Promoting Sustainable Stewardship of Green Spaces in Venice:

Creating an interactive catalog to match people with land

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Abstract

This study cataloged 182 green spaces in the historic city of Venice, Italy. Data collected at each space includes location, accessibility, vegetation, amenities, land condition and photos. These spaces are categorized as parks, gardens, urban wilds, farmlands and courtyards. This in-depth data is aimed to help parties that want to use green spaces (residents, tourists, environmentalists, etc.) as well as stewardship organizations interested in their maintenance and possible reutilization. The resulting catalog is available to the public in the form of an interactive map, website, and booklet, all aimed to promote sustainable stewardship in the city.

Table of Contents

List of Figures

Authorship

Alana Miska was one of the main co-authors for this report. She focused on learning GIS methods and mechanisms to collect/display map data. She also worked on editing and formatting proposal flow, and contributed to each of the writing sections.

Margot Schassler was one of the main co-authors for this report. She researched relevant studies, located many green spaces, and created graphics for the project. Margot was also a main point of contact for our sponsor We Are Here Venice. She edited and contributed to each section of the paper and booklet.

Hope Hutchinson was one of the main co-authors for this report. She focused on learning how to use the website builder WIX to develop the interactive catalog of green spaces and creating the green space ownership form. Hope also edited and contributed to each section of the paper.

Michael Rideout was one of the main co-authors for this report. He focused on learning to control a drone to capture images to be used in the catalog of green spaces. He also contributed to editing and writing all sections of the paper, and to the WIX site.

All group members contributed equally to the construction of this report, and to bring this project to fruition.

Acknowledgements

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Professor Fabio Carrera and **Professor William Michalson** for their guidance and assistance throughout the project.

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We would also like to thank **Michele Savorgnano** and **Piero Toffolo** for their contributions to the project.

1. Introduction

Venice, Italy is well known for its canals and historic architecture but not known for its vibrant green spaces, which are scattered throughout the city in the form of public parks, gardens, urban wilds, farmlands, and courtyards. Many of these spaces are frequently used and well-maintained, while others are overlooked and overgrown. Finding seclusion from dense, bustling urban centers—such as the historic city (Cittá Storica) of Venice—is important for human wellness. Natural landscapes are also essential for preserving ecosystems and can help to combat climate change. Venice has a unique relationship with the environment, as it is a complex puzzle of land and water that hangs in delicate balance. Remarkably, thorough information about green spaces in Venice is not readily accessible to the general public. Furthermore, lack of knowledge about these spaces can inhibit sustainable land stewardship. A public archive could contribute significantly to sustainability efforts as well as provide support to green initiative organizations and Venetians alike.

There are many Venetian organizations currently working towards sustainability and environmental improvements for the city. One such organization is We Are Here Venice, a non-profit association that advocates for evidence-based policy changes relating to the social and environmental challenges faced by Venice and its residents. This organization collaborates with universities, businesses, and other institutions to complete research-based projects that leave lasting impacts on the city. Some of their recent projects include advocating against cruise ships, and increasing awareness of over-tourism and the housing strain on Venetians. Our team is working with We Are Here Venice to assist their sustainability efforts and provide a method to produce a public archive of green spaces.

Some information databases on green spaces in Venice have been compiled, including research conducted by a previous IQP team in 2017 at the Venice Project Center (Drewniak, Entov, McNamara & Wang, 2017). This team collected information—such as land type, condition, and reutilization recommendation—about green spaces on the island of Giudecca. These spaces were then mapped in QGIS and overlaid onto an interactive Google Map. This team collaborated with Michele Savorgnano, a local farmer and activist. He has since added to this team's data by mapping some green spaces on the main island. The scope of our project is to reach more green spaces on the main island as well as collect more detailed information on green

spaces that were previously mapped in the Cittá Storica. We plan to design a new resource platform, in the form of a website, that will be composed of detailed information on green spaces of all types. The website will be easy to access, update, and expand upon, all in order to advance the movement towards a greener and more sustainable Venice.

In collaboration with We Are Here Venice, the goal of our project is to promote a more sustainable city by creating a catalog of green spaces and providing Venetians with informational resources to access this data. To meet our goal, we have identified the following objectives:

1. Inventory and categorize green spaces into an interactive catalog.
2. Promote sustainable stewardship through the dissemination of knowledge.
3. Develop a mechanism to match green spaces with potential stewards.

A public green space database will provide residents with an informational platform to encourage land stewardship and a greater appreciation of green spaces to protect the natural heritage of Venice.

2. Background

This chapter begins by addressing the need for healthy green spaces in urban settings. We cover the concept of sustainability efforts in Venice and describe the importance of green space knowledge exchange. We also discuss examples of existing green spaces in Venice and clarify how each green space category is defined. Finally, we will go over past studies and existing green space databases in Venice and their uses.

2.1 Using green spaces to heal the environment

Studies show that maintaining green spaces in urban settings greatly benefits the environment. A study in China's capital city, Beijing, validated this idea through the collection and analysis of carbon values in the city. Above ground carbon levels were measured from breast height and tree height in 326 survey plots throughout the city. It was determined from this study that city areas with a higher percentage of green spaces have a lower carbon density, suggesting that the growth of green spaces in cities may help to combat climate change (Sun et al. 2019).

It is important that green spaces are preserved to best serve the ecosystem and environment as a whole.

In addition to these environmental implications, green spaces are vital for the physical and mental wellness of humans. The World Health Organization recommends a minimum of 9 m^2 of accessible green space per person in any given area (Russo & Cirella, 2018). This international standard reflects research conducted to explore the relationship between green space availability and human health. A green value can be calculated for an area by dividing the total amount of accessible green land area by the population of that area. For spaces that fall below this international standard of 9 m^2, there is said to be a green deficit.

Given the lack of natural landscapes in urban centers, it is important to increase public awareness of existing spaces to better preserve them. To accomplish this, there is a need for a centralized comprehensive database that outlines information on the quantity and quality of existing urban greens. Only with the availability of this data will preservation and reutilization efforts become feasible.

2.2 Venetian lagoon environment

There are more than one hundred islands throughout the Venetian lagoon, which is split into six governing municipalities. Venice is the capital of the northeastern Italian region of Veneto, and is home to about 259,000 people (Comune di Venezia, 2021). These six municipalities are sectioned into three main sections as shown in **Figure 1**: Terraferma, Cittá Storica, and Estuario. For the purpose of our project, we are focusing on the Cittá Storica. Emphasis was placed on completing the sestiere of Castello, as it contains the greatest abundance of green space.

Figure 1: The Terraferma, Cittá Storica, and Estuario regions of Venice.

The historic center, or Cittá Storica, is a collection of islands approximately three kilometers off the coast of the Venetian mainland. This area is a major hub for art, culture, architecture, history, landmarks, and tourism in the city of Venice. Approximately 50,000 Venetians reside in the historic center of the city (Comune di Venezia, 2021). The Grand Canal snakes through the region and splits it in half, while the network of smaller canals divide the space up even further. The Cittá Storica contains six burrows, or sestiere, as shown in **Figure 2**: Castello, Cannaregio, San Marco, San Polo, Dorsoduro, and Santa Croce. A few of the most prominent green spaces in the Cittá Storica include the Giardini Della Biennale, Giardini Papadopoli, and Parco Savorgnan.

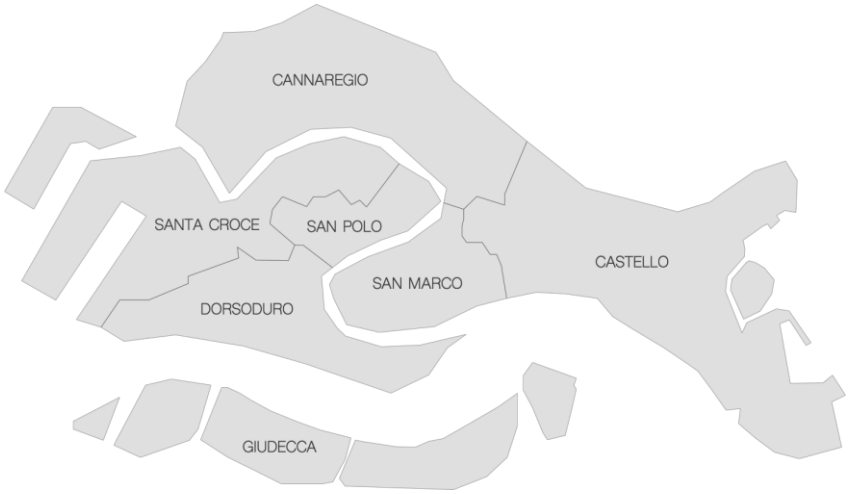

Figure 2. The mapped sestieri of the historic city.

The open land of Venice across its islands has inherent value as a stakeholder in this project. These areas contain habitats and ecological systems that house many species and contribute to the global preservation of biodiversity. Increasing green space accessibility to humans also ensures the vitality of the green spaces and that of its natural occupants.

2.3 Partners for a sustainable and green Venice

Sustainability is a critical topic for Venice, given its unique environment and dense population. It is important to protect green spaces to offset the man-made structures in the city. To that end, We Are Here Venice is working to foster a more sustainable urban environment. Sustainability efforts previously completed in the city include *A Greener Venice*, which created a map of Giudecca in 2017 and identified reutilization opportunities that could optimize existing green spaces on the island. This project was adapted and continued by this project group's sponsor, *Fattoria Urbana Diffusa*, as the Urban Widespread Garden map project, which expanded upon the 2017 project to include other spaces throughout Venice (Drewniak et al., 2017). While many new spaces have been added, there is still much to be done: spaces added after the completion of the 2017 project are missing large amounts of information, such as type of green space, land condition, accessibility, and more. Additionally, many more green spaces that can be seen on the satellite images on Google Earth have yet to be mapped.

2.4 Urban green spaces

An urban green space is a planned or unplanned urban area where vegetation can grow. When mapping urban green space, it can be easy to overlook small-scale or mixed-use areas as functional green spaces. Here, we outline the range of lands that will be categorized as green space for the purposes of our project.

Farmland and agriculture

Farming is an important industry in Venice, but farmland is threatened by climate change and other encroachment issues. For example, water levels are rising, causing intense flooding. Flooding is a well known issue that has caused much damage to architecture throughout the city, but its damage to agriculture is lesser known. Rising sea levels result in contamination of groundwater by lagoon water, affecting the health and productivity of Venice's farmland (Da Lio, C., et al., 2015). One process that may aid in the preservation of these farmlands is documenting existing areas and identifying opportunities for other green spaces to be repurposed into farmlands. **Figure 3** shows the Vineyard and Farm of Sant'Elena in the sestiere of Castello.

Figure 3. View of the Vineyard and Farm of Sant'Elena

Urban Wilds

An urban wild can be defined as a piece of natural land in an urban context that is not formally maintained. Parcels of lands like this can be found in just about any city. For example, abandoned lots or green spaces on the edge of highways could be considered urban wilds. They are usually small, natural habitats that can support a large variety of spontaneous vegetation and

wildlife. There are many different perspectives in which these plots of land can be viewed. Often, the aesthetics of these unmaintained spaces are portrayed in a negative light due to their often messy and neglected appearance. Their existence may also be seen as threatening to city dwellers because of an uncontrolled notion of "wilderness" (Del Tredici & Rueb, 2017). Nature enthusiasts might see this "wilderness" in a positive light, as they often appreciate spontaneous and unrestrained vegetation. For the purposes of this project, urban wilds are seen as a source of potential reutilization. These are natural green spaces that can be reutilized to cater to the needs of the city in a sustainable manner. For example, an urban wild with proper soil can be repurposed as farmland or a garden. One such space is located behind Basilica di San Pietro di Castello, as shown in **Figure 4**.

Figure 4. View of the urban wild located behind Basilica di San Pietro di Castello.

Parks

Urban and residential parks are most easily identified as well-kept, outdoor public recreational areas. These lands tend to include open, flat, grassy areas with interspersed vegetation, such as trees, and can be natural, semi-natural, or planted. Some parks also contain dirt or paved walking paths and manmade structures set aside for specific uses, such as restrooms, picnic tables, gazebos, and spots or playground equipment. There can also be micro-parks, known as parklets, which offer small respite from surrounding urban spaces. Most parks are available to the public for recreational use and tend to be well documented on

Figure 5. View of Parco delle Rimembranze

city maps. Aside from the well-known Parco Savorgnan and Parco delle Rimembranze, seen in **Figure 5**, parkland in Venice is scarce.

Gardens

Gardens include land set aside for the planned cultivation of vegetation such as flowers, shrubs, vegetables, and fruit. These areas can be private or public and may include raised and/or enclosed beds for vegetation. Gardens can serve a variety of purposes in urban settings; They can act as food sources, give solace from city life, provide habitats and food-sources to support biodiversity, and can be aesthetically pleasing. Gardens differ from farmland in various ways including how they can be used for food security, artistic expression, public venues, and pollinator habitats. One such garden is located within Chiesa di Sant'Elena, shown in **Figure 6**.

Figure 6. View of Chiesa di Sant'Elena garden

Courtyards

Courtyards are green spaces in which vegetation is incorporated in a planned architectural design. These spaces often belong to a specific building, for which they were designed. Many are found on private property for use by residents of the surrounding buildings but public courtyards also exist. These spaces may be used in a similar capacity as a park or a garden but their purpose is less formally defined. **Figure 7** depicts the courtyard of Chiesa di San Francesco.

Figure 7. View of Chiesa di San Francesco

2.5 Learning from previous studies

A Greener Venice, which was completed by a WPI project team in 2017, provides us with an excellent case study for methods to use in Venice, seeing as our goals are very similar to theirs. The primary difference between this previous project and our project is location. While the 2017 team focused on Giudecca, we prioritized green spaces in the Cittá Storica, specifically Castello. The strategies used to map green spaces in Venice through *A Greener Venice* were effective and resulted in a green space map of the island. The diagrams created through this 2017 project were easy to understand and indicated how simple it would be to improve the amount of green space in Venice by transforming urban wild areas into spaces like parks. Another way we can learn from the 2017 project is by studying their methodology. The previous team used a drone to survey Green Spaces from above, and they analyzed important facets of the spaces including soil quality, health and safety, and upkeep, among other things (Drewniak et al. 2017).

This project provides many useful recommendations for future projects that may be similar. We learned from their successes and failures, and will use recommendations to craft our own methodology. We added to their data map with more recorded green spaces and included greater detail for each green space as well as made this data accessible to Venetians through our Wix website containing the green space catalog.

In 2015, several organizations located throughout Europe developed an outline for green space assessment using GIS software (RSA iSPACE, et al., 2015). The methodologies outlined in the paper have been used globally for green space assessment with valuable results. The paper outlines five main pillars to consider when developing data collection strategies: maintenance, sustainability, attractiveness, profitability, and fair supply. Within each pillar, there are several possible indicators that can be analyzed. For example, under maintenance, one may wish to research the age of objects within the green space, number of plant classes per area, soil condition, etc. Key indicators for each pillar are listed as: effort of maintenance (maintenance), fulfillment of ecological functions (sustainability), recreational value (attractiveness), capitalisation potential, and fair supply (fair supply). The paper recognizes that different combinations of relevant key indicators and pillars are necessary depending on the type of green space and purpose of the research.

Another section of the paper outlines the overall process of data collection for green spaces in a standardized implementation workflow. First, current data and what data is missing must be identified. Next, GIS programming and indicator calculations should be mapped out. Finally, web maps and databases should be created with the collected data. The paper also recognizes that the starting point and specific goals of the target groups will likely differ between projects.

Existing Databases

Information on the green spaces of Venice is currently available - to an extent. The Comune di Venezia website offers a map (https://geoportale.comune.venezia.it/Html5Viewer/index.html?viewer=geourbanistica.geourbanistica&LOCALE=IT-it) that includes many green spaces within the city (Comune di Venezia, 2021). However, this database is not comprehensive. Another data platform is the Conoscere Venezia website (Conoscere Venezia, 2021). This site offers a map (https://www.conoscerevenezia.it/?p=40997) of most of the public and private green spaces in the city. This is another helpful option, but again, not every green space in the city is on the map. In addition, the information included about the spaces is limited. It's important to know more about the quality of each space. As another guide, ItaliaKids.com is a resource that provides a number of family-oriented activities across Italy (ItaliaKids, 2017). One of the features of their website is the "Parks and Playgrounds" section (https://www.italiakids.com/venice/parks-and-playgrounds/), which allows the user to select a city and subsequently find a list of parks in the area. Once again, the accessible information on this website is limited.

3. Methodology

In collaboration with We Are Here Venice, we intend to provide Venetians with informational resources about the city's green spaces to promote sustainable stewardship. The objectives we will pursue to achieve this goal include:

1. To inventory and categorize green spaces into an interactive catalog
2. To promote sustainable stewardship through the dissemination of knowledge
3. To develop a mechanism to match green spaces with potential stewards

The details of our methodology strategies are outlined below.

3.1 Inventory and categorize green spaces

The first step of this process is to locate green spaces. This involves the analysis of three main resources in order to form our list of spaces: Google Maps, Conoscere Venezia, and the geoPortale on the Comune di Venezia website. Google Maps provides a birds-eye view of Venice from above, allowing us to spot green spaces easily. Conoscere Venezia and the geoPortale offer maps of Venice with some pinpoints/mapped areas of green spaces. The combination of these three resources helps us to create a comprehensive list of spaces, which we display on our own Google Map using coordinates. Once these spaces are pinpointed on our Google Map, we are ready to head out into the field.

After locating each green space on the map, the next step is to visit green spaces and survey them using a Google Form, as shown in **Appendix A**. When creating the Google Form, we considered multiple perspectives that our catalog could be viewed from: artists & architects, residents & tourists, environmentalists & stewards, and farmers & gardeners. We determined that all stakeholder groups would find the following data categories useful: land type, accessibility, land condition, location, water supply, restrooms, covered structures and photos. We then considered the individual interests of each stakeholder. As shown in **Figure 8**, we created a mind map to visualize these interests, which are all included in our Google Form.

Figure 8. Mind map of groups that may be interested in green spaces and the attributes they would likely look for.

Upon filling out our form for the individual green spaces, we categorized each into different categories of land type, as this is an important tool to help stewards quickly find what kind of green space they are looking for. **Figure 9** depicts an example of each land type category.

Figure 9. Green space land type classifications.

Spaces were then grouped based on three types of accessibility: no access, limited access, and full access. No access green spaces are completely inaccessible to the public. Limited access green spaces could be accessed depending on certain criteria. For example, time of day, time of year, or permission. Full access spaces are easily accessible to the public, at all times. **Figure 10** describes these accessibility types and includes examples of each.

Figure 10. Green space accessibility descriptions and examples.

Next, we classify land condition. The Google Form will ask the team to rank the maintenance, litter and aesthetics on a scale from one (poor) to five (outstanding). We will use these three individual ratings to calculate a rating for the overall land condition. This is done by adding together the rating score (one to five) from each of the subcategories, and defining a range for this total number to coordinate to an overall ranking. The rubric to define each rating score, as well as the ranges that correspond to the total land condition result, is shown in **Appendix B**. This rubric also includes photographic examples of each overall ranking category. Land type, accessibility, and land condition are the three most important characteristics for green space stakeholders to consider as they help to determine when the spaces can be visited, who can visit them, why one may want to visit, and which spaces have the most potential for reutilization.

The latitude and longitude of the space was also recorded in the Google Form using a Mercator projection based on the World Geodetic System (WGS) 1984 geographic coordinate system (datum). This data was used to correspond to our Green Space Tracking Google Map, and helped coordinate the addition of polygons into ArcGIS.

Vegetation data that we collected includes the percentage of the total area of coverage for each category: trees, shrubs and flowers, grass, weeds, barren, and walkways. This question was designed as a checkbox matrix in the form and also includes whether the vegetation is potted or unpotted. The percentage for trees is an estimate of canopy coverage, as determined from direct observation in the field as well as Google Maps referencing. The percent ranges found in the form are 0%, 1-20%, 21-40%, 41-60%, 61-80%, and 81-100%. A list of most of the species present will also be included with the help of the plant identification app PictureThis.

One field form will be filled out per green space with at least two team members filling it out together. Once field data is collected for each green space, we will incorporate that data into a map using ArcGIS software. We will first draw each green space as a polygon in the ArcGIS layer. Once this step is complete, we input the green space ID, exactly matching the ID in the Google Form, into the attribute table. The final Google Sheet can be connected to the attribute table, with the connecting factor being the space ID, resulting in the complete data catalog added in the ArcGIS layer attribute table. This will result in a map that can be integrated with a Google Map that lets the viewer look at the overall green space offerings in Venice, click on any of the polygons, and the entire catalog entry for that space will be listed.

3.2 Promote sustainable stewardship through the dissemination of knowledge

To develop and promote sustainable stewardship, we organized the green space information into an interactive website-based catalog. The goal of this platform is to provide a resource for the general public to access information on green spaces in Venice, facilitating the dissemination of urban park information to residents and visitors to Venice.

We used the free website builder WIX to create our platform. On WIX, we created a page for each green space, which includes all of the information obtained via our land surveying Google Form. Additionally, these pages are accessible through results of the search bar and the interactive Google Map, both of which are embedded onto the website Home page, which is visualized in **Figure 11** below:

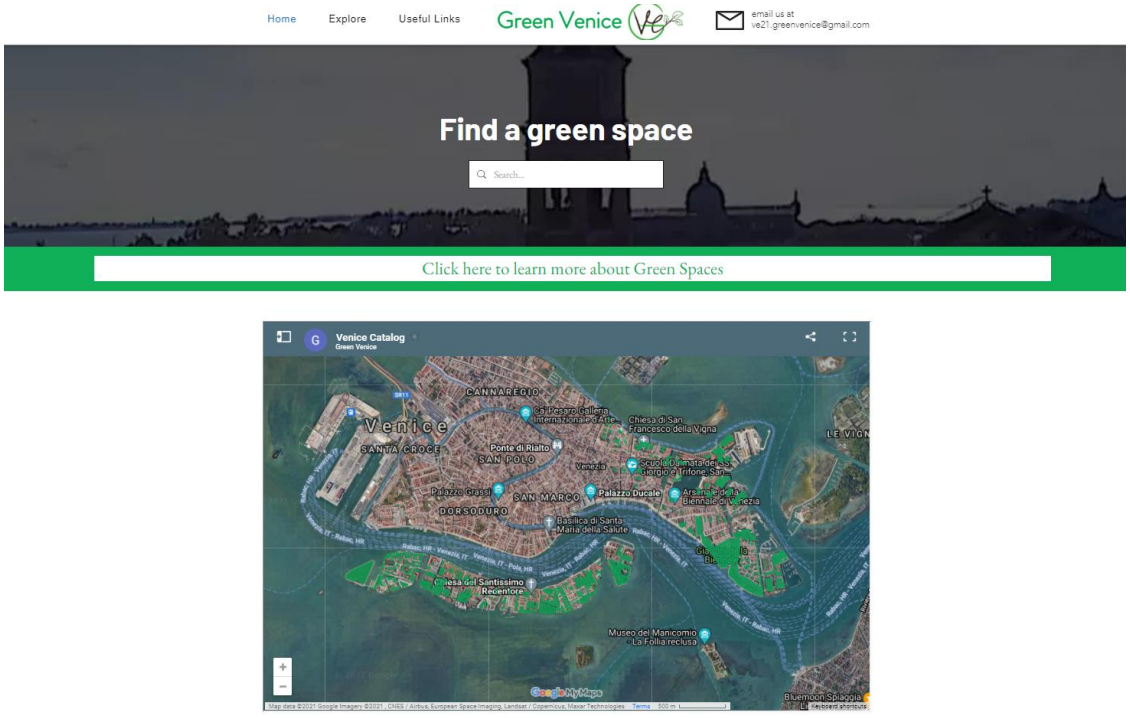

Figure 11. Wix website Home page.

On the Home page, both the search bar and interactive Google Map act as tools to aid in the matching of potential stewards to available green space. Users can type a keyword, phrase, or green space name into the search bar, which populates a results page with all site entries relating to the entered search term. For example, a farmer looking for areas containing fruit trees may use ‘persimmon’ as a search term, which brings up all green spaces that have persimmon trees

recorded. This search bar can also serve other stakeholder groups, as they may wish to search for other characteristics of interest to them. For example, tourists with small children may search ‘playground’ to find green spaces for which a playground was recorded.

The interactive map embedded onto the Home Page allows users to browse all of the mapped green spaces in reference to their exact location. Users can drag and zoom in on the map right from the Home Page as well as click on spaces they may be interested in to see the attribute table containing all of the entered data for that space. If the user wishes to see the full catalog entry for that space, they type the name or the green space ID into the search bar to easily navigate to this page. As shown in **Figure 11**, the header for each page also includes a menu, with options such as Home, Explore, and Useful Links, each of which will allow the user to navigate to different portions of the site.

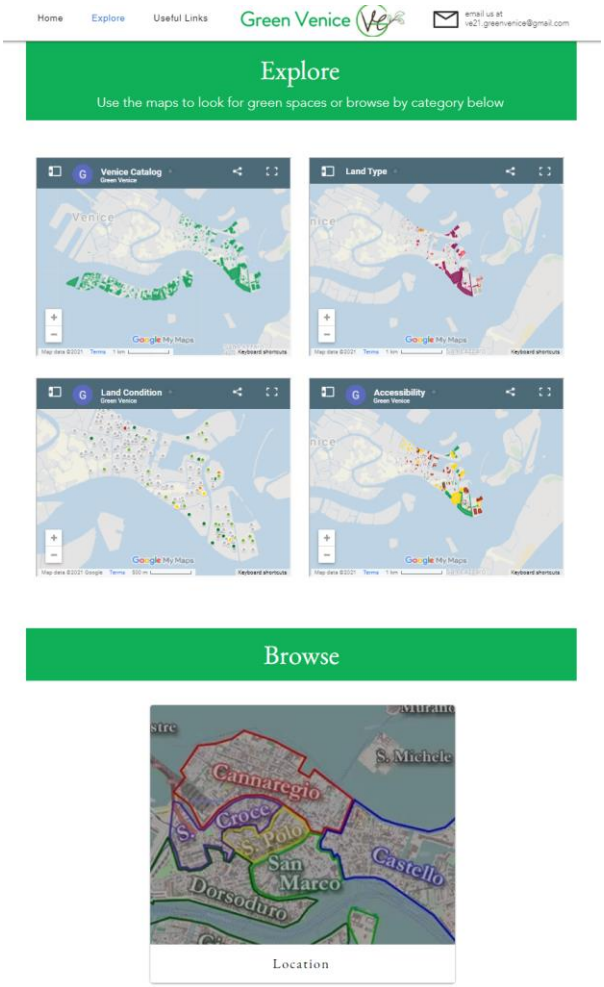

Figure 12. Wix website Explore page.

The Explore page, shown in **Figure 12**, features four versions of our Google Map, displaying different filter layers of our map. The four layers displayed here are the full green space map as well as maps by land type, land condition, and accessibility. There is also an option to browse by location, which redirects the user to our location page when clicked. This location page lists the sestieri in the Cittá Storica as well as the island of Giudecca. Only the Castello and Giudecca pages contain data, although all pages have been created and formatted for easy expansion as more project groups collect data. Clicking on a sestiere or island on this page will bring the user to the full data collection for that location. A screenshot of the Castello collection is shown in **Figure 13** below:

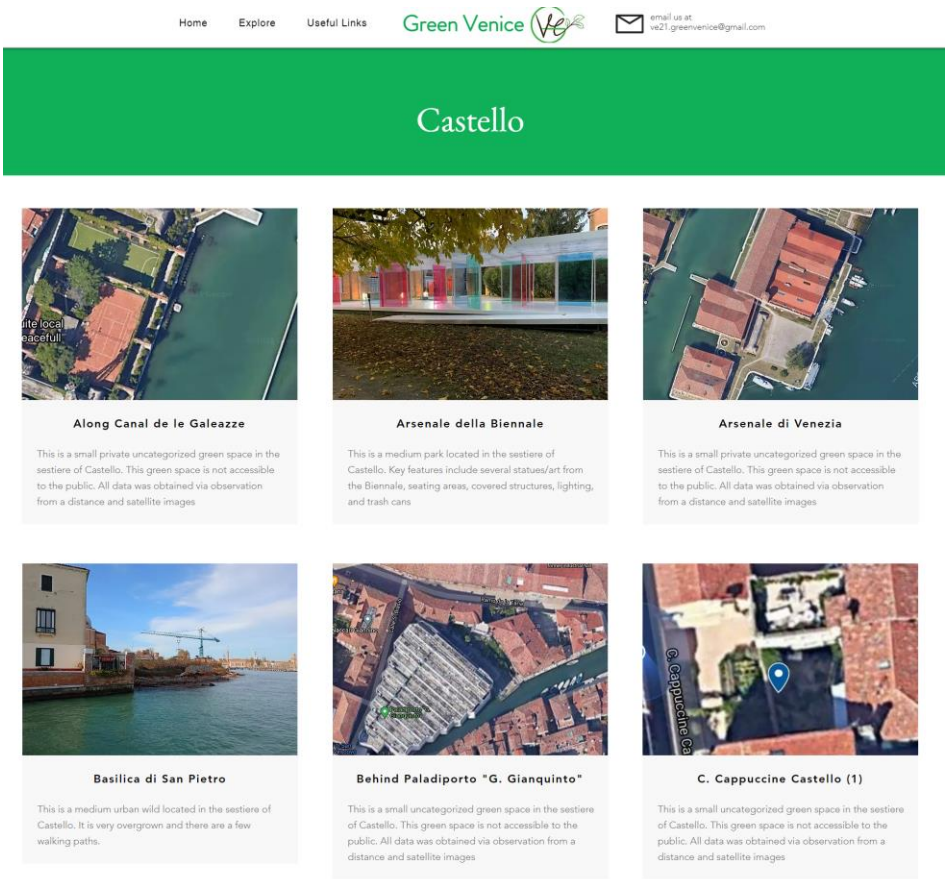

Figure 13. Wix website Castello collection

The collection page for each sestieri contains a preview of each green space surveyed in that area. Each green space has a cover image, name and short description as a preview. If a user would like to learn more about a space, they may simply click on the green space name and the

page will redirect to the full entry for that space. An example of a full green space entry is shown in **Appendix C** and contains all of the collected data for that space.

3.3 Developing a mechanism to match green spaces to stewards

The final aim of this project is to connect potential stewards with underutilized green spaces. There are many organizations which exist with the purpose of creating a more sustainable Venice that could benefit from gaining access to green space opportunities, one of which is our sponsor We Are Here Venice. Our website offers a feature that is able to match environmental organizations in search of green spaces with specific land areas that could satisfy their needs. As previously mentioned, the Home page of our website presents a search bar. Interested participants can enter any information that they are looking for in a green space, including location/sestiere, type of space (urban wild, courtyard, etc.), size (small, medium, or large), and land condition (poor, fair, good, great, or outstanding). For example, steward organizations that are looking for green spaces in need of revitalization can use this search bar feature to discover areas with lower land condition rankings. Searching this information leads participants to a results page consisting of the spaces that match the given characteristics. Clicking on one of these spaces then brings you to that space's own website page, which includes all the information our team has collected on that specific land area.

This new accessibility of green space information permits the creation of a more sustainable Venice. This is vital because it provides a method for improved stewardship and protection of the natural heritage of Venice. Green spaces are also essential for the health of Venetian residents and the strength of the community overall. A catalog platform will increase public awareness of available verdant areas, encourage a more sustainable city, and provide a greater appreciation of urban green spaces in Venice. The availability of this matching feature will pipeline the efforts of relevant environmental groups, and consequently the development of a greener Venice.

4. Results

At the completion of this study, the entirety of the sestiere of Castello was surveyed. This data consists of 182 total green spaces in the Castello region. We found 27 parks, 32 gardens, 8 urban wilds, 2 farmlands and 6 courtyards. The remaining 107 spaces could not be categorized due to lack of accessibility. The map visually distinguishing the green spaces by land type is shown in **Figure 14**.

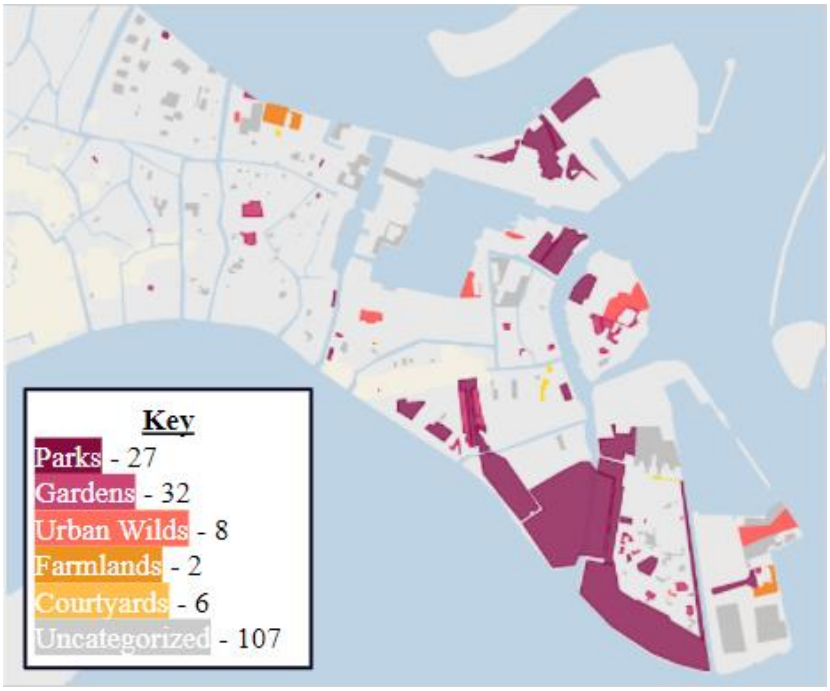

Figure 14. Castello green spaces mapped by land type.

Figure 15 shows the percentage of green space area comprised by each land type category. Parks made up the overwhelming majority of land area at 80.9%, or 194,000 m². It is important to note that urban wilds come in as the second largest proportion at 7.7%, or 18,400 m². This is a significant amount of land with great reutilization potential.

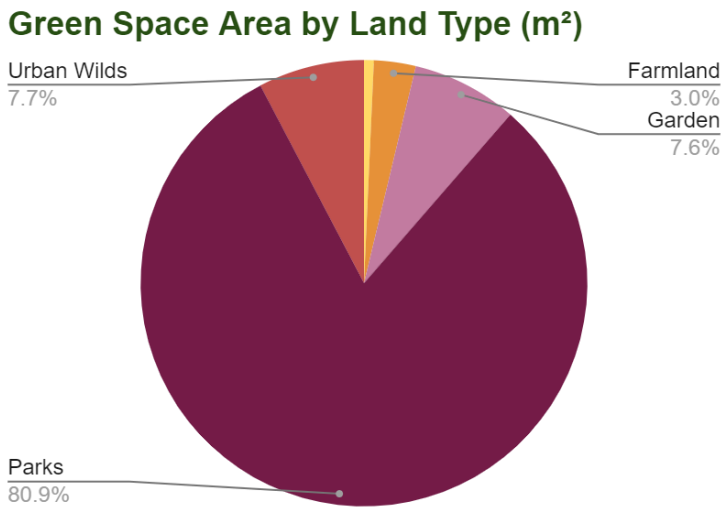

Figure 15. Percentage of each green space type in Castello (by area).

Each green space was also mapped by land condition. We found 2 poor, 2 fair, 5 great, 23 great and 13 outstanding spaces, based on our rubric as previously referenced in **Appendix B**. The map of Castello green spaces by land condition is shown in **Figure 16**.

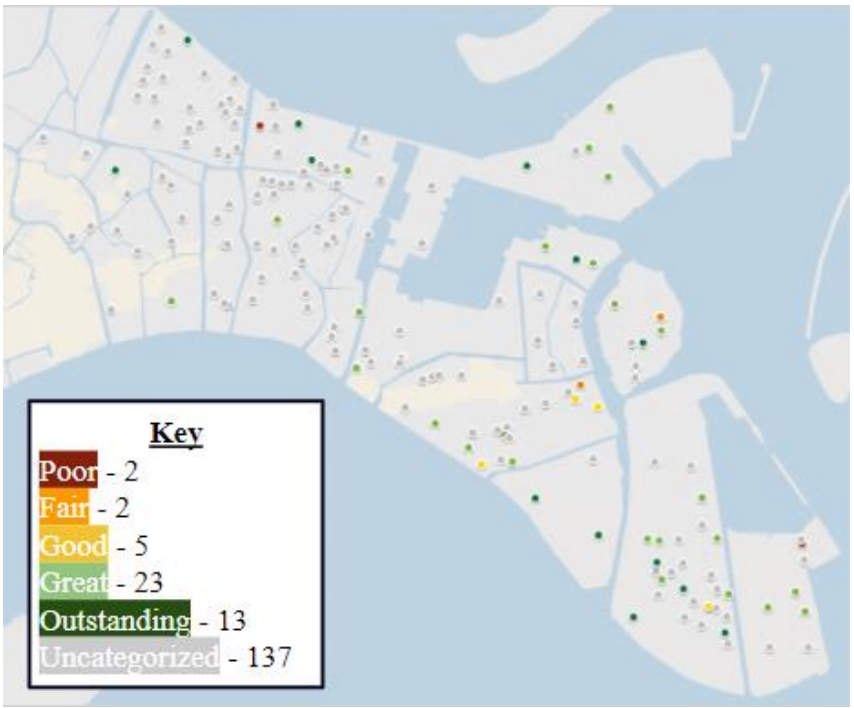

Figure 16. Castello mapped by land condition.

Finally, we mapped each green space by accessibility. We found 22 full access, 44 limited access, and 116 no access spaces. While there is a far larger number of no access green

spaces, they only make up 28% of the green space area in Castello. The map of the spaces by accessibility is shown in **Figure 17**.

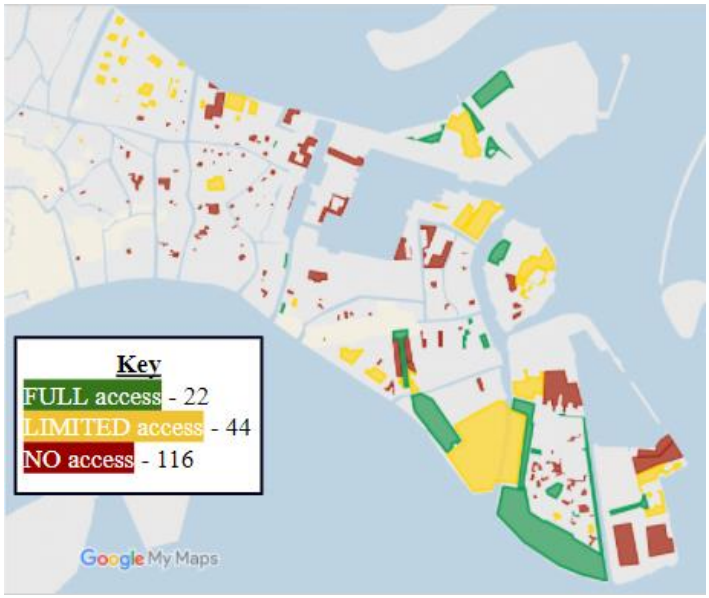

Figure 17. Castello mapped by accessibility.

The detailed data on each space collected, using our Google Form, was organized in a Google Sheet and transferred to the ArcGIS attribute table associated with the polygons for each corresponding green space. The finalized ArcGIS layer was overlaid on a Google Map and added to our Google and Wix websites for easy catalog navigation. The raw data was also formatted and added to the Wix site. As a result, the site contains a page for each green space surveyed, including the data collected on Giudecca in 2017. Overall, the website acts as a complete interactive online catalog of the green spaces we mapped. It is easily navigable and has multiple ways for users to discover and locate specific spaces: location, land type, size, or land condition. In addition, there is a search bar on the home page which allows users to locate keywords on the website. So again, if a user wanted to find green spaces with, for example, persimmon trees, they would need only to search the word persimmon and all pages containing that word would appear. An example of a full page on the website is shown in **Appendix C**, and an image of the full home page is shown in **Appendix D**.

In addition to the online databases, we developed a printed catalog that outlines all of the green space data. This is a landscape, A4 booklet, designed using Google Slides, that is also

accessible from our Google website. Example formatting of pages from the booklet are shown in **Appendix E**.

We also developed several statistics on the green deficit of Venice. The World Health Organization recommends at least 9 m^2 of green space per person in any given area. We calculated, based on the residential population of Castello and the total fully accessible area of green space in it, a total of 8.8 m^2 of green space available per resident. This means there is a green deficit of 0.2 m^2 of green space per resident; however, these calculations do not take into account the population including tourists, which is approximately double that of the residential population alone. This results in a green deficit of 4.6 m^2 per person. This calculation, as well as the rest of this green deficit analysis, can be found in **Appendix F.**

Castello contains many of the large parks in Venice, which implies that the green deficit in this sestiere may not stay consistent throughout the rest of the historic city. Since all of the largest parks in Castello are at the eastern end of the sestiere, we also performed a green deficit analysis on Castello Ovest because it better represents the distribution of green spaces found in the rest of the historic city. A map of Castello Ovest can be seen in **Figure 18**. Since there are only two fully accessible spaces in Castello Ovest, there is only about 0.1 m^2 of green space per resident (not including tourists).

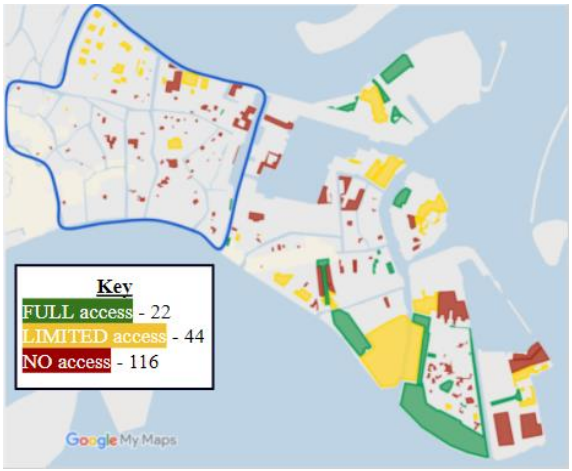

Figure 18. Map of Castello by Accessibility, with Castello Ovest highlighted in blue. (Green - fully accessible, yellow - limited accessibility, red - no access)

When considering all of the green space in Castello Ovest, regardless of accessibility, there is only 5.7 m^2 of green space per resident. This means that there is not enough green space

present in this section of the city to reach the recommendation of 9 m^2. However, given the nature of the city, it would be very difficult to add to the green space availability, so it is very important that the green spaces currently available are used to their highest potential and opened to the public, in order to improve the quality of life for residents.

5. Recommendations

5.1 Advice for future endeavors

There are several additional details that our team would recommend implementing in the pursuit of similar projects in the future. Primarily, we would recommend following a similar locate first, survey second methodology to complete surveying the Cittá Storica and the rest of the Venetian island. It would also make sense to continue breaking down the data collection by sestiere. For those looking to follow our direct methodology, we created a document detailing how we mapped spaces using ArcGIS in **Appendix G**, and instructions for how to use the WIX website can be found on our Google Site (https://sites.google.com/view/greenvenice/files?authuser=0). Another way to carry on with the efforts of our team would be to survey the green spaces on the island of Giudecca with our updated Google Form and surveying process. This would increase the level of detail of the data that we currently have in our database regarding these spaces.

In addition to continuing the surveying process, there are a few other types of data that we decided may also be useful to collect at each space. First, providing soil quality information by collecting soil samples would greatly assist stewards looking for green spaces. Some steward organizations are in search of potential farmlands to utilize; having this data available will reveal which land areas are the most pertinent. Similarly, outlining the air pollution levels of each individual space would be a key feature of this endeavor. One of the most impactful elements of green spaces is their contrast from the characteristics of urban life. Having a numerical value of air quality to associate with a space will aid future land users in their green space exploration. Related to this concept, noise pollution has very similar applications for finding seclusion from hectic city centers. The inclusion of these green space elements in future research would contribute to the success of the overall cause.

Other useful data that could be collected includes space owners' contact and collaboration information. Making this information publicly available would allow stewards to connect with privately owned land. Our team developed a second Google Form survey for land owners but, due to time constraints, IRB approval was not obtained and therefore the survey was not implemented. This form was meant to be filled out independently by land owners that are

willing to participate or by the team members in an interview format. The form opens up to the first section, which includes information about our team, our project, and our sponsor. The next section begins with a disclaimer outlining the contents of the survey and the intentions with which the data is being collected. Question 1 asks if the green space owner is willing to share their contact information with the public and explains that if they answer yes, the contact information they provide below will be displayed on our catalog website. Next, we ask for the name of the land owner and/or organization with which the green space is associated. Question 3 asks for the telephone number the owner would like to provide, given that they answered yes to Question 1. Question 4 asks for the email address to be shared, given that they answered yes to Question 1. Question 5 provides a long answer text box to answer how the green space is currently being used. Questions 6 and 7 ask for the frequency of maintenance and any goal or future plans for the green space, respectively. Question 8 asks if they would be open to collaborating with others for reutilization and/or maintenance efforts of the green space. Checkbox answers for this question include "YES - I am currently collaborating on this space", "YES - I would be open to collaborating on this space", "MAYBE - I may be open to collaborating on this space", "NO - I would prefer not to collaborate", "NO - I do not feel there is a need to collaborate", and "Other", where the owner may type their own response to the question. Question 9 asks if the owner has any questions regarding our group, our project, or our sponsor, which we can reply to via email or through contact with We are here Venice. Finally, Question 10 asks the owner to type their name to confirm that the responses provided are accurate and reminds them that in providing this e-signature they are also agreeing to the terms described in the DISCLAIMER. All questions will be provided to land owners in both English and Italian (as translated by So Young Han from We are here Venice) to allow for full comprehension of the material. The form questions, as described above, are listed in **Appendix H**.

Another way to continue this project in the future would be revisiting some of the private mapped spaces with the intention of getting in contact with the owners and gathering more information about the spaces. There are a large number of private areas which we could not collect any data on other than location. Since these private spaces make up a large portion of the catalog, this would be a significant improvement on the extent of the data collected from the project.

Another important thing to remember about this project is the methodology - it is important to have it extremely well-defined, so you know exactly how to map each green space. Make sure the methodology is exactly what it needs to be before starting the process of mapping, because having to change it later will become more difficult. Make the entire process as smooth as possible - in our case, we created and used a detailed Google Form to enter data, which was sent to a spreadsheet, reformatted with excel functions, and then manually copied over to our Wix site. Streamlined processes like these where the computer does as much work as possible will save time. Our Google Form has been used enough times that we've been able to work out the problems, so we would recommend using it to grow the database of surveyed spaces. Also, different spaces take different amounts of time, and while it is possible to map 2 or 3 large spaces in a work day, it's also possible to find over 15 small ones. So, plan accordingly, and use resources such as Google Maps satellite view and Conoscere Venezia to identify groups of green spaces to map together in one day. Field work takes time, so it's important to avoid having to revisit areas.

Finally, since there are many places to focus on in the future for this project, it is useful to know whether or not buying a drone would be a good idea for future groups. In our project, we focused both on some large spaces, which took a lot of time, and some small spaces, which we were able to map large quantities of in a day. For a group which is more focused on individual spaces, the drone is a powerful asset, because it allows the users to see the space as a whole, and get great photos of it for the website. However, not every space is a "drone friendly" one - it's probably not a good idea to fly it around places like Rimembranze, where there are lots of people. Unfortunately, this describes many of the larger spaces in Venice, and since the drone isn't useful in mapping many small spaces either, it's probably best to only get a drone for groups which plan on looking closely at large, open spaces, and which really think they could benefit from it.

5.2 Potential stewardship reutilization

As we surveyed the many green spaces in Castello, there were a few spaces in particular that we noticed to have a high potential for reutilization. We would like to recommend these spaces to local stewards such that they may be used to benefit the Venetian community.

The first space that we would like to recommend for reutilization is an urban wild located on the island of San Pietro known as Campazzo San Pietro. This is a large urban wild that covers approximately 6,500 m^2 and is accessible by land through Basilica di San Pietro di Castello and by water along the coast by the San Pietro di Castello boat stop. **Figures 19** and **20** show images of the green space, and an outline of the space on a map, respectively.

Figure 19. Photos of the urban wild located behind Basilica di San Pietro di Castello.

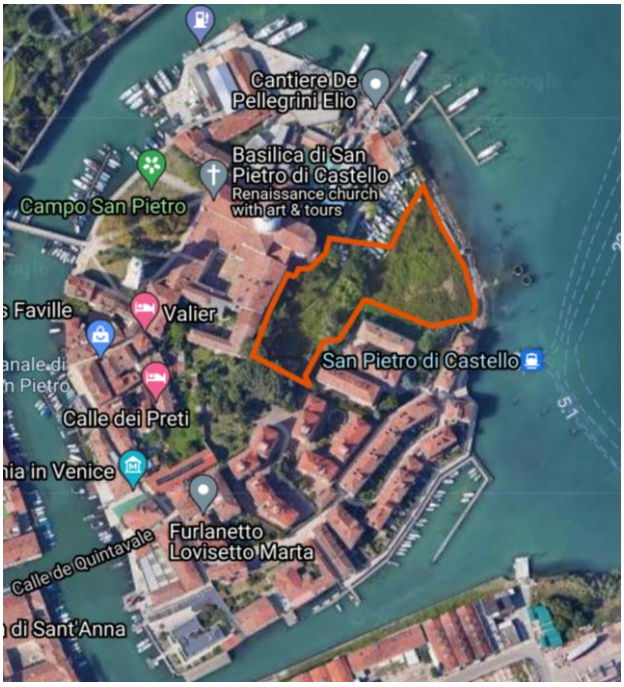

Figure 20. The island San Pietro, with the urban wild outlined in orange.

There are many reasons why this space has a high potential to be reutilized, first being the size of the space. Since it is so large, especially in comparison to surrounding green spaces, there is a lot of flexibility for its possible uses. This space could even be divided into multiple smaller green spaces if desired. For example, this space could be split and used as both farmland and a public park. Although we did not have access to this space, the extent of diversity in the ecosystem was clear. We encourage testing soil quality in this space to determine its viability as farmland. The location of the space is also very beneficial, since it is very close to an ACTV boat stop (San Pietro di Castello) that provides easy access to the public. It also falls on a shoreline, providing direct water access to the space.

Another space that has high potential is the Ex-Gasometri, a privately owned space in Castello Ovest that has no access to the public. It is located near the Chiesa di San Francesco, as seen in **Figure 21**, and there are plans in place to build a luxury hotel for tourists in the area. Doing so will take away from the available green space and contribute to over-tourism in Venice. However, this is a large space at 3,635 m^2, and if it is given proper stewardship and turned into a park or garden, for example, it would greatly benefit the city. There are only two fully accessible

spaces in Castello Ovest. If this space were to be reutilized and opened up to the public, the land area of fully accessible green space in Castello Ovest would increase by a factor of 10.

Figure 21. Satellite image of the Ex-Gasometri green space in Castello Ovest.

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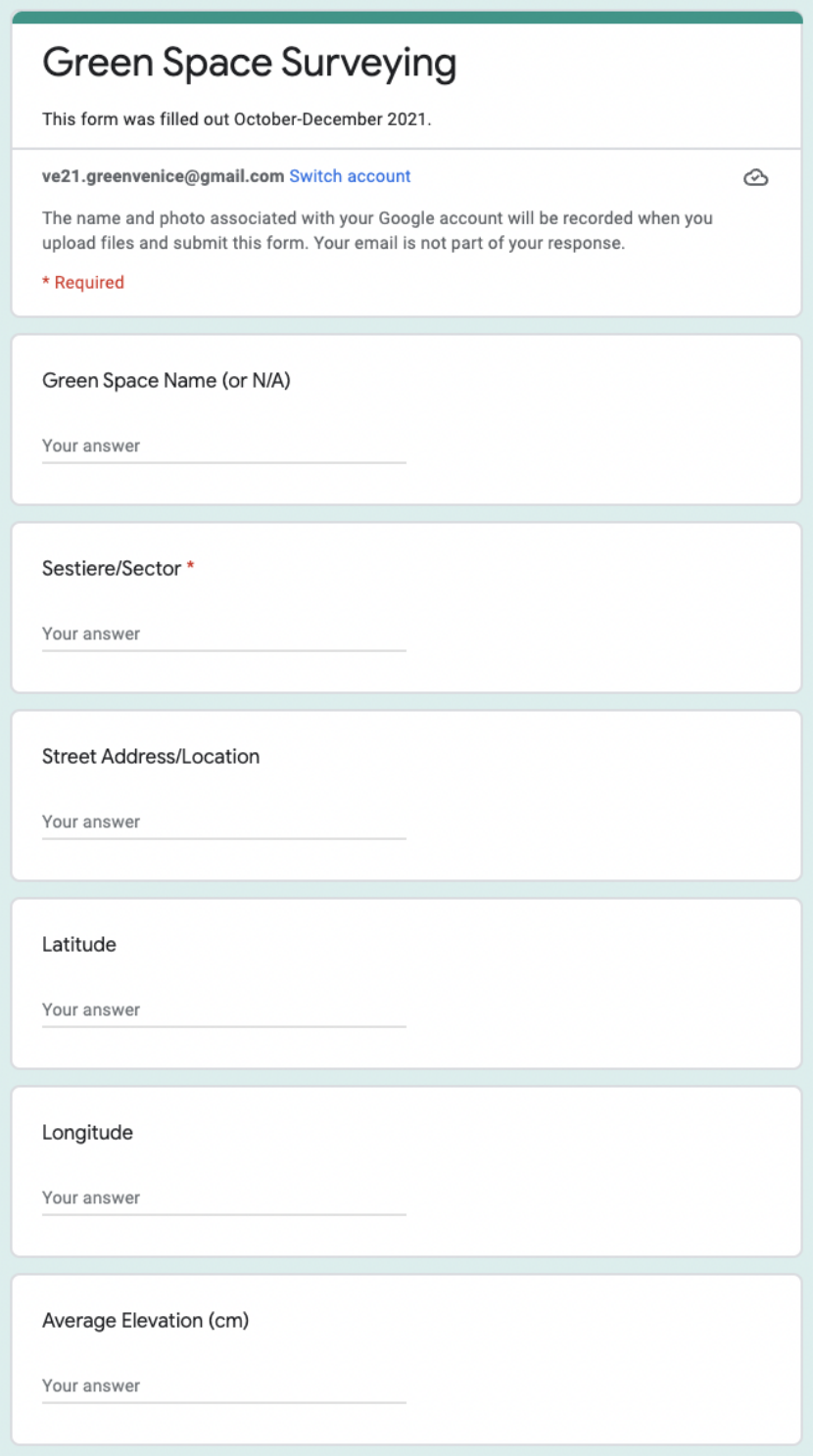
Appendices

Appendix A: Land surveying Google Form



Green Space Surveying

This form was filled out October-December 2021.

ve21.greenvenice@gmail.com Switch account

The name and photo associated with your Google account will be recorded when you upload files and submit this form. Your email is not part of your response.

* Required

Green Space Name (or N/A)

Your answer

Sestiere/Sector *

Your answer

Street Address/Location

Your answer

Latitude

Your answer

Longitude

Your answer

Average Elevation (cm)

Your answer

Space identification

Type of Green Space

- [ ] Urban wild
- [ ] Garden
- [ ] Park
- [ ] Farmland
- [ ] Courtyard/Landscape architecture
- [ ] Other: _____

Space ID (XXxx_name_#)

Your answer

Accessibility

	NO access	LIMITED access	FULL access
Private	○	○	○
Public	○	○	○

Hours of Operation

Your answer

Describe Land Access (Handicap accessible?)

Your answer

Describe Water Accessibility (Canal Access)

Your answer

Are dogs allowed?

- ○ Yes
- ○ No
- ○ Other: _____

Describe Key Features

Your answer

Amenities

- ☐ Restroom
- ☐ Water Supply (within 20 meters)
- ☐ Seating area
- ☐ Covered Structure
- ☐ Storage
- ☐ Compost
- ☐ Statue/Art
- ☐ Lighting
- ☐ Trash Cans
- ☐ Playground
- ☐ Sports equipment
- ☐ None
- ☐ Other: _____

Describe seating area (type, number)

Your answer

Amenities Notes

Your answer

Vegetation details

Vegetation

	0%	1-20%	21-40%	41-60%	61-80%	81-100%	Potted	Unpotted
Crops	☐	☐	☐	☐	☐	☐	☐	☐
Trees (Canopy Coverage)	☐	☐	☐	☐	☐	☐	☐	☐
Shrubs & Flowers	☐	☐	☐	☐	☐	☐	☐	☐
Grass	☐	☐	☐	☐	☐	☐	☐	☐
Weeds	☐	☐	☐	☐	☐	☐	☐	☐
Barren	☐	☐	☐	☐	☐	☐	☐	☐
Paved	☐	☐	☐	☐	☐	☐	☐	☐

Crops [List Species [fruit/vegetable] (#)]

Your answer

Trees [List Species (#)]

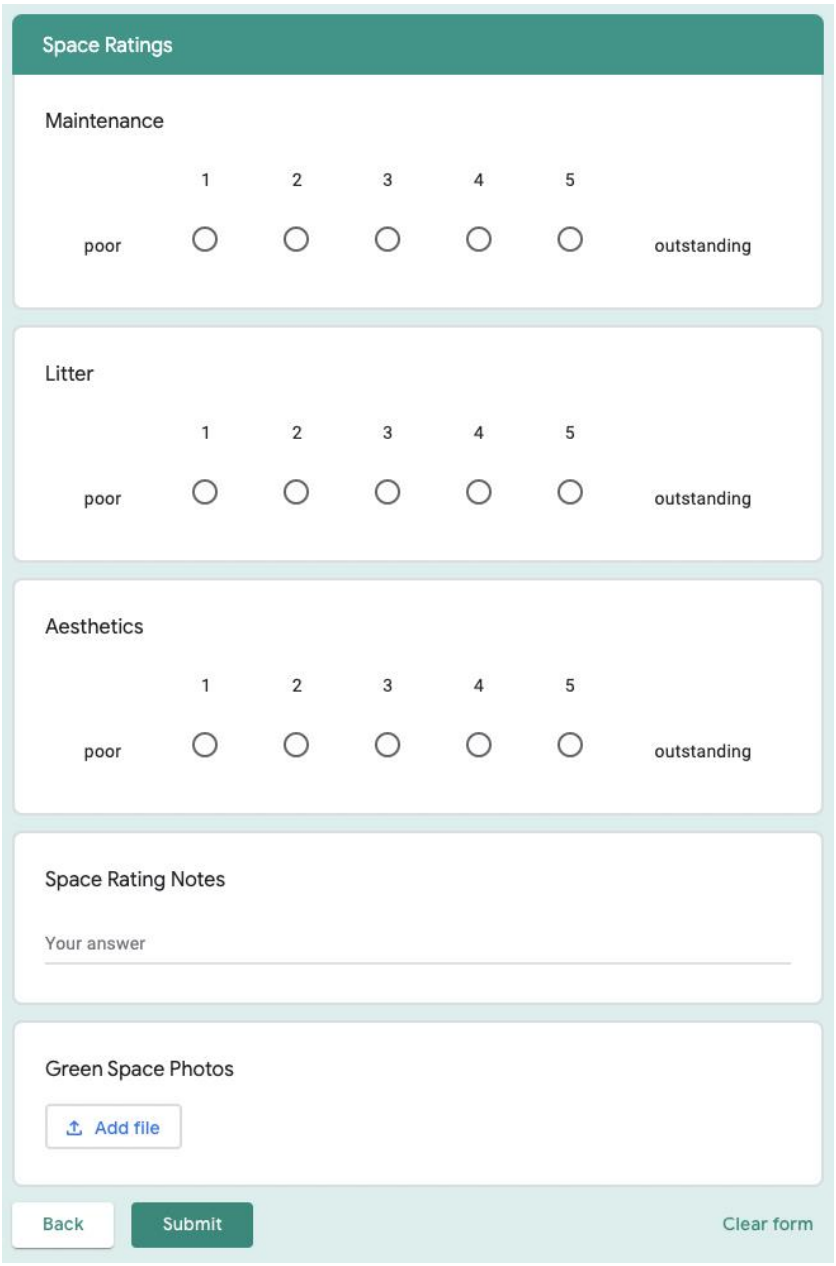
Your answer

Other Vegetation [List Species (#)]

Your answer

Vegetation Notes

Your answer


Space Ratings
Maintenance
1 2 3 4 5
poor
outstanding
Litter
1 2 3 4 5
poor
outstanding
Aesthetics
1 2 3 4 5
poor
outstanding
Space Rating Notes
Your answer
Green Space Photos
Add file
Back
Submit
Clear form

Appendix B: Land condition rating rubric

	1 "Poor"	2 "Fair"	3 "Good"	4 "Great"	5 "Outstanding"
Maintenance	No maintenance; overgrown or barren	Minimal maintenance; mostly barren ground	Some maintenance; poorly cut grass, minimal barren ground	Maintenance is present; cut grass, fallen leaves or branches around land	Excellent maintenance; green cut grass, well kept vegetation, no barren land
Litter	High density of litter, and dangerous elements	Unhygienic and lots of litter	Not clean, many instances of litter present	Low instances of litter, relatively clean	Very clean, safe space, little to no litter present
Aesthetics	Eye sore; space takes away from the area surrounding it	Unpleasant; space lacks color, and has messy looking vegetation	Okay; has no distinct sections that are enjoyable to look at	Pleasant; has good looking vegetation and is an inviting space	Excellent; very pleasant to the eye and improves the aesthetics of the area surrounding

Overall Land Condition	**3-4 "Poor"** (D in 2017)	**5-7 "Fair"** (C in 1017)	**8-10 "Good"** (No equivalent in 2017)	**11-13 "Great"** (B in 2017)	**14-15 "Outstanding"** (A in 2017)

3-4 "Poor" (D in 2017)	

5-7 "Fair" (C in 1017)	
8-10 "Good" (No equivalent in 2017)	
11-13 "Great" (B in 2017)	
14-15 "Outstanding" (A in 2017)	

Appendix C: Example Wix green space page

Home Explore Useful Links

Green Venice

email us at
ve21.greenvenice@gmail.com

Giardini Napoleonici
(CSpk_Napoleonici_1)

Description

This is a large, well maintained park and garden in the sestiere of Castello. Key features include two playgrounds, over 50 benches, and 18 statues. This green space permits leashed dogs.

Location:	Castello Via Giustizia, 23 - 30174 Mestre
Hours of Operation:	10:00-18:00 everyday
Area:	15,826 m^2
Land Condition:	Outstanding
Average Elevation:	188 cm

Accessibility

Public; limited access

Water Access:	No direct water access.
Land Access:	Can be accessed from several open gates along the perimeter and is handicap accessible.

Vegetation

Densely populated with many species of unpotted trees, shrubs and flowers, and grass.

Crops:	None

Trees:	The canopy of trees was estimated to cover approximately 80% of the total land area, including walkways. Species include hackberry (many), sycamore (many), hemlock (~10), gingko (few), and wisteria (1).
Shrubs and Flowers:	Shrubs and flowers were estimated to cover approximately 21-40% of the total land area, including walkways. Species include spindletree (many), dog rose (many), and Laurustinus viburnum (many).
Grass:	Grass was estimated to cover approximately 61-80% of the total land area, including walkways.
Weeds:	Weeds were estimated to cover approximately 1-20% of the total land area, including walkways.
Barren:	Approximately 0% of the total land area, including walkways, is estimated to be barren.

Amenities

A restroom, playgrounds, seating areas, trash cans, statues/art, and a restaurant.

Manmade Structures:	Two adjacent playgrounds, each containing a swing set and a slide. A drinking fountain is also located on one of these playgrounds along with ping pong tables. A carousel structure incorporates a wisteria tree into a beautiful art piece with benches nearby.
Walkways:	Paved walkways around the perimeter. Within the green space, there are many wide, flat gravel walkways. Walkways are estimated to cover approximately 61-80% of the total land area.

Related Links

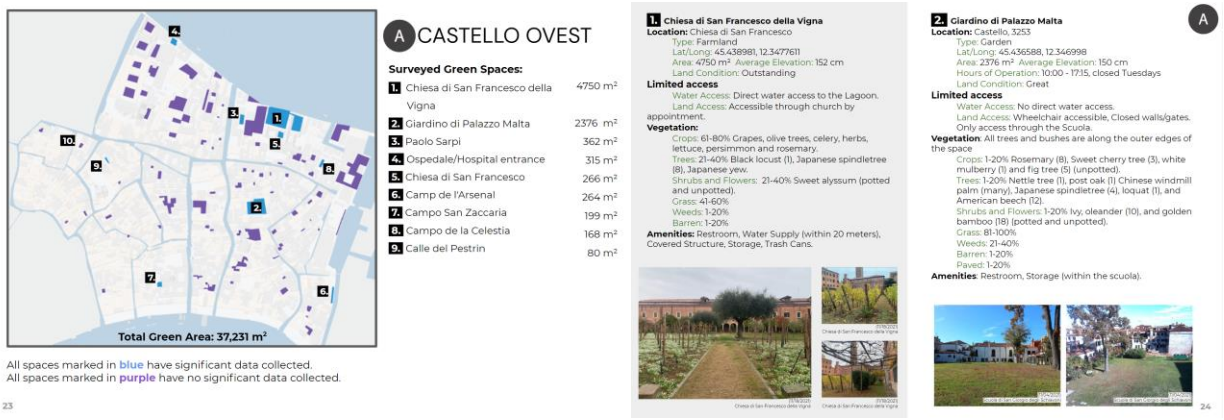
https://www.comune.venezia.it/sites/comune.venezia.it/files/page/files/R5%20Castello%20-%20Giardini%20Napoleonici.pdf

Appendix D: Wix home page

Appendix E: Example Booklet Formatting

Large Spaces:

Small Spaces:



Appendix F: Green deficit

Value Calculation

Green space area ÷ Population

Castello

Total green space area: 321,119 m^2

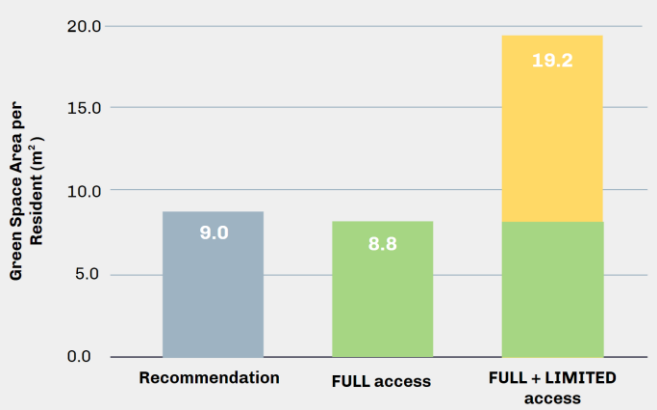
Fully accessible green space area: 106,209 m^2

Limited accessibility green space area: 125,861 m^2

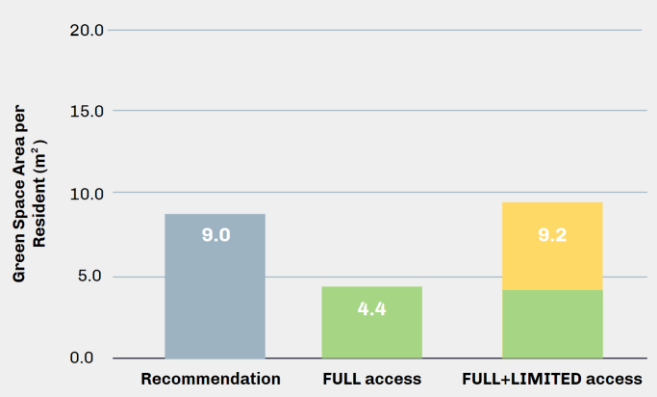
Residential population: 12,067

Estimated population with tourists: 24,000

Considering residential population only:



Considering residential population and tourist population:



Castello Ovest

Total green space area: 37,231m^2

Fully accessible green space area: 432 m^2

Limited accessibility green space area: 17,511 m^2

Estimated residential population: 6,500

Castello Ovest calculations, not including tourists:

Appendix G: ArcGIS Tutorial

How to Create a Polygon in ArcGIS Desktop

1. Open a new map file
2. Select the Add Data drop down, and Add Base Map
    a. Select any base map that is most helpful, we used Imagery
    b. Zoom in to the area of the map you will be working on
3. Select the Catalog Icon  , and Connect a Folder  where you can save and access files from your computer, and to import any data.
    a. Create a folder in your computer documents within your connected folder called "Shape Files." Each shape file consists of many different files, so creating its own folder will help keep everything together
4. Right click on your Shape File folder in the Catalog, and select New > Shapefile
    a. Name your file
    b. The feature type should be Polygon
    c. In the Spacial Reference Description, select Edit to change the coordinate system that corresponds to the area.
        i. For Venice, we used Projected Coordinate Systems > UTM > WGS 1984 > Northern Hemisphere > Zone 33N
    d. A new Layer should be added to the Table of Contents on the left panel
5. Right click on the new layer, and Start Editing
6. Select Create Features  , which will open a new panel, then click on the layer you are editing
    a. After this, when you hover your mouse over the map, it will look like a cross
    b. Now you can create a shape by clicking your mouse to create points around the green space.
    c. To finish the polygon, double click on your last point
7. Add as many polygons as you want, then save and stop editing.
8. Right click on the layer in the Table of Contents, and Open Attribute Table
    a. There is a row with an ID for each polygon created. You can select a row and it will highlight on the map.
    b. In Table Options, Add Field. Name it SpaceID, and select the Type Text
9. Start editing your Layer again, and open your Attribute Table. Once you are editing your layer, you can double click each section in the SpaceID field and type the ID for the space.
10. Calculate Area:
    a. Add a new field (short integer) called area_m2, (m2 is to indicate square meters but arcGIS only allows certain formats for titles)

b. When the attribute table is open, right click on this field, and "calculate geometry"
c. Define the units as square meters (or whatever units you indicate in your field title)
d. This will calculate the area for each drawn polygon. Repeat the "calculate geometry" process after new polygons are added

Transfer recorded data to ArcGIS

1. Finalize catalog on Google Sheets
2. Save as .csv (comma delimited) file
    a. Open and remove photos column, and any other unnecessary columns
    b. Make sure to save it in the folder that is linked to your ArcGIS files
3. Add all of the polygons for the green spaces recorded, and record the Space ID in the attribute table for the layer
4. Use Add Join tool on ArcGIS (you can search for this in the Search tool)
    a. Drag the layer with all recorded polygons in "Layer Name or Table View"
    b. Select SpaceID for Input Join Field
    c. Browse for the saved .cvs file to input in the "Join Table"
    d. Select SpaceID for "Output Join Field"
5. Allow the file to load, then open the Attribute Table for the Layer, and all of the recorded data is added to ArcGIS

Transfer map to an interactive Google Map

1. Convert the Layer with all of your green space data to a KML or KMZ
    a. "Layer to KML" tool
2. Go to MyMaps on Google, and create a new map or open an existing map
3. Select "Add Layer", and Import
    a. Browse or drag in your KML/KMZ file

Appendix H: Green space ownership interview questions

Disclaimer in English: all green space stewards are entitled to using/maintaining their land as they see fit and may not wish to collaborate with outside organizations or individuals. We will honor the steward's decision on whether their contact information may be shared with others.

Questions in English:

1. Name/Organization
2. Telephone Number
3. Email
4. Are you willing to share your contact information: with the public? With WahV?
5. How are you currently using and maintaining the green space?
6. Do you have any plans or goals for the green space?
7. Would you be open to collaborating with others for reutilization or maintenance efforts?
8. Do you have any questions or concerns regarding WahV or this project?

Domande sul possesso di uno spazio verde

Dichiarazione di esclusione di responsabilità in italiano:
Tutti gli amministratori degli spazi verdi hanno il diritto di usare/mantenere il loro terreno come meglio credono e potrebbero non voler collaborare con organizzazioni o individui esterni. Rispetteremola decisione dell'amministratore di condividere o meno le sue informazioni di contatto con altri.

Domande

1. Nome/Organizzazione:

   _____
2. Numero di telefono

   _____
3. Email

   _____
4. Voi siete disposti a condividere le Vostre informazioni di contatto:
   - con il pubblico?
   - con WahV?
5. Come state usando e mantenendo lo spazio verde?

   _____

_____

_____

6. Avete dei progetti o degli obiettivi per lo spazio verde?

_____

_____

_____

7. Sareste disponibili a collaborare con altri per il riutilizzo o la manutenzione?
    - Si
    - No

    Note: _____
8. Avete qualche domanda o pensiero in merito a WahV e/o questo progetto?

_____

_____