PILOT EVALUATION REPORT - PADOVA

Summary reports on the main outcomes of pilot actions and the lessons learnt within, with an outlook to prospective follow-up actions and potential transfer of the results to other areas within the same FUA and beyond.

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1. Activities and outcomes

1.1 Brief summary

The Pilot in Padova was a great opportunity to conduct a complex many-fold activity impacting directly on well established working methods of involved offices as well as providing policy makers with up-to-date decision making tools.
The Pilot Area has been chosen for several good reasons: it was urgent to preserve and to put in value a so called "green triangle" inserted in a consolidated and densly urbanised settlement scheme. It is strategically located, crossing both urbanised and rural contexts, as well as two planned urban Parks, establishing a GI perspective at FUA level. The variety of UGS typologies (biodiversity) and functions (Multifunctionality), allowed an effective assessment of both environmental and socio-economic benefits. The main results concerned an enhanced knowledge base of our territorial unit, an improved GIS model and database, a predictive indicators set, a mobile application.
In particular, **29 new indicators** have been developed and eventually calculated, grouped into three macro-categories addressing social, ecological and managerial dimensions. Before UGB, local urban planning was based solely on quantitative data set of public green spaces. In order to acquire these new data set, the GIS databse has been upgraded with new classes and functions.
4 Key indicators have been also developed and calculated, as to have a concise overview of selected topics related to UGS: Environmental index, Economic index, Recreational index, Landscape quality index, obtained by an accurate blending of both basis and composite indicators.
12 new thematic maps have been produced from both field work and photo-interpretation (satellite images), e.g a map of field hedges providing quantitative assessment of their length and a map of public and private green based on NDVI mapping on orthophotos.
1 multiple user mobile application, both for Municipality personnel and active citizens, able to feed the new data set of GIS databse with public and private green spaces data.

1.2 Activities performed – What happened in you pilot action?

Padova Team focused on environmental indicators analysis and data set. The Municipality owns or manages only 10% of total green spaces. The main challenge was in fact to achieve a significant share of UGS mapped, especially privately owned, through a wide participatory process and new mobile application use. Another challenge was to define a set of indicators able to compare the specific contribution of different typologies of UGS and forecast the potential impact of specific measure. Data refers to green spaces directly managed by the municipality of Padova. A further goal was to include such results and methods in the policy paper for sustainable management of private and public UGS (Regolamento del Verde). Specifically, the aim was to improve planning, management and the decision-making processes of the public sector as to urban green spaces, creating an integrated system of planning and management of green areas based on a series of quantitative/qualitative indicators.
Indicators have been firstly identified and eventually calculated to assess the performance of green infrastructures with respect to two simple but well defined main objectives:

- increase the availability and accessibility of public green spaces
- increase and maintenance of the tree cover

The study involved a wide sector of the city identified during the local assessment definition together with relevant stakeholders. The Pilot area was chosen on the basis of its environmental and socioeconomic characteristics, and the presence of a variety of urban fabrics, providing a fairly complete yet representative sample of the city as a whole. The agricultural areas count 742 hectares circa, with a total percentage of SAU (Agricultural Surface Used) of 34%, close to the municipal average of 32%. The population residing in the area counts 60.504 inhabitants out of a total of 210 thousand.
Indicators were applied to urban units, since this subdivision appeared the most adequate to represent the variability of the quantity and quality of the green infrastructure. Such solution enables also their use in defining planning and management priorities, and ensure citizens availability/access of green spaces as well as quality tree populations, equally distributed in the territory.
Indicators have been applied to a defined set of Urban Units: the historic center (urban units 1.1; 1.2; 1.3; 1.4), within the sixteenth-century city walls, part of the South-East district (urban unit 1.5), the South-West district (urban units 2; 3; 14) including Basso Isonzo Agricultural Park, and part of the West district (urban unit 15). The total pilot area is 2,175.02 hectares, about 23% of the total municipal area (9341.88 hectares).

1.3 Outcomes - What are the results?

A first group of indicators concerned quantitative knowledge of municipal green space available to citizens and to what extent it is indeed accessible and enjoyable.
1. Green area per capita [m2/in] (Sustainability 2A)
2. Percentage of green areas [%] (Sustainability 2B)
3. Share of green area over the pilot [%] (Sustainability 2C)
4. Accessibility [%] (Attractiveness 3)
5. Distance from municipal UGS entrance to public transport (efficient stops) <300 m (Basic 6)
6. Distance from Municipal UGS entrance to Pedestrian Lanes [m] (Basic 5)
7. n antennae [n] (Basic 8)
8. Surface of municipal playgrounds per capita per specific age-group [mq/in] (Attractiveness 2, age-group 3-11)

Initially, we measured the overall availability of public green surfaces, since regardless their typology and use, they all provide inhabitants with ecosystem services and benefits. These indicators are able to highlight the lack of green spaces in certain urban units and be used as a tool to support planning choices concerning both new areas and the management of existing ones. We then proceeded to evaluate the extent to which public green spaces are actually enjoyable for recreational purposes hence accessible to residents. Accessibility means the possibility for citizens to access green areas within a sufficiently short distance from home. According to standards most commonly used in the European Union, spaces shall be located no more than five minutes walk. This distance can be quantified in linear terms in about 300 m. For the calculation of this indicator, a catchment area for each green area present in the study area was first estimated, then for each urban unit was identified the share of resident population included in the potential catchment area. The indicator therefore shows us to what extent the needs of access to green spaces for the inhabitants are met in each urban unit.
A second group of indicators describes the characteristics of the tree populations present in public green spaces of the Pilot area.
9. Canopy cover [%] (Sustainability 5)
10. Tree density [n/ha] (Maintenance 2A)
11. Trees for 100 residents [n/100 in] (Sustainability 3)
12. Trees on streets [n/km] (Basic 19)
13. Tree density in green spaces [n/ha] (Maintenance 2B)
14. Tree DBH distribution [categorical classes of scarcity] (Maintenance 3)
15. Number of species [n] (Sustainability 8A)

16. Species per 100 trees [n] (Sustainability 8B)
17. Number of species forming 50% of the population [n] (Sustainability 8C)
18. Number of species over 5% [n] (Sustainability 8E)
19. Equitabiliy of Pielou [0-1 range] (Sustainability 8D)
20. Share Semi-natural maintenance of municipal green areas [%] (Maintenance 4A)
21. hare Intensive maintenance of municipal green areas [%] (Maintenance 4B)

The canopy cover is widely recognized as one of the most significant indicators of a city's green infrastructure. This indicator has often been used to define and monitor urban green planning objectives. The extensive use of this indicator is justified by the close link existing between the tree cover and the environmental benefits provided by the green infrastructure and by its easy measurement also through remote sensing methods. The canopy cover can be detected both for public and private green spaces, which is the widest portion of the arboreal populations of the city.
However, the "canopy cover" indicator offers us a static picture of urban tree population, without giving us information on what could be its future development, also in relation to different management scenarios. For this reason other indicators have been included, based on the information available in the municipal tree cadastre, highlighting other important characteristics of the tree population. These data are currently available only for trees owned by the Municipality.

A third group relates to rural-urban landscape indicators.
22. Meadows in Farming spaces FUGS [%] (Basic 15)
23. Length of Hedges in Farming spaces per hectare [m/ha] (Basic 16)
24. Areas for certified organic food production per capita [ha per person] (Sustainability 13)
25. Number of farmers markets and direct-to-consumer point of sales per 1000 capita [n/1000 persons] (Sustainability 14)
26. Share of uncultivated agricultural surface in total farming space [%] (Profitability 1)
27. Share of agricultural areas in total space (urban unit) [%] (Profitability 2)
28. Average agricultural patch extension [ha] (Profitability 3)
29. Surface of total Urban Green spaces and Farmer spaces per capita [Mq/in] (Sustainability 2)

Moreover, we identified 4 Key indicators, on the basis of accurate blending of specific composite and/or basis indicators (see annex):
1. **K1 Environmental index**
BA19 Trees on streets, MA2A Density of trees, MA2B Tree density in green spaces, MA03 Tree DBH distribution, SU02A Green area per capita, SU02B Percentage of green areas, SU02C Share of green area over the pilot, SU03 Trees for 100 residents, SU05 Canopy cover, SU08A Number of species, SU08B Species per 100 trees, SU08C Number of species forming 50% of the population, SU08E Number of species over 5%, SU08D Equitabiliy of Pielou, BA16 Length hedge in farming spaces, BA15 Meadows in farming spaces, SU13 Areas for certified organic food production per capita, P01 Share of uncultivated agricultural surface in total farming space, P03 Average agricultural patch extension, BA08 Max N mobile telephone antennae and high, medium and low voltage lines with distance < 100m fron UGS centroid, MA04A Semi-natural maintenance of municipal green areas, SU01 Surface of total UGS + FUGS per capita
K2 Economic index
MA02A Density of trees, MA02B Tree density in green spaces, MA03 Tree DBH distribution, SU08B Species per 100 trees, SU08C Number of species forming 50% of the population, SU08D Equitabiliy of Pielou
SU08E Number of species over 5%, SU14 Number of farmers market and direct-to-tconsumer point of sales per capita, SU13 Areas for certified organic food production per capita, MA04B Intensive maintenance of municipal green areas
K3 Recreational index
A03 Accessibility
SU02A Green area per capita, SU02C Share of green area over the pilot, SU03 Trees for 100 residents, PA02 Share of agricultural area in total, public, municipal and private spaces, BA04 Distance to cycle lanes, BA05 Distance to pedestrian lanes, BA06 Distance to public transport, A02 Surface of municipal playgrounds per capita per specific age-group (3-11)
K4 Landscape quality index
MA02B Tree density in green spaces, SU05 Canopy cover, SU08B Species per 100 trees, BA16 Length hedge in farming spaces, BA15 Meadows in farming spaces, P02 Share of agricultural area in total, pub-

lic, municipal and private spaces, P03 Average agricultural patch extension, BA08 Max N mobile telephone antennae and high, medium and low voltage lines with distance < 100m fron UGS centr

The following thematic maps and related data sets were also created for UGB pilot area.
- A new map of the adjusted census sections (new shapefile)
- A land use map comparing the years 2007 and 2017 using cadastral parcels and attributing the nomenclature of the Corine classification
- A map of field hedges providing quantitative assessment of their length
- A map of food market and direct-to-consumer points of sales.

A further mapping (based on photo-interpretation and NDVI (Normalized Difference Vegetation Index) has been conducted on the entire Municipal territory:
- Map of effective and potential urban green from NDVI on orthophotos AGEA/REVEN 2015 with 0.15 threshold integrated with selection from the Geo-topographic DB (municipal);
- Map of agricultural and non-agricultural green areas based on mapping from NDVI on 2015 orthophotos;
- Map of public and private green based on NDVI mapping on orthophotos 2015;
- Map of municipal and non-municipal green spaces based on NDVI mapping on orthophotos 2015;
- Map of the land cover of Padua from supervised classification on images Sentinel-2 of June 2017;
- Map of the land cover of Padua from unsupervised classification on images Sentinel-2 of June 2017;
- Comparison map between actual or potential green areas of Padua from NDVI on orthophotos 2015, supervised and unsupervised analysis on Sentinel-2 2017;
- Comparison chart between actual or potential green areas in four sample urban units from NDVI on orthophotos 2015, BAF index and supervised analysis on orthophotos 2015.

2. software development
A brand new mobile Application has been developed. Papp-UGB has been conceived to be configurable on the basis of the user profile: professional (Municipality personnel) or private user (Citizens). Papp-UGB allows to upload basic data and photos.
A backoffice portal has been also created to collect information via mobile application and double-check quality of data acquired.

3. Communication activities
June 10th 2018 - Urban Green Fest
July 10th 2018 – Public event: Papp-UGB presentation
September 19th-21st 2018: Flormart fair
September 23rd 2018: European Sustainable Mobility Week/Sustainable Sunday

4. stakeholder involvement
July 2nd 2018: SP meeting
July 10th 2018: Public event: Papp-UGB presentation

1.4 Evaluation – Are you satisfied with the results?

Based on previously identified success indicators, the following evaluations may be conducted:

- ✓ Indicators data set have been populated as to make the new GIS architecture work properly and, consequently, data retrieval has been ensured by periodical updates.

All indicators we have identified in the Pilot Activity Concept have been developed and duly calculated (tested). Shape files have been acquired by the Municipality and the GIS database properly fed with information. On this basis, graphic representations, geo-referring data to each Urban Unit, may be en-

quired online via webgis open platform. At this moment, though, such data are only available via the Municipality Intranet. They will soon be available also for the general public.

- ✓ Privately owned UGS data have been successfully collected and uploaded in the GIS database.

Although 60 users are currently registered, only 10 actually mapped objects (either spaces or objects or both) providing in total 58 single data entry. We did not set a specific threshold in terms of number of users or data uploaded, nevertheless we are not satisfied with this result. Still, we knew this scenario was highly probable since the very beginning. In march 2018, preparing our mid-term evaluation report, we already realised we needed a contingency plan. The negative impact of this scenario has been partially mitigated engaging the GIS Science Master Course staff of the University of Padova-ICEA Dept, whose contribution has resulted in the 8 maps cited above (*based on photo-interpretation and NDVI (Normalized Difference Vegetation Index)* and correspondent data sets (shape files).

- × UGS cadastre is open to public consultation (webgis, citizen use).

Tree/UGS cadastre as well as indicators data set will be fully available to the wider public in the shortest delay.

- ✓ Both Apps (public oriented and professional use oriented) are fully implemented and used to update the database.

Budget table

Costs description	**Budget line** *(external/ equipment/infrastructure)*	***Status*** *1) performance in progress/ 2) performed but not paid/ 3) performed and paid)*	**Final amount of the costs**
Software development	*BL4 External Expertise and services*	*performed and paid*	*3.318,40*
Software development	*BL4 External Expertise and services*	*performed and paid*	*4.684,80*
Software development	*BL4 External Expertise and services*	*performed and paid*	*6.246,40*
Software development	*BL4 External Expertise and services*	*performed and paid*	*2.342,40*
Software development	*BL4 External Expertise and services*	*performed and paid*	*6.246,40*

Communica-tion/dissemination activity	*BL4 External Expertise and services*	*performed and paid*	*500*
Indicators calculation/data retrieval	*BL4 External Expertise and services*	*performed and paid*	*5.000,00*
Indicators calculation/data retrieval	*BL4 External Expertise and services*	*performed and paid*	*5.000,00*
Indicators calculation/data retrieval	*BL4 External Expertise and services*	*performed and paid*	*6.000,00*
		Total costs:	***39.338,40***

2. Follow-up actions

2.1 What about the future?

Please consider and describe the following aspects for the future:

- sustainability of the pilot: how could the pilot activities continue? which tools/methods or activities are worth to continue?
- potential transfer of the results/pilot activities to other parts of the Municipality or the FUA or other regions (interesting for the smart governance manual)?
- dissemination potential for communication activities/stakeholder workshops etc. (already or still to be conducted),
- (approx. 750 words)

The analyses conducted in the Pilot Area, on the basis of the new set of indicators, will be extended to the entire administrative unit. The fruitful cooperation with both University of Padova and IUAV University of Venice substantially enhanced the knowledge base available before pilot activities started and provided an innovative indicators system to be used as decision-making tool. In particular, the new cartography produced by the University of Padova-ICEA Dept. advanced such projection of pilot activities at city level. However, private green spaces data, including agricultural spaces, shown in cartography provide aggregated amounts, that is, a quantification, through remote sensing methodologies in open source GIS environment, of the total area actually or potentially occupied by vegetation within the territorial unit of Padova. In other words, we need to further detail the characteristics of such spaces, in terms of variety of species, tree population, cultivation typology, etc..This deeper and detailed knowledge requires a systematic contribution from private owners as well as the municipality personnel.
The greenery analysis confirmed the relevance of land take in Padova: the areas excluded from the calculation of the potential green and therefore considered as built environment count 44% of the municipal area. This figure, still very high, is a few points lower than indicated in the latest ISPRA report on soil consumption, that is 49% (2018). It would be interesting to investigate this difference and find possible connections with data extraction methodologies (as we have seen, some classification procedures on
satellite images tend to underestimate green or permeable surfaces).
Regarding the classification by property show a clear prevalence of private green spaces over public ones. On the one hand, this stresses very much the importance of private green and its preservation in terms of urban environmental benefits, on the other, raises the question of access and collective usability of these assets, in a such a context of scarce public green resources, which implies the concept of commons and the relationship between administrations and individuals in their management.
To ensure the sustainability of the pilot, a stronger cooperation among all relevant-to-the-topic City Administration Departments and Offices, namely the Environment and Territory Dept., the Urban green, Parks and urban agriculture Dept., the ICT Dept., is needed, by establishing a permanent and formalised multi-department task force. Besides, a much deeper engagement of residents is unavoidable if we are to consider the entire territory in terms of ecosystem services, especially social and cultural benefits. In this sense, more informal participatory tools are needed to increase the sense of ownership beyond the pure rational arguments. The Municipality advanced in a project proposal (UIA 4th call on Land use and NBS) the setting up of a participatory GIS, that is, an enhanced interactive mask, based on the one already available, able to launch interactions (perception oriented) with engaged citizens and at the same time improve the Papp-UGB application including new functions and possibilities.
A relevant Eu-funded projects the city is carrying out point also to an integrated strategy: the LIFE project Veneto Adapt will lead 4 cities of Veneto central plain (Vicenza, Padova, Treviso, Venezia), basically an urban continuum (the so called *città diffusa* or disseminated city) with 3,5 Mln inhabitants, to the approval of their Action Plan for Climate and Energy (SECAP) by 2020.

The inter-municipal cooperation in the framework of Veneto Adapt, which will end in 2022, might also be the perfect ground to disseminate with peer-cities the activities and methodologies performed during the UGB project.

2.2 Lessons learned to upgrade the draft models to "make them smart" – What can be transferred?

Useful results and insight to be shared across the TWGs, potential integration of findings in Manual and the local roadmaps!

Based on your experiences gained from the pilot, please describe the combination of tools applied by you successfully, 1. within one model or from different (2 or even all 3) models which could be an ideal application of the tools tested in the pilots and to be described in the model as a result of the pilot actions. This text will be synthetized in the Pilot Synthesis Report and channeled to the Models and the Manual as adaptable good practice for other municipalities or authorities responsible for urban green management. (approx. 500 words)

1. Extensive territorial analysis (relevant results)
The rapid urbanisation in recent decades, together with the changes induced on planet's climate and urban mesoclimate, pose serious questions for the future sustainability of our living environments. If our final goal is to ensure the inhabitants of the city livable yet dynamic places, it is necessary to plan and implement properly instruments to tackle these issues in time. The green infrastructure, and in particular the "urban forest" constitute one of the most important components for the functioning of the city. Indeed, the urban forest provides a number of ecosystem benefits and services, including mitigation, the regulation of surface runoff, the increase in biodiversity, the improvement of the health and social well-being of the inhabitants.
Most of the environmental services provided by green infrastructures are directly linked to the tree component, in terms of number of individuals and leaf area or biomass, and of populations. No wonder that, to address these issues, many cities are carrying out ambitious "urban forestation" programs to increase this green asset. Although supported by excellent motivations, these programs are often lacking a comprehensive vision, and in particular, concerning the values to be pursued with the planting and management of tree populations. This also determines an inevitable difficulty in monitoring and assessing the effects of different urban forest planning and management scenarios.
2. Indicators set
The need for more sustainable methods of maintaining green areas, together with the challenge posed by climate change and the risks associated with it, requires that public administrations acquire better operational models. Specifically, we wanted to tools to increase planning, management and improving the decision-making processes of the public sector linked to urban green spaces, creating an integrated system of planning and management of green areas based on a series of indicators. We have therefore tried to identify indicators that could be used as decision tools in the sustainable design of urban green areas and implement policies aimed at improving or enhancing this component in a predictable way. The indicators can be grouped into three macro-categories that cover social, ecological and managerial dimensions. Before UGB, local urban planning was based solely on quantitative data set of public green spaces. In order to acquire these new data set, the GIS databse has been upgraded with new classes and functions.
3. Focus on agricultural spaces and organic cultivation
Urban agriculture is seen more and more as an asset in terms of global challenges, including urbanization, public health, food security and climate change. There is general agreement on its importance for local food production, in regulating green and blue water flows, organic waste flows and pollination as well as socio-cultural or recreational values. The available data, though, are not integrated in traditional urban green management, nor urban planning, posing a paradigmatic shift. Our choice to include this

very specific class of green areas in our pilot, is not only a direct consequence of the peculiar urban-rural fabric distinctive of the disseminated city (cited above) of Veneto (but in general Po river valley region). The city of Padova has a quite relevant agricultural component especially in its peri-urban fabric, bringing a high potential in terms of being a resilient city, taking advantage of its multi functionality.

4. Mobile Application

The development of a brand new application, configurable according to the profile of its user (being either a professional or an active citizen), provides the City administration with a tool with a huge potential impact, also in view of prospective activities (participatory GIS, for instance).