by ratios of between 1,37 and 3,09 (5), with an estimated value of the provided ES of US $3,8 billion per year in the United States of America (6). Thus, despite years of researches and because urban environment differs from the natural one, urban vegetation lives in inhospitable conditions, so that its lifespan is limited – an urban tree lives on average between 19 to 28 years (7) – impacting their ability to provide long-term services (8). Because of this underestimation, in the last years, many researchers have begun to develop strategies to enhance the impact of nature on human settlements, giving a primary scientific role – yet with many possibilities of growth (3) – to urban nature, its implementation and its management, which is crucial to ensure the optimal contributions to the physiological, sociological and economic well-being of urban societies. Urban vegetation should be studied with an integrated, interdisciplinary, participatory and strategic approach to planning and managing its presence in and around cities (3). Therefore, being an interdisciplinary matter, urban vegetation planning and management is highly complex, having to deal with several topics, such as landscape ecology, arboriculture, urban planning and environmental sciences; meanwhile satisfying the different interests of the stakeholders – mainly, citizens, public authorities, researchers and the involved industries.

Today, the overall urban natural capital need strong research support for its long-term development, which should address four major components:

1. the conservation, implementation and adaptation of natural entities within cities, in order to improve their fitness to the urban environment, therefore enhancing the provided ES;
2. the spatial configuration of the urban green areas: well-designed and planned systems can assure better conservation of biodiversity, linking rural and urban areas;
3. the management of the urban nature – an aspect that still needs to be deeply examined – developing local and tailored plans, thus being able to satisfy peculiar needs;
4. an improvement in decision-making processes needs to be more participated and transparent with quantitative data provided by reliable frameworks.

The following document wants to represent one of the first trials in this direction, a methodology that is still to be fine-tuned and can be replied and implemented in similar case studies.

2. What are Ecosystem Services?

The term Ecosystem Services (ES) was introduced in the early 1980s and then developed in the following decade, mainly thanks to the researches of Daily (9) and Costanza (10). The latter conducted one of the first global estimation (10) to calculate the overall value of the ES annually provided by Earth to humanity, with a resulting amount between 16,000 and 54,000 billion dollars. These studies led to further researches developed in limited fields, that were first integrated on an international scale thanks to the Millennium Ecosystem Assessment (11). Here, ES are defined as the benefits that humanity obtains, or can obtain, from ecosystems. Costanza proposed 17 types of ES, while MEA reduces them to 4 main categories, strongly underlining the close relationships – with different potentiality and intensity – between ES and human well-being in terms of security, essential material provision, health and social relations – all aspects fundamental to guarantee freedom in choices and actions. MEA analyses ES concept applying the idea of direct use value (to indicate benefits derived from the direct use, whose value can be obtained via surveys), or indirect (to indicate benefits derived from processes, thus not directly available, such as processes that lead to soil formation, water purification, pollination...). Moreover, MEA adds the declination of ES value in different individual and future levels (indicating the value we are willing to assign to the need for conservation and transmission to the next generations of natural resources, therefore not using a part of the available natural resources).

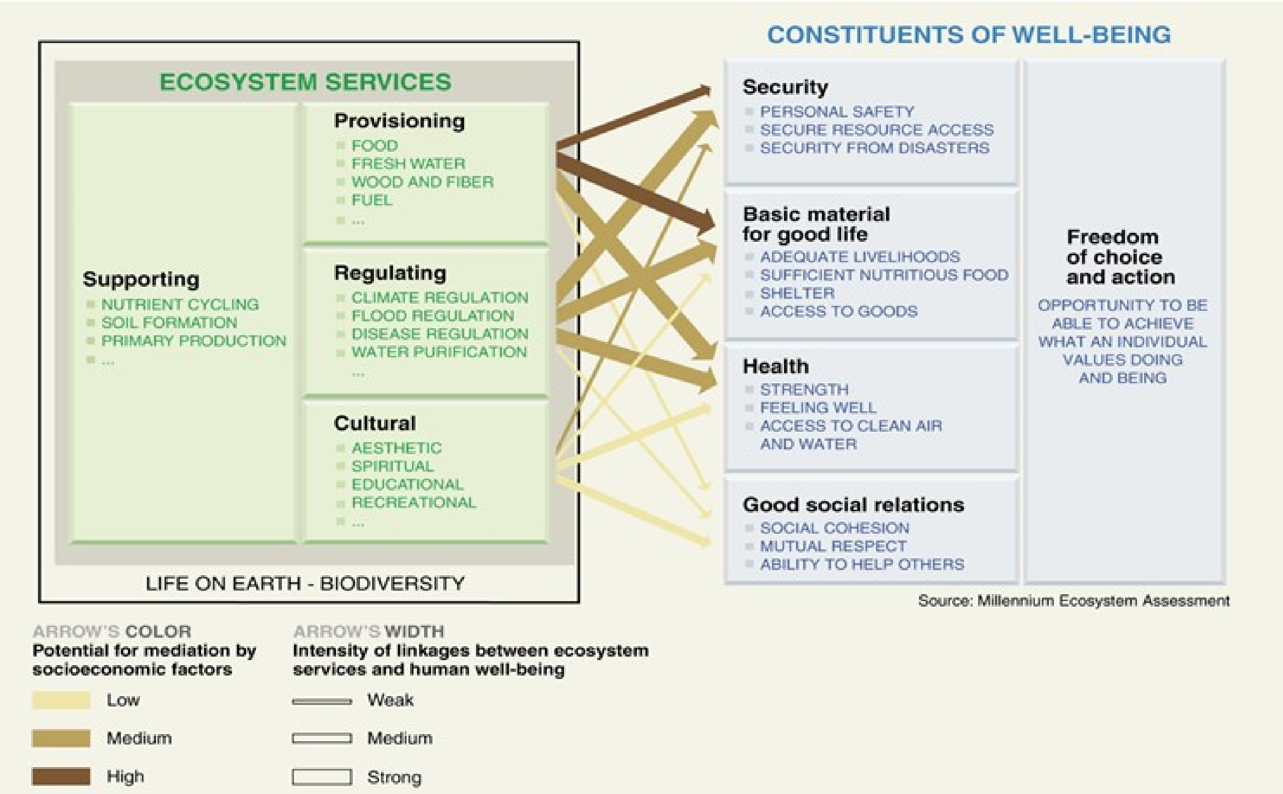

Fig. 1 Ecosystem services, their classification and relationships with human well-being. Source: Millennium Ecosystem Assessment, 2005.

MEA represents a fundamental milestone: not only it defines the four ES categories, but it raises academic and stake-holders attention on the state of degradation of natural environments, since more than 60% of the ES were classified as at risk (12).

The four categories include provisioning services (e.g., material goods such as food, drinking water, timber, fibres, medicinal plants); regulating services (e.g., environmental processes that have effects on the natural capital as well as anthropogenic activities), and cultural services (e.g., mainly non-material, such as spiritual enrichment, cognitive development, recreational activities, aesthetic values and experiences, knowledge systems, social relationships). To these three main categories, supporting services were added, to indicate fundamental processes – e.g., the production of atmospheric oxygen, the formation and protection of the soil, the water cycle, the formation and maintenance of habitats – necessary to maintain the first three categories.

In the latest years, the ES concept gained even more importance thanks to Agenda 2030 and the achievement of its goals, that underline the importance of providing ES for human well-being: e.g., Agenda's 11 goal highlights the need for sustainability in our city, setting precise targets that should be reached within 2030:

- *11.6 Reduction of the per capita negative environmental impact, paying particular attention to air quality and urban waste management.*
- *11.7 Provision of universal access to safe, inclusive and accessible green public spaces, especially for women, children, the elderly and persons with disabilities.*
- *11.a Support positive economic, social and environmental links between urban, peri-urban and rural areas, strengthening national and regional development planning.*
- *11.b Considerable improvement of cities adopting and implementing integrated policies and plans to foster inclusion, resource efficiency, climate change mitigation and adaptation, disaster resistance, that promote and implement holistic disaster risk management at all levels, following the Sendai for Disaster Risk Reduction 2015-2030.*

Therefore, it is essential to preserve, improve and implement green areas in urban and peri-urban areas, enhancing and evaluating ES provision, to achieve Agenda 2030's ambitious goals, and guarantee sustainable and pleasant environments for citizens inhabitants.

Current decision-making process analysis

In Milan, as in most Italian cities, it is necessary to obtain a specific permission before proceeding at any construction works. Similar restrictions apply if necessary to cut trees:

the proposer has to present a technical evaluation report to the public offices, following the Milan Municipality rules and requirements. In our case study, the construction project followed the correct process and presented the needed reports, which were accepted. In these reports, a compensation hypothesis is proposed based on the method, currently accepted by the Milan Municipality (13), to estimate the economic value of a tree. According to this method, tree value depends on fixed factors - the definition of which is partly left to the subjectivity of the evaluator - multiplied by a price coefficient, called "unit price", which is a tenth of the price of a tree with ten cm² of basal area (e.g., having 3.57 cm in diameter or 11 cm in circumference), taken from the 2018 nursery Price List. This methodology considers different tree parameters (aesthetic value, phytosanitary status, size and position) multiplied by the economic value. However, in our case study, this value is very low compared to the actual tree sizes and dimensions: indeed, it is clear that a Cedrus libani with a circumference of 11 cm can not be considered equal to a mature specimen with a circumference of more than 200 cm, such as those once found in the area. So, to have a more consistent economic estimate of the original green spaces, it would have been advisable to use bigger plants' prices than those of a nursery price list.

Moreover, with the related economic calculation, the report mainly focuses on tree aspects - such as the aesthetics, position and size of each specimen -, not considering the systemic dimension of the area. Different elements have not been analysed - such as soil and its characteristics; the herbaceous layer; the water cycle; the perception of the green area among citizens and users. All these elements are fundamental to form the natural capital of the area and should be considered during a redevelopment project, since they actively contribute in defining the value of the area. This is an evident lack in the evaluation methodology, that leads to a miscalculation of the area's real value: however, the lack is not attributable to planners and architects, but much more the actual methodology required by most Italian cities.

Furthermore, the documents do not show a precise situation of a static and pathological assessment for each tree mentioned in the project tables: it would be useful to have access to this assessment, to better understand the technical and scientific ratio that led to the decision of cutting some trees and to transplant others. Usually, evaluators follow specific protocols – e.g., ISA protocol – to evaluate tree static conditions and then decide the necessary interventions according to a logical process based on four fundamental phases: anamnesis, diagnosis, prognosis and prescriptions. In these protocols, the first fundamental step is to individually evaluate each tree, filling out a VTA (Visual Tree Assessment) form, which reports the tree characteristics and any visible defects, with general information about the environment in which it is rooted. If necessary, the evaluator can deepen the analysis with appropriate tools and techniques (e.g., dendrodensimeter, sonic tomography, pulling tests with SIM method) in order to further investigate the stability of a tree, with the final attribution of a grade (A, B, C, C/D, D), which represents the propension at the failure, establishing re-checks in the following years, or tree care maintenance or removal (grade C/D and D) to be performed immediately (14).

Therefore, both the lack of the current methodology and of the project documents are clearly noticeable. With our work, we tried to have a more complete picture of the natural capital in the area.

4.2 Herbaceous layer analysis

Our analysis began studying the herbaceous layer. Three field inspections were carried out (in February/March 2020) to complete the herbaceous species' inventory. Most of the species were identified in situ, while few samples were collected to have a sure identification thanks to the discriminating morphological characters and the use of dichotomous keys, according to "Flora d'Italia" (15, 16).

The inventory was then organised in a floristic list, with scientific names (and any synonyms), biological forms and chorotypes derived from Pignatti, bioindication values according to Ellenberg-Pignatti (17), and other particular notations (e.g., allergenicity and toxicity).

With biological form, we mean the strategy adopted by each species to overcome the adverse season, regardless of taxonomic affiliation; chorotype can be defined as the belonging of each species to a geographical distribution area; the Ellenberg/Pignatti bioindication values are a numerical index referring to seven ecological parameters – four regarding soil (pH, organic matter content, water availability, salinity), and three regarding environmental conditions (light, temperature, climate conditions), which represents the optimal environmental conditions of each species for each ecological parameter. Thanks to these indicators, qualitative evaluations of the study area can be derived.

4.3 Soil and vegetation analysis

At the same time, we investigated soil and vegetation characteristics. During our field visits, soil samplings were taken. At first, eight areas were identified with homogeneous soil characteristics, considering the ongoing construction works. In each area, sub-samples were randomly collected and, according to the quartering method, were then mixed and homogenised, obtaining samples of about 500 g of soil per area. (Fig. 8)

Fig. 8 The eight soil sampling areas.

A certified laboratory then conducted the analyses. The results provided information regarding:

- pH; Granulometry; Total limestone; Active limestone; Organic carbon; Total nitrogen; C/N ratio; Assimilable phosphorus; Exchangeable bases (Na, K, Mg and Ca); Cation Exchange Capacity;

We also looked for the following heavy metal concentrations: Arsenic, Cadmium, Chromium, Mercury, Lead, Copper, Zinc.

It is essential to underline that soil was already modified by construction works, especially in sampling areas 1, 2 and 3 (fig. 8). Therefore, the soil analyses results may not correspond to the original characteristics of the topsoil (first 0-30 cm.) since surface soil had been moved.

4.4 ES analysis and quantification

The ES evaluation provided by the green areas was conducted on three different phases:

- firstly, considering the original green areas and natural capital, as it was before the construction works,
- then, assuming and considering as granted the redevelopment plan – thus simulating the ES provision at the end of the works,
- finally, to better understand the natural capital's dynamic evolution, we simulated ES provision in the next 30 years, using as starting point the available construction project.

Regarding the tree and shrub component, which can be seen as an Urban Forest (UF), the I-Tree software (www.itreetools.org), developed by the United States Department of Agriculture (USDA) (18), was used. This software can calculate different benefits provided by trees and shrubs in urban environments; therefore, it was considered the most suitable tool for this kind of study.

The data collected during the inspections were used as input for the model. Since we had no access to the original scenario, our analysis was based both on collected data, both on satellite images, which represents the situation before the start of the work. To understand ES provision granted at the end of the works, we used as input the information provided with the project. Therefore, the first phase took place thanks to the data provided and partly deduced. The second phase was based on data obtained from the project documents to assess the impact of the proposed redevelopment project and the related ES. These data were then subjected to a simulation for the next 30 years, thus considering the greenery's growth and development to have a clearer picture not only in year 0 but in perspective too. Indeed, removing adult and mature trees and shrubs and not being able to replace them with similar elements, it is essential to evaluate the redevelopment project in the medium term, to understand if the newly planted specimens are able to guarantee – or even exceed – the same levels of ecosystem services offered.

The parameters used by I-Tree as input are different and numerous. Given the limited information available, we proceeded to select the few specific or easily calculable inputs, such as weather and pollution data (obtained from Linate airport weather station, the closest to the area), taxonomic information (genus and species), height and diameter of each tree, extension and volume of the canopy and exposure to sunlight. Additional information - crucial for the analysis - such as details of the phytosanitary status have not been entered because not provided and not possible to be estimated. The software, thanks to these inputs, can calculate the following outputs:

- Structure and composition of the urban forest,
- Carbon storage and Carbon sequestration,
- Oxygen production,
- Atmospheric pollutants removal (PM 2,5; O_3; NO_2; CO),
- Effects on water cycle (avoided run-off).

For each of these outputs, the software – in addition to the quantification – can calculate an economic value, corresponding to the quantities removed multiplied by monetary coefficients (see attachment 1).

Each output is quantified thanks to the use of different mathematical models calibrated and validated for each simulation, with high reliability, certified by multiple peer-reviewed scientific papers, as well as by other case studies concerning urban forests analysis in different parts of the world.

4.4.1 Structure and composition of the urban forest

Understanding the actual UF composition is crucial to properly assess and quantify the provided ES. In this perspective, the database has great importance: the more detailed are the data, the greater is the accuracy of the analysis. As explained, the case study is based on a partial data collection, therefore incomplete compared to the vegetation's original structure and composition. Despite this, I-Tree can still analyse UF, providing, for example, a complete framework of the present species, the most common diameter classes and their origin. In addition to these purely informative outputs, I-Tree can calculate leaf area and vegetation cover, used as metadata to quantify ES.

4.4.2 Carbon storage and Carbon sequestration

UF role in climate change mitigation is well known, thanks to the capacity of sequestering and storing atmospheric carbon. In particular, trees reduce carbon levels, sequestering it from the atmosphere and storing it in the new growth that develops year after year. To estimate the amount of carbon sequestered, the model bases its analysis on each tree's diameters – provided as input, in the year considered 0 – and then calculates the estimated average annual growth, using specific genus and species parameters and the health conditions provided. Therefore, I-Tree estimates tree diameter and relative sequestration in the year 0 + 1 (19).

Instead, carbon storage can be defined as the amount of carbon in the tree biomass – aerial and underground (20). To calculate C storage, the model estimates each tree's total biomass, starting from the measured data and bibliographic references. Since trees with expanded crown and subjected to maintenance – as the ones under analysis – tend to have less biomass than trees in natural environments, where most of the models are calibrated, I-Tree solve this issue by multiplying the results with a standard coefficient of 0,8. This adjustment is not performed on trees considered as grown in natural conditions. Finally, the model multiplies the dry biomass by 0,5, thus obtaining the carbon stored in each tree.

4.4.3 Oxygen production

Oxygen production is one of the main and best-known benefits guaranteed by UF (21). The oxygen produced each year is directly related to the carbon sequestration activity. The total oxygen produced is therefore estimated thanks to C sequestered and its atomic weight:

$$O_2 \text{ produced (kg/year)} = \text{net C sequestered (kg/year)} / 32/12$$

It is interesting to underline that the production of oxygen by vegetation has a relatively minor impact from a global point of view: indeed, our atmosphere contains high and stable oxygen levels, mainly thanks to the aquatic component of the planet.

4.4.4 Air pollution removal

Bad air quality is a common issue in many urban areas and can cause various problems to human health and natural ecosystem processes (22). Vegetation, especially in urban environments where anthropogenic pressure is maximum, can lead to air quality improvements, for example, by reducing its temperature, directly removing pollutants and lowering energy consumption in nearby buildings, which consequently reduces emissions of air pollutants due to energy consumption. In our analysis, the model considers vegetation impact on the removal of the most common urban pollutants: ozone, sulphur dioxide, nitrogen dioxide, carbon monoxide and particulate matter (PM) of 2,5 microns.

These estimations on air pollution removal derive from different models (23), which consider the hourly foliar resistances, calculated with a hybrid foliar model. Furthermore, since the removal of carbon monoxide and PM is not directly related to transpiration, the removal rates for these pollutants have been calculated from average values obtained from the literature, adjusted according to phenology and leaf area. Regarding the removal of fine atmospheric particulate, the model considers a resuspension rate equal to 50 % of the deposited particles, which then return into the atmosphere – due to adverse weather, which in particular cases can also lead to an increase in the concentration of PM 2,5 in the atmosphere (24).

4.4.5 Future ES simulation provision

To quantify ES provision in the future, it was considered useful to carry out a medium-term simulation – 30 years – to evaluate the evolution and the development of the green area after construction works. This simulation was conducted only on tree and shrub component, implementing the I-Tree Forecast tool (25), not finding in the literature useful and reliable tools to simulate the ES offered by the other components under consideration (soil and herbaceous layer, water cycle and cultural services). This tool simulates UF growth and development in a future period. Providing geographical data, tree information (trunk diameter, obtained from the project), the model can simulate the community's annual evolution, taking into account possible disturbing factors (parasites, adverse weather events) that may alter tree development. Also, the tool allows the setting of some parameters regarding UF vitality, including death rate and new plant/year rate, which affect UF consistency and composition. The tool is thus able to simulate the provision of the following ES:

- Carbon storage
- Carbon sequestration
- Air pollution removal (NO_2, O_3 and SO_2 removed)

As well as for UF composition and evolution.

4.5 Analysis and quantification of the water cycle

Water cycle management has acquired importance in recent years due to the critical conditions of urban drainage networks and the heavy damage frequently caused by weather events in Milan. To limit these damages, mainly due to uncontrolled soil consumption and soil sealing, Regione Lombardia has adopted a new regional law (n. 7, 23rd November 2017, “Compliance criteria and methodology to respect hydraulic and hydrological invariance") (26) which pursues the principle of hydraulic invariance. This means that, in the case of construction works, the flow and volume rates of meteoric run-off discharged in urbanised areas into natural or artificial receptors must not be greater than those recorded before the construction. This new law aims at avoiding urban floods, with their considerable social, economic and environmental damages. Therefore, in our case study, it appears as a priority to evaluate the water cycle and the surface water run-off in the area. The evaluation is conducted from two points of view: firstly, it is calculated by I-Tree based on UF rainfall interception by tree leaves, in particular simulating the difference between the annual surface run-off with and without vegetation. Although there are different parts of trees (leaves, branches, bark ...) that can play a role in intercepting precipitations and therefore mitigating surface run-off, in the simulation – due to the limited data available and model calibration – it is taken into consideration only the precipitation intercepted by leaves and calculated on each tree's leaf area.

Fig. 10 Dynamics of water cycle in urban areas, with evident effects due to the different soil sealing percentage. Source: US Dept. of Environmental Protection (2003), Protecting Water Quality from Urban Runoff.

It is then necessary to analyse the water volume capable of reaching the ground despite UF's interception.. To analyse and quantify the dynamic of water reaching the ground, it was decided to deepen the analysis using other scientific tools found in literature and to quantify the total run-off volumes, not only those due to tree leaves interception. Indeed, many variables play a fundamental role in the water cycle – and so in surface run-off –, such as soil characteristics, vegetation cover, percentage of sealed soil and slope of the area. Also, we have to consider the overall rain frequency and intensity affecting the area under analysis, and we have to understand which rainy events generate surface run-off. Therefore, to reach a more accurate water cycle assessment, the HIRM-KW model - Hydrological Infiltration Runoff Model - Kinematic Wave) (27) was tested within the case study. HIRM is a hydrological model able to simulate water dynamics (run-off and infiltration) in soils. The model was chosen among several available on the scientific panorama due to its characteristics: its reliability and the strong mathematical background; secondly, because it is a "freeware" software, freely available, with a easy graphic interface. Furthermore, the model was specifically developed to simulate the water infiltration and run-off dynamics in soils characterised by small slopes and limited surfaces, simulating the effects caused by each rain event. Considering the case study characteristics, it was therefore evaluated particularly suitable for our research.

To conduct the analysis, two types of inputs are required: on the one hand, the rainfall recorded on site; on the other, the soil characteristics of the area. Regarding rainfall, we obtained weather data for the 2001-2019 period from the ARPA weather station located in Lambrate, choosing to simulate water cycle dynamics in the year 2019, using sub-hourly weather data (10-minute intervals).

To assess water cycle dynamics, as for the soil sampling activity, the study area was considered divided into the same two areas, considered as homogeneous:

Fig. 11 The two homogeneous areas where surface run-off was estimated.

This division was made necessary due to the physical obstacles separating the areas, affecting the free water flow. For each of the two areas, HIRM-KW requires different inputs. First of all, topographic parameters (such as width, length and average slope); the Manning coefficient – considered as fixed at 0.3 s/m^1/3 –; and the vegetation cover coefficient, which is considered a constant value 1 m^2/m^2. The model requires some physical and hydrological parameters, too, as the Ks – water conductivity at saturation – and G_0 – the effective soil net capillarity. To obtain the necessary inputs – in particular bulk density and water conductivity at saturation – we used SoilPar (Soil Parameters Estimate) (28) , a software developed by the Research Center for Industrial Crops (CRA-CIN), able to calculate soil characteristics, using as inputs texture, top soil depth and organic carbon, via Jabro and Campbell methods. Thanks to the inputs, HIRM-KW conducts simulations for every single rainy event in the selected time frame, and it can assess the water cycle and quantify surface run-off, which happens when soil infiltration capacity is exceeded. At the end of each simulation, HIRM-KW returns several outputs, including:

- Precipitation hydrogram (total and cumulative);
- Flows depth and rate evolution;
- Infiltration rate evolution;
- Total hydrological balance with the estimation of surface run-off.

Fig. 12 Conceptual map of HIRM-KW model with the main hydrological processes considered. Source: Ditto D. et al., 2016, Step by step development of HIRM-KW: a field-scale run-off model, Italian Journal of Agrometeorology.

4.6 Analysis of the avifauna present in the green area

Green areas represent a precious ecological niche for biodiversity protection in urban contexts. In these environments, the survival of numerous plant and animal species is strictly limited to the presence of natural areas, even of limited size, where they can carry out their vital functions. Therefore, urban green areas represent 'islands' where birds can find shelters, breeding sites and food resources essential for survival. In this context, the birds' census represents a useful tool to encourage policies to protect urban greenery's ecological functions. Moreover, birds provide socio-cultural ES of considerable value in the urban context: firstly, birds observation in urban green areas has an immeasurable aesthetic value. The value of these experiences, such as seeing a robin (*Erithacus rubecula*) outside the kitchen window or listening to a blackbird's melodic song (*Turdus merula*), is difficult to quantify in material and economic terms. However, it is still a valuable emotional and cultural experience. In addition to the aesthetic value, birds presence have undoubted therapeutic value. Some studies (29,30) conducted in urban parks and gardens have highlighted a link between the richness in bird species and benefits for public health in terms of psychophysical well-being and degree of satisfaction in the neighbourhood of residence. Finally, birds presence has an educational and recreational value since their presence intrigues citizens, fosters a passion for nature, and promotes a pleasant and relaxing activity such as birdwatching. The green area under analysis covers all these aspects, and it represents an essential ecosystem for the avifauna that populates the Milanese metropolis. To analyse avifauna composition and richness, surveys were conducted during the year, depending on Covid-19 restriction.

4.7 Analysis of intangible ecosystem services (cultural ecosystem services)

To complete our analysis, we decided to investigate the so-called cultural ES, which are more difficult to quantify and analyse as they are purely intangible and often depend on subjective aspects. However, it is stated that urban population is becoming everyday more sensible about environmental topics and benefits offered by urban natural capital. To adequately investigate the green area's perception among local citizens, a questionnaire (Attachment 4) was prepared and proposed to the citizens. The questionnaire structure was mainly based on the works of Rosalind (2016) and Collins (2019) (31, 32). In these researches, questionnaires were useful to understand citizenship evaluation of green areas and involve them in developing management policies of public spaces in cities. The same approach was thus applied, looking for information about the green area's perceived value and the overall natural capital. Due to the Covid-19 restriction, the questionnaire was spread via social network and thanks to the local Municipality and universities' collaboration.

a. Legislative analysis

The first activity that was carried out was the scouting of the legislation on the management of urban green areas at European, national and regional level in the three insular contexts (Sardinia, Balearic Islands and Madeira) by the three relevant partners, respectively ANCI Sardegna, FELIB and AREAM.

When it comes to **international regulation** and legislation regarding green areas a few pieces of legislation have been identified:

- Convention on the Protection of the World Heritage, Cultural and Natural. Paris, 1982
- Florence Charter on Historic Gardens. ICOMOS, 1982
- Mediterranean Landscape Charter. Seville Charter, 1992
- Recommendation No. R(95)9 on the Conservation of Cultural Sites integrated into Landscape Policies. Council of Europe, 1995
- European Directive 2009/128/CE establishing a framework for community action at the end of the sustainable use of pesticides
- Regulation 1107/2009 relative to the immission of the market for phytosanitary products and that abrogates the directive of the Consiglio 79/117/CEE and 91/414/CEE;

Italian legislation

- Ministerial Decree 1444/1968 (URBAN PLANNING STANDARDS)
- Law 29 January 1992, n. 113 - "Obligation for the municipality of residence to plant a tree for each newborn, following registration" and subsequent amendments"
- Legislative Decree 24 April 2001, n. 212 - "Implementation of directives 98/95/EC and 98/96/EC concerning the marketing of seed products, the common catalogue of

varieties of agricultural plant species and related controls" and subsequent amendments;

- Legislative Decree 19 August 2005, n. 214 - "Implementation of directive 2002/89/EC concerning protective measures against the introduction and spread in the Community of organisms harmful to plants or plant products" and subsequent amendments;
- Decree of the Ministry of Agricultural and Forestry Policies of 1 December 2005 – "Discipline of the marketing of seed of varieties, for which an application for registration in the national registers has been submitted (derogation pursuant to article 37, paragraph 2, of law 25 November 1971, n. 1096, and article 3-bis, paragraph 2, of law 20 April 1976, n. 195). Implementation of Commission Decision 2004/842/EC of 1 December 2004";
- Legislative Decree 14 August 2012, n. 150 "Implementation of directive 2009/128/EC which establishes a framework for community action for the sustainable use of pesticides" and subsequent amendments;
- Law 14 January 2013, no. 10 Rules for the development of urban green spaces
- Decree of 13 December 2013: «Minimum environmental criteria for the public green management service and for the purchase of soil improvers, ornamental plants and irrigation systems»
- Minimum Environmental Criteria (CAM) for the public green management service and the supply of green care products
- Decree of the Ministry of Agricultural, Food and Forestry Policies of 23 October 2014 (Establishment of the list of monumental trees of Italy and principles and directive criteria for their census) and subsequent amendments;
- UNI/PDR 8/2014 Guidelines for the sustainable development of green spaces;

Spanish Legislation

- Law 16/1985. Spanish Historical Heritage
- Royal Legislative Decree 7/2015, of 30 October, for which the refunded text of the Ley de Suelo y Rehabilitación Urbana was opened.

- National Strategy for Green Infrastructure and Ecological Connectivity and Restoration. Ministry for the ecological transition and the demographic challenge.

Regional Balearic Regulation

- Law 6/1991, of March 20, for the protection of unique trees in the Balearic Islands
- Law 12/1998, of December 21, on the historical heritage of the Balearic Islands
- Royal Decree 630/2013, of August 2, which regulates the Spanish Catalogue of invasive alien species
- Law 12/2017, of December 29, on urban planning in the Balearic Islands
- Law 8/2019, of February 19, on waste and contaminated soil in the Balearic Islands

Portuguese Legislation

- Law No. 31/2014, of May 30, on the general bases of public policy on land, land use and urban planning
- Decree No. 80/2015, of May 14 - Approves the revision of the legal regime of the instruments of territorial management

b. Surveys and data collection

Once analysed the relevant and existing European, national and local directives and laws, the partnership has been focused on understanding how these rules are actually applied and perceived by local stakeholders. This has to be seen as a crucial step, since - specially in islands and rural places, with clear gaps in training and formation opportunities - the implementation of ambitious policies often fails, with poor practical results and no effects on environmental quality and urban livability.

To explore this, VL partners reached consensus on developing and distributing a tailored survey, where to ask focused questions to the target stakeholders - municipalities and their technicians.

Out of the 6713 municipalities within VL territories, the partners selected a sample of representative municipalities to be involved in the survey. To form this sample, open public procedures were organised, aimed at inviting the interested municipalities to manifest their interest in being part of the project.

Overall, 28 municipalities replied to the open procedure, subdivided as follows: 14 municipalities from Sardinia, 10 municipalities from the Balearic Islands, 3 municipalities from Madeira. One municipality from the Czech Republic was involved too, with the purpose of having a benchmark.

The questionnaire, which was drafted in English and then translated into the local languages (Italian, Spanish, Portuguese and Czech) consists of 22 questions (with slight differences from one version to the other) addressed to the technicians of the municipalities. The questions consisted of a mix of multiple options or open replies, to collect different information, from technical, management and staff sides. It was developed and shared using Google Forms. In order, the questions were the following:

- Where is your municipality?
- What is the population of your municipality?
- Does your municipality have a GIS (geographic information system) system for tree inventory?
- What is the format of the GIS system in your municipality?
- Would your municipality be interested in developing a GIS tool for the tree inventory?

- Does your municipality have a historical record of the tree inventory?
- Does your municipality have a classification of risks for trees in your municipality?
- In your municipality, who manages the municipal parks?
- Are there any monumental or unique trees in your municipality?
- Does your municipality celebrate Tree Day or Nature Day?
- What does your municipality do during the day of Tree Day or Nature Day?
- Does your municipality carry out tree replacement activities (annually)?
- If yes to the previous question, what's the replacement rate?
- Are there any technical staff in your municipality who look after the public green areas?
- What is your municipality's annual expenditure on public parks?
- Do the workers in charge of the green areas in your municipality receive continuous training?
- Does your municipality feel the need to carry out training for workers in charge of green areas?
- Evaluate the following management sectors of the green areas of your municipality in descending order
- Which benefit of the public green areas do you consider most important for your municipality?
- What is the biggest problem regarding green areas in your municipality?
- Is there a particular tree/plant disease/pest that is of concern to your municipality? if yes, which one?
- What would you like to get from this project in terms of added value?

As per open public procedure and in line with the VL timeline, the municipalities had a few weeks to complete the questionnaire, with the results then analysed and collected by each partner, and later discussed together in the VL Transnational Meetings in Madeira and Assisi.

c. Data analysis

Once gathered the information and formed the database, during VL transnational meetings, the partnership agreed on a common procedure to analyse and compare the collected data. To standardise the analysis, several methodologies were compared and discussed among partners. Agreement was reached on a twofold methodology, that puts together two separate analyses: the SWOT and the PESTEL ones.

A SWOT analysis is a strategic planning tool used by businesses, organisations, and individuals to assess their current situation and make informed decisions. The acronym SWOT stands for Strengths, Weaknesses, Opportunities, and Threats. The analysis involves identifying and evaluating these four key elements to gain a comprehensive understanding of an entity's internal and external environment. VL partners agreed on the following methodological principle in conducting the SWOT analysis:

1. Define the objective: Clearly state the purpose of the SWOT analysis.
2. Assemble a diverse team to conduct the analysis, to have knowledge and expertise in different areas relevant to the analysis. This is well represented by the various backgrounds that VL partners and their employees have.
3. Identify strengths: List the positive attributes, resources, capabilities, and advantages that the entity possesses. These could be related to assets, skills, reputation, unique selling points, market share, or any other aspect that provides a competitive edge. Examples: Strong brand image, skilled workforce, innovative products, efficient processes, loyal customer base.
4. Recognize weaknesses: Identify the shortcomings, limitations, and areas where the entity is at a disadvantage compared to its competitors or where improvement is needed - such as outdated technology, inadequate resources, high employee turnover, inefficient internal communication.
5. Explore opportunities: Analyse the external factors and trends in the market or the industry that could positively impact the entity's growth and success. Examples: Emerging markets, changes in regulations, new technologies, growing demand for certain products/services.

6. Identify threats: Examine the external factors and trends that could pose risks or challenges to the entity's performance and viability. Examples: Intense competition, economic downturns, changing consumer preferences, potential disruptive technologies.
7. Conduct research and gather data: The team should collect relevant data and information to support the identified strengths, weaknesses, opportunities, and threats. This can involve market research, customer feedback, financial analysis, industry reports, and other reliable sources.
8. Prioritise and combine factors: Once all the factors have been identified, it should be prioritised based on their significance and impact on the entity's objectives. Combine similar factors to avoid duplication and create a clear overview.
9. Interpret and strategize: Analyse the SWOT matrix and consider how the strengths can be leveraged, weaknesses can be addressed, opportunities can be pursued, and threats can be mitigated. Develop strategic initiatives and action plans that capitalise on strengths and opportunities while addressing weaknesses and threats.
10. Implement and review: Put the strategies into action and monitor their progress regularly. SWOT analysis is an iterative process, and it's essential to revisit and update the analysis periodically to adapt to changing circumstances and to refine strategies accordingly.

The data analysis is then completed with the PESTEL analysis. Compared to the SWOT, the PESTEL can provide a more concise and action-directed analysis. Typically used to assess the external macro-environmental factors that can impact an organisation, industry, it stands for Political, Economic, Social, Technological, Environmental, and Legal factors. The analysis helps understand the broader context in which an entity operates and identifies potential opportunities and threats, with a logical analysis.
VL partners defined the following steps to conduct the PESTEL:

1. Define the scope and objective: Clearly state the scope of the analysis, such as focusing on a specific industry, region, or organisation. Determine the purpose of the analysis and what insights you aim to gain from it.
2. Gather relevant information: Assemble a team of experts or individuals familiar with the entity or situation to collect data on the various PESTEL factors. Use a combination of primary and secondary sources to obtain comprehensive and up-to-date information.
3. Analyse political factors:
    - Identify political factors that may influence the entity, such as government stability, policies, regulations, and political trends.
    - Assess how political decisions and changes in the political landscape can impact the entity's operations, market access, and overall business environment.
4. Examine economic factors:
    - Look into economic indicators like GDP growth, inflation rates, exchange rates, interest rates, and unemployment rates.
    - Analyse how economic conditions can affect consumer behaviour, demand for products/services, and the financial health of the entity.
5. Consider social factors:
    - Study social and cultural trends, demographics, lifestyle changes, and consumer attitudes and preferences.
    - Understand how societal shifts can create new opportunities or challenges for the entity.
6. Explore technological factors:
    - Investigate technological advancements and innovations relevant to the industry or organisation.
    - Assess how technological changes can impact production processes, distribution channels, and competitiveness.
7. Evaluate environmental factors:

- Examine environmental concerns, sustainability issues, and the entity's impact on the environment.
- Consider how environmental regulations and consumer expectations for eco-friendly practices can affect the entity's operations and reputation.

8. Assess legal factors:
   - Review current and upcoming legal and regulatory frameworks that affect the entity's industry or operations.
   - Analyse how compliance with laws and regulations can impact the entity's ability to conduct business and potential legal risks.
9. Identify trends and implications: After gathering data on each PESTEL factor, identify key trends and potential implications for the entity. Determine which factors have the most significant influence on the organisation and its strategic decisions.
10. Develop strategies and responses: Based on the analysis, develop strategies to leverage opportunities and address potential threats. These strategies should align with the entity's goals and help navigate the external environment effectively.
11. Monitor and update: The PESTEL analysis is not a one-time exercise. It should be regularly monitored and updated to account for changes in the external environment. Review the analysis periodically to ensure its relevance and adaptability to evolving circumstances.

Leveraging on these two methodologies, Viridi Loci partners aim at assessing the collected data, to present a picture of the actual management level and related needs.

3. Results

The surveys, their data and the correspondent SWOT and PESTEL analysis were developed by each partner, with frequent updates between partners and coordination by the project leader. At the Transnational Meeting in Madeira, survey results were analysed with raw data analysis. The SWOT and PESTEL methodology were also agreed, and the results thereof were presented and discussed in Assisi. The results have been unified in this document and they are available for consultation in the appendix.

As stated above, the survey sample for the overall VIRIDIS LOCI project consists of 28 municipalities equally distributed across the project territories. This sample gives an exhaustive overview of the current state of the art in management of urban green areas: the analysis of the survey results will be the cornerstone for the following project outputs.

The four questionnaires distributed in each of the four partner countries can be easily compared based on the answers to 13 questions that were asked with exactly the same formulation across municipalities, as it follows:

The first question inquired about whether the municipalities can count on an in-house gardening/landscaping service or rely on an external supplier to carry out that task on behalf of the public body.

In Sardinia, out of the 14 municipalities surveyed, 8 rely on an external firm for the gardening service whereas 6 municipalities do own a gardening service in-house.
In the Balearic Islands, 60% of the municipalities implement a mixed system consisting of their own resources and an external contractor. 20% of the municipalities manage the public green areas with their own resources. 20% of the municipalities entrust the management of public parcs to an external contractor.

In the Portuguese island of Madeira, the three municipalities surveyed declared that each one of them has a team responsible for the management of Urban Green areas within the municipality itself.
Finally, the questionnaire returned from the Czech Republic for the city of Brno, also records a context where the municipality entrusts the gardening to an internal garden service.
This state of affairs shows that where the municipality owns an internal gardening service, the public body invests in developing its local human capital even though the actual skill level of the personnel assigned to the gardening service has to be assessed.
Conversely, when the service is outsourced to an external contractor the implication for the municipality is that it refrains from growing its own structures and improve staff proficiency in that particular domain.
The advantage of having a gardening service in-house for the local public body amounts to retaining control over the tasks to carry out in the field, while potential issues related to the workload and to the work in general may arise.
Moreover, in-house managers have direct contact with the municipality technicians implementing the measures, which creates a synergy between the planning phase and actual implementation phase. The training process and the appraisal of skill level and training needs is more straightforward when the whole procedure is kept within the municipality.
The use of an external contractor in a mixed system (as in the Balearic Islands) helps the municipality to manage more efficiently its own green heritage as long as a certain degree of control over the work of the external firm is retained.

The second question aimed to determine whether the personnel assigned to the gardening service follow ongoing training and courses.

The picture that is revealed by the returned questionnaires shows that in Sardinia, all municipalities except from the capital city Cagliari do not take advantage of ongoing training. That is echoed by the Portuguese municipalities where no training is provided.

In contrast, 70% of the municipalities in the Balearic Islands organise continuous training for their green workers and 100% of the sample feels the need to provide it.
The Czech city of Brno does provide training to its gardeners/arborists as it can count on the available budget for continuous learning.

The third question asked whether municipalities have a tree inventory of their green patrimony.

Again, Sardinia and Madeira share a similar situation whereby only Cagliari has a tree inventory, while all other Sardinian municipalities (even the second city, Sassari) lack this tool. In Madeira no municipality has a tree archive.
In Spain, 40% of the municipalities surveyed in the Balearic Islands have a tree heritage inventory. Monumental trees registered in the official catalogue of the singular trees of the Balearic Islands.
The Czech city of Brno has its own archive of the tree heritage present within the municipality's territory.
It is advisable for the municipality to develop a historical archive of its arboreal heritage to better manage what is owned by the public local body and attribute an economic value to its timber, forest products, eco-tourism, carbon sequestration and provision of ecosystem services.
The presence of a tree inventory also helps to gain a better picture of the safety issues that the trees may pose to the citizens, buildings and objects and inform the risk assessment of the arboreal heritage.

The following question inquired about the presence in the surveyed municipalities of a Territorial Information System (TIS) based on a Geographic Information System (GIS).

GIS, or geographic information systems, are computer-based tools used to store, visualise, analyse, and interpret geographic data. Geographic data (also called spatial, or geospatial data) identifies the geographic location of features.

The survey returns a patchwork of results for the sampled territories. In Sardinia, only 3 municipalities have TIS in digital format (the two most populous cities and a small town) whereas the others do not rely on TIS tools.

For the Balearic Islands, only 20% of the municipalities have a geographic information system but 70% aim to acquire one in the future. The digital format is preferred by the 40% of the entities.

Madeira and the Czech Republic declared to be equipped with a digital TIS system for all the municipalities involved in the survey.

A computerized TIS has several benefits such as optimising resource allocation and planning by providing accurate spatial data and improves efficiency and productivity by streamlining processes, reducing manual tasks. The lack of this tool results in poor territorial management, no real-time monitoring and makes the decision making process cumbersome.

The tool also facilitates the maintenance of green areas and the ex-post evaluation process.

The questionnaire then asked the municipalities whether, within their territories they record the presence of monumental trees.

The classification of a monumental tree can take place if at least one of the following requirements is met:

- Age: the longevity of the plant is a significant element
- Dimensions: Very large size for the species or larger than the other individuals of the same species present in the examined area
- Particular shape or bearing: Unusual shape or bearing for the species
- Ecological value: this is the case, for example, of trees that become a refuge for small fauna or home to a large number of organisms including fungi and insects);
- Plant architecture, e.g., due to particular cultivation methods;
- Botanical Rarity; a rare species certainly acquires a great value in unusual places;

- Value, historical, cultural, religious: they are tall trees that bear a precise reference to events or memories relevant from the historical, cultural, documentary or local traditions point of view; this is also the case of tall trees inserted in particular architectural complexes of historical and cultural importance, such as villas, monasteries, churches, botanical gardens and private historical residences.
- Landscape value: for example rows and trees of particular landscape value, including those inserted in urban centers;

Monumental trees are present in all of the sampled territories with a generic affirmative answer for Portugal and the Czech Republic, a somewhat imprecise answer for Sardinia (monumental trees recorded in eight municipalities, with three municipalities aware that they do not own any such tree and three other municipalities which are not aware whether those trees exist within their confines.

The Balearic Islands returned a very precise answer, declaring that 40% of the municipalities surveyed have monumental trees (Palma: 4, Ciutadella: 1, Es Mercadal 2, Formentera 5 trees).

Monumental trees can represent a precious element in defining territorial identity with potential ramifications on awareness raising among citizens and positive contribution for cultural activities and tourism.

Monumental trees are registered in official catalogues of notable trees from which derives a legal liability for the potential damage inflicted to the tree (especially vandalism and groundless logging).

It is therefore advisable to give publicity about the presence of such trees in the municipality with a positive return on the image of the public administration and the promotion of an eco-friendly municipality.

The sixth question examined whether the municipalities attribute a risk class for critical trees, namely dangerous trees.

In Sardinia, only the two biggest cities (Cagliari and Sassari) have a ranking of their trees according to the danger level (in this respect the questionnaire reveals an oddity in Sassari which does not have a tree inventory but is able to classify its trees by a risk class).
In the Spanish Balearic Islands 30% of the municipalities surveyed have a risk classification of the events (adverse weather) that could affect their green areas.
In Madeira there is no ranking in place while Brno does not know whether such classification is being held by the municipality.
The assessment of risk is an essential part of the public green management which comes at a cost for the municipality. By investing in proactive risk classification, municipalities can minimise potential liabilities, protect public safety and maintain the environmental and economic benefits provided by trees.

The seventh question asked whether the trees planted in the municipalities are native (autochthonous) or allochthonous.

In Sardinia, all municipalities involved, declared they plant native trees except from Sassari and two other small towns where allochthonous trees are found.
In Spain most of the trees are allochthonous. Exotic plants tend to compete with autochthonous plants and climate change is causing summers to last longer and lack of water (little rain and extreme weather events) which is in turn hindering the planting of trees, for which alternatives are being sought.
We have no data for Portugal, whereas the Czech municipality of Brno records the presence of both, autochthonous and allochthonous species.
In our parks and green areas there are more and more allochthonous plants which enrich the urban landscape, increase biodiversity and may represent a benchmark to evaluate the impact of global warming on tree species and their ability to adapt.

The following question investigated about which plant disease and/or pests are of concern to the municipalities

In Sardinia the most problematic pests are the Red weevil (3 municipalities), Holm oak parasites – Processionary (4 municipalities), Pinus-related issues such as road instability (1 municipality), pests in Oleander and Judas Trees (1)

Spain highlighted the *Cerambix cedro, Tomicus destruens, Thaumetopoea pityocampa, Paysandisia archon, Lymantria dispar, Rhynchophorus ferrugineus, Xylella fastidiosa.*

The Portuguese municipalities of Madeira declared that no pest is of concern which may indicate that the municipality is not fully aware about specific threats against the urban trees.

Finally the Czech municipality of Brno singled out Cameraria, Cadalima perspectalis, Ips typhographus, Erysiphalles, Aphids as threats to the trees.

The results, on the one hand show the need to select resistant species and varieties and while most issues are easily managed and do not seriously harm humans and plants, some require invasive treatments (spraying, in the case of Horse-chestnut leaf miner disease and microinjections) and better project management cycle.

Question 9 inquired about whether municipalities carry out a renewal of trees and the rate thereof.

Out of 14 sampled municipalities in Sardinia, 8 do renew their trees whereas 6 do not operate a regular tree renewal. Two municipalities declared that the rate of tree substitution is between 5% and 20%.

In Spain, 60% of the municipalities surveyed carry out renewal of trees annually. In Portugal two municipalities renew their trees by up to 20% of the total number of trees, whereas one municipality does not carry out any renewal.

The Czech Republic answered affirmatively to this question.

Continuous renewal of the trees leads to air quality improvement, creates a micro environmental system which keeps the cities cool in the summer and warmer during the cold period, helping against drought and keeping the water levels in the area stable.

However, the environmental consequences of replacing trees need to be evaluated further.

The following question intended to find out whether the municipality administrations produce a green balance sheet at the end of their mandate, demonstrating the impact of the administration's activities on public green areas.

The answers to this question show a diverse picture for the four territories involved.

In Sardinia, only the two major cities Cagliari and Sassari are legally obliged to produce such document recording how the administration policy has impacted on the parks and green areas within the municipality's confines.

In Italy, the requirement to produce a green balance sheet is a legal obligation only for municipalities having a population of more than 15.000 individuals.

In Spain and Portugal there is no legal obligation whereas in the Czech Republic the public administration draws up, at the end of each year, a balance of felling, pruning and tree planting. The data are then sent to the superior body - the Department of the Environment of the Municipality of Brno - where they get elaborated further.

For those municipalities which are mandated to produce a green balance sheet, a follow up document should include a budget for the maintenance of the additional trees planted by the outgoing administration as well as a technical balance to record how many trees stay alive after planting.

For municipalities that have less than 15.000 inhabitants it turns out to be impossible to track and assess changes in green areas.

The maintenance of green areas where municipalities leave a mapping of their operations for the incoming administration may be overall more expensive but can also encourage eco-tourism, improve the cities micro-climate with positive repercussions on the health of citizens and long-term economic benefits for the municipalities and its surroundings.

Is a tree actually planted for every child born or adopted within the municipality?

Italian 10/2013 Law 'Regulations for the development of urban green spaces' stipulates that in municipalities with 15.000 inhabitants or more a tree has to be planted when a child is born or adopted within the community.

The results for Sardinia show that the major cities Cagliari and Sassari comply with the law and two smaller towns (namely Sant'Andrea Frius and Villasalto) follow the directive even though they are not obliged to comply with it.

In Spain, Portugal and the Czech Republic there is no legal obligation to plant a tree for every child born or adopted, although it does happen sporadically in some urban areas in the Czech Republic.

Municipalities have to pay attention to what plant species are planted and what planting techniques are used as well as where the plants are actually planted in order to guarantee a good rate of tree survival. Often planting campaigns fail because of bad decisions when it comes to the areas where the plants are planted and lack of proper maintenance.

Initiatives involving tree planting would actively involve the general population, especially the younger generations. For every new born or adopted child, the corresponding tree planted should be given a name so that the child can take care of it throughout its life. Depersonalisation should therefore be avoided as it brings about deresponsabilitation from the municipality.

The twelfth question asked the surveyees what kind of activities are organised by the municipalities on the occasion of the National Tree Day.

National tree day varies in all the territories involved in the VIRIDIS LOCI project: For Italy the date falls on 21th November, for Spain falls on the 21st March, for Portugal is on 21st September and for the Czech Republic the date is 20th October.

The questionnaire results returned for Sardinia show that 6 municipalities organise awareness raising and valorisation events, 5 of them organise tree planting, 2 of them organise green walks and one of them organises thematic workshops.

For Spain, 40% of the sample stated that events are organised for National Tree day with tree plantation (16%), excursions (4%) and workshops (4%).

In Portugal the three municipalities surveyed stated that they organise reforestation activities and tree watering.

The Czech Republic did not provide an answer to that question.

These initiatives imply a certain level of collaboration between the municipalities and civil society. The activities educate and raise awareness among citizens (especially the young and the elderly) about the public arboreal heritage empowering people to take action in favour of a more sustainable future for all.

The last question asked the municipalities what benefits they attribute to well maintained parks and green areas

For Sardinia 66.7% of the respondents declared that green areas may be seen as a possible solution for the mitigation of hydraulic-hydrogeological risk which represents a serious issue where there is lack of territorial maintenance, planning and because of climate change.

For the Spanish municipalities involved, green areas are a safeguard against climate change and demonstrate the commitment to the care of nature. In fact, attentiveness to these values will inform public policies which are aligned with them.

For the Portuguese municipalities surveyed, the most valuable benefit of green areas is biodiversity conservation.

In the Czech Republic the benefits of green areas are seen as improvement of the local climate, the conservation of biodiversity and the reduction in the share of brownfields.

The corollary is that these benefits are the driving force for keeping parks in good condition and may lead to the disbursement of financial support for the green sector in the municipality.

4. Conclusions and next steps

The first project product, the Standard Setting for urban forestry maintenance, aimed at a particular target of the Viridis Loci project - the municipal technicians - has provided valuable information that will be helpful to further shape the next phases of the project.
As the first result delivered by the partnership, this Standard Setting can be seen as a starting point of the cooperation itself, with useful insights from each partner and an overall positive team work.

The chosen data collection form - online questionnaire - and the following data analysis - SWOT-PESTEL analysis - were carefully selected in order to:

- achieve stakeholder engagement, with active involvement among the municipalities and their technicians;
- collect proper information about what is really going on at practical level, so to have a better understanding of the implementation of European directives and uniformity between different European areas;
- eventually, analyse the questionnaire outcomes in a standardised way, leveraging on two solid and well-known methodologies.

With these baselines, the following key factors can be visible and should be addressed in the next steps of Viridis Loci, such as:

1. The management of green areas is conducted in various forms among countries, with internal and/or external services. In both cases, a proper training to correctly manage urban forests is needed and is seen as a priority: this, beside confirming the stakeholders needs that led to Viridis Loci proposal, underlines the urgency of offering VET experiences, especially in rural areas;
2. The baseline to manage public goods relies on having a perfect and updated knowledge of the assets to manage. When it comes to urban greening, specifically to trees. Here, based on the surveys, it appears as a priority to increase the awareness

of having tree inventories and, in specific countries and conditions, to fulfil law requirements. This represents a key aspect for the next stages of the project.

3. Related to inventories and territorial management, a huge lack is represented by the low use of GIS tools to manage assets. This is due to digitalization gaps within European territories: as it is proved by multiple experiences, there are several benefits to relying on GIS techniques - another priorities to be addressed in the next phases of the project.
4. Tree risk assessment is perceived as a topic by the stakeholders, but it seems the application of variable and not capillary. This, despite the benefits of conducting risk assessments, to properly manage and face the safety risks - and correspondent liability - inherently linked to trees in urban areas.
5. Viridis Loci’s territories have in tourism one of the core economic sources: the presence of monumental and veteran trees can be seen as a further enhancement of the touristic offerings, capable of attracting tourists particularly open to green and sustainable experiences. However, this would require specific skills to preserve, maintain and promote veteran trees.
6. Specific technical needs seem to correspond in the different areas, with issues with specific insects, or pathogens, or in the autochthonous/allochthonous choice. Overall, technical guidance is needed to deal with these issues - and this guidance can be gained thanks to specialised trainings, encompassing European environmental requirements too.
7. The benefits granted by urban trees and a positive communication to public stakeholders, such as citizens, is needed, for example to quantify and communicate the ecosystem services provided by trees: also in this direction, Viridis Loci will provide guidance to municipal technicians.

Therefore, the questionnaire and the following analysis represented the stepstone to further develop the VET experience for the selected target, that will be developed in the forms of guidelines and technical expertise, with practical case studies, to guide municipalities to meet a more sustainable urban environments, with new skills.

5. Appendix