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A Greener Venice: The Inventory and Reutilization of Green Spaces on the Giudecca Island

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Abstract

Our study identified and classified green spaces on the island of Giudecca in Venice, Italy. We developed a methodology to classify each of the green spaces as an Urban Wild, Park, Private Garden, or Farmland, and proposed options for reutilization. As a result of our research, we explored several case studies in depth. This methodology can be implemented in other parts of Venice or its Lagoon. If implemented, our recommendations for reutilization on Giudecca would increase usable land by 31%, ultimately making for a more sustainable and greener Venice.

Executive Summary

Green spaces in Venice have potential for reutilization but their location and attributes are not well known. Local volunteer groups, particularly on the island of Giudecca, would like to reuse green spaces creatively. Separated from the rest of the historic city of Venice by a wide channel, the islands of Giudecca had many agricultural uses until the nineteenth century, when the industrial revolution replaced some of these green spaces with factories and boat yards. In the last fifty years, many of these formerly agricultural or industrial spaces have been abandoned and the land is now underutilized.

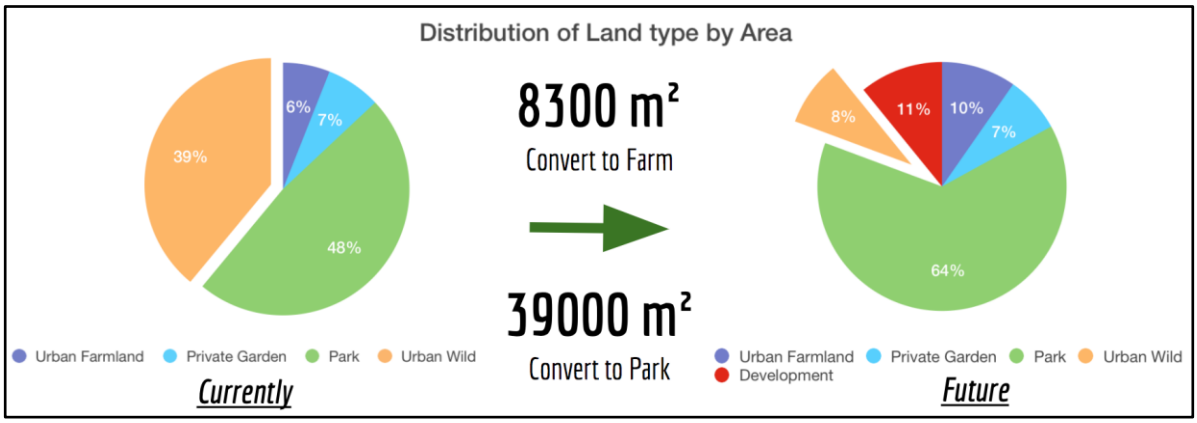
The goal of our project was to assist Fattoria Urbana Diffusa (FUD) to inventory green spaces on Giudecca and develop proposals for reutilization that optimize the land's potential. Founded by Michele Savorgnano in 2015, FUD has created urban farms on Giudecca and works to promote human-nature interactions. Mr. Savorgnano transformed roughly 4000m^2 of abandoned space at the eastern end of Giudecca into an urban farmland. Vegetables and herbs grown in this area provide 30% of the total food needed for a nearby restaurant in the five-star Cipriani Hotel. This reutilization provides a farm-to-table and zero-kilometer food experience for the restaurant and its customers. Our mission was to find other green spaces in Giudecca that could be transformed in similar ways.


Before: Urban Wild *After:* Farmland

Results of Classification and Re-utilization Proposals

We surveyed more than 230 green spaces on Giudecca and classified each as either Urban Wilds, Urban Farmland, Parks, or Private Gardens. Based on assessment of the condition and other attributes in a method described in more detail below, we proposed reutilization for each area of Urban Wild. The results of these recommendations are illustrated in the following Figures. The map below highlights the reutilizations that we would recommend to make better use of the green space on Giudecca. Currently, 39% of the area on Giudecca is classified as Urban Wild; after reutilization, only 9% or the land would remain in that state. As shown by the

pie charts in the figure below, the changes proposed represent a 31% increase in utilized land.



The area of farmland and parks on Giudecca would increase dramatically, by transforming the underutilized or abandoned urban wilds. We added development as a category for the future because some spaces were in poor condition, so development was determined to be the best reutilization for those lands. We expanded upon the reutilization plans of multiple urban wilds that we found to potentially have the highest impact on Giudecca.

We also proposed more detailed case studies for redevelopment for several parcels with high potential for reutilization.

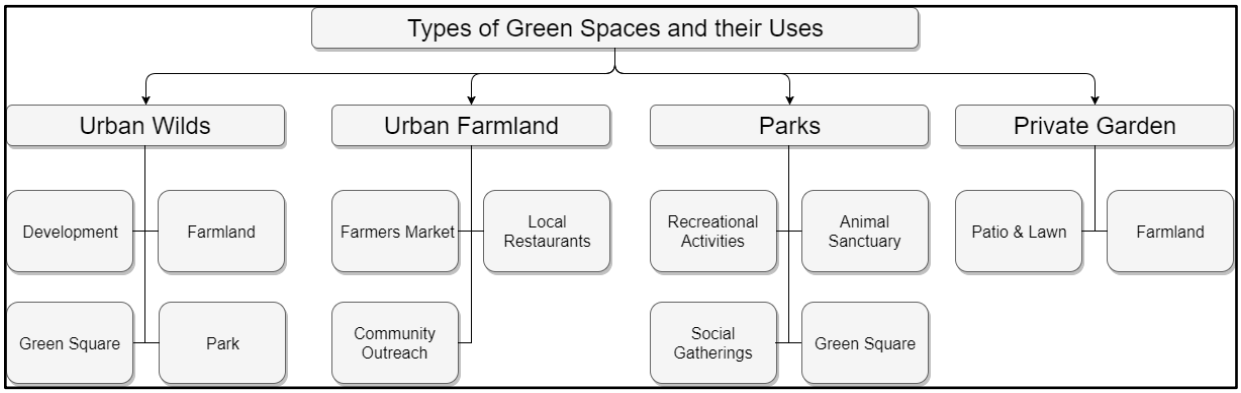
Process for Classification of Land

We collected data on green spaces and created a web application so that others could reproduce the methodology of classification that we developed. The web application allows the user to outline a green space by drawing a polygon around it. Once the polygon is drawn, a form will appear on the screen asking for details about the green space, such as the upkeep, biodiversity, soil quality, and invasive species on the land. Once the form is submitted, three additional fields are calculated and populated: condition, final score, and potential reutilization of the land.

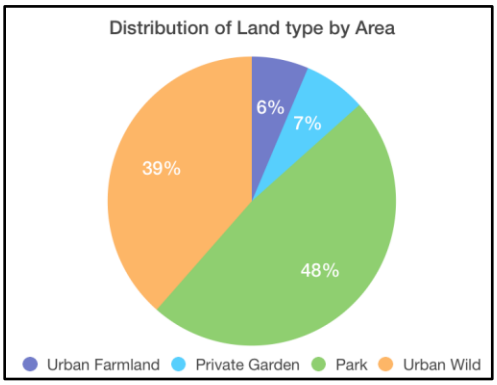
To complete this process required three types of data: current land type, land condition, and access to the land. To determine the land type, the data of each green space is stored and processed through a flowchart to be categorized into one of the following four types: urban wild,

urban farmland, park, or private garden. From there, each of the green spaces go through a detailed evaluation process to determine whether each green space is being used to its potential.

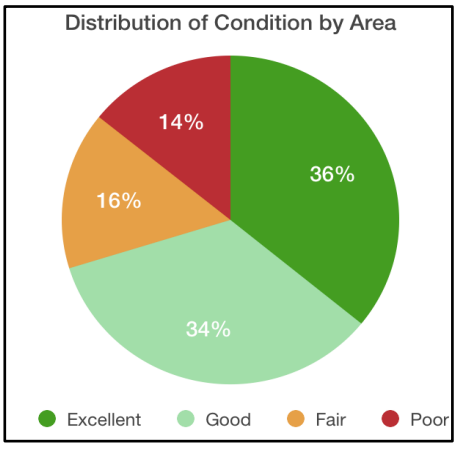
Each of the four land types have different potential re-utilizations, which can be found below. We concentrated mostly on the lands classified as urban wilds since such parcels of land are more likely to be abandoned and underutilized. Areas owned by the city may be more amenable to proposals for reutilization than areas under private ownership.



Our classification of 113 parcels of land designated 39% as an urban wild, as illustrated in the figure on the right. Areas designated as urban wild have a high potential for reutilization. Though smaller parcels also could be re-utilized, such small spaces do not result in as significant a transformation as the reutilization of larger plots. Therefore, we devoted more attention to analyzing the larger spaces designated as urban wild.



The condition of the land was also calculated. Each green space was categorized as either "Excellent," "Good," "Fair," or "Poor." The condition of each green space is crucial, since land classified as "poor" has a diminished potential for reuse. Of the land that we had previously designated as Urban Wild in Giudecca, our methodology classified 70% of this land by area as in either Excellent or Good condition. These areas have a high potential for reuse. To summarize, of the total land area that we surveyed in Giudecca, 39% of the land by area was urban wild, and therefore at least 9% of the total land area has a high potential for reutilization.



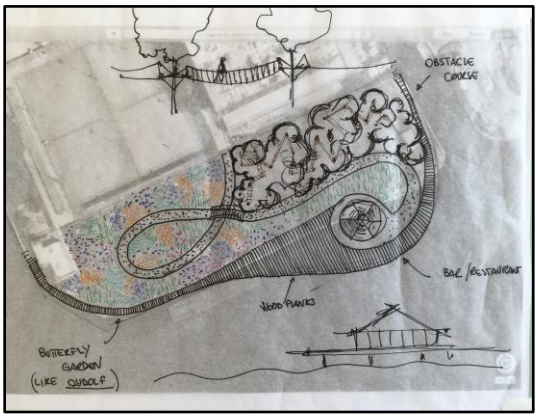
Methods of Observation

In collecting this data on Giudecca, we were able to classify areas that were directly observable or could be surveyed by drone. A small number of parcels were inaccessible and

remain unclassified. Many lands were open to the public or easy to gain access to thanks to FUD; we collected data on these lands by direct observation. Some neighborhoods or residences in Venice are bounded by high brick walls. In these cases, we used a drone to fly above the level of the wall to capture aerial footage of the green space. We then reviewed the video to classify the land through the view recorded in the video. For areas of land that remained completely inaccessible, either because there was no path to provide public access or because it was unsafe to use the drone, locations were recorded in our database and a future study may be able to obtain access.

Case Studies for Reutilization

We developed several case studies of for parcels with a high potential for reutilization. First, an excellent example of a potential transformation is an urban wild on the island of Sacca San Biagio, an island on the far western portion of Giudecca, which stands next to an indoor swimming pool and two tennis courts, as illustrated below on the left. Due to the location overlooking the water and the size of the green space, as well as the athletic uses in the abutting parcels, we decided, along with Mr. Savorgnano, that the unused area in red could become an obstacle course, or offer similar recreation opportunities, for children. This would create an

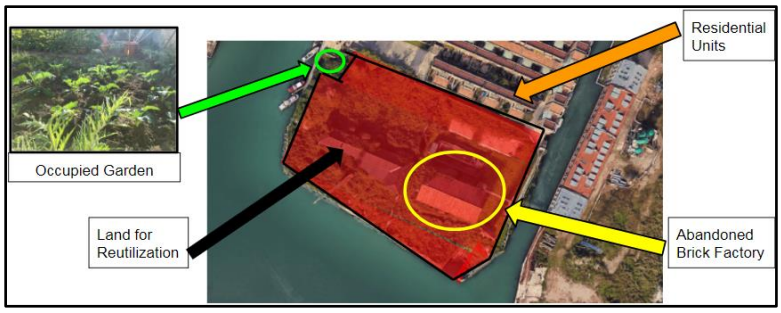


attraction for the island and help bring more value to the area.

Since this land is maintained by the city, the reutilization process would begin by contacting the city to organize approval and funding for the children's adventure park. Ideally, the park would include multiple structures such as rock climbing and log walking. According to Mr. Savorgnano, this addition could pull the area out of the "ghetto" stereotype and help to generate revenue to improve the area. Changes such as the addition of a walkway and a fence would make it clear that the land is no longer abandoned and draw people to the space. To cater to the aesthetics, a restaurant could also be included in that space, as shown in the above sketch on the right. Lastly, the inclusion of a dock would allow for boat access and would bring in more people to the area.

A second case study of potential reutilization is an urban wild that could be transformed to farmland. As illustrated in the figure, a large green space exists behind a former brick factory,

abandoned after the construction company developing the area went bankrupt. In the top left corner (circled in green), a small area is already used as a garden and is in “good” condition. This space is still owned by the city but was transformed by a resident of Giudecca.



Ideally, we would extend garden to the larger area of land in this space and use the existing building to create a large hydroponic farm, a farm that requires only nutrients, water and light to grow. After some renovations and preparations, this building alone, which has over 1000 m^2 of available space, could produce 12,000 heads of lettuce per month, which is enough to supply over 30 restaurants with lettuce! This would ultimately help make Giudecca a more sustainable island.

Overall Recommendations

The data we collected is pivotal for volunteer groups and urban planners looking to revitalize the green spaces in Giudecca. Groups can use our data and ideas to create their own specific plans for reutilization. Our project can also be extended to the mainland and the lagoon area with the use of our web app in terms of data collection. If this methodology is continued in other areas of Venice or its Lagoon, more reutilization opportunities like our case studies could be identified and reutilized. Urban planners and landscapers can use our data or additional data collected with our methodology to revitalize underutilized green spaces, which will ultimately lead to a more self-sustaining and greener Venice.

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Authorship

Nathan Drewniak was one of the main co-authors for this report. He worked on editing the proposal for flow, formatting, and grammatical mistakes. He worked with Nicola on the development of the web application for this project. He also contributed to much of the executive summary, background, methodology, and conclusion along with data collection.

Gabriel Entov was one of the main co-authors for this report. He concentrated on learning the technical sides of app development such as Geographic Information System (GIS). He also developed a Quantum Geographic Information System (QGIS) plugin to help with data collection. He also contributed to much of the background, methodology, and conclusion along with data collection.

Kinsey McNamara was one of the main co-authors for this report. She focused on the research and the notetaking required for this project. She worked with Chenggu to collect and organize data on the green spaces of Giudecca. She also contributed to much of the background, introduction, methodology, and results, along with data collection.

Chenggu Wang was one of the main co-authors for this report. He concentrated on creating figures and infographics using his technical and artistic skills. He worked with Kinsey to collect and organize data on the green spaces of Giudecca He also contributed to much of the background, introduction, methodology, and results, along with data collection.

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

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Professor Fabio Carrera for his guidance and assistance throughout the entire project, shifting our focus when the team was heading astray.

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Professor Melissa Butler for her guidance in constructing our project proposal and for teaching us about technical writing and the social aspects of our project.

Michele Savorgnano for his guidance in the formation of our rubric from a farming standpoint in terms of aspects to access for his expertise on green space classification. He also introduced us to many different Venetians who may benefit from our project. Since he is a local, he also gave us access to many pieces of land that we would not have been able to access otherwise.

Alessandra Manzini for her guidance in the formation of our rubric from an urban planning standpoint and providing information on the cadastral data.

The Venice Project Center for their assistance in the app development (Nicola Musolino) and GIS portions (Piero Toffolo) of our project.

Leonardo Marotta for his assistance in the formation of our rubric and flowcharts to correctly classify green space.

Laura Robinson for her assistance in finding reliable sources for our project.

Sebastiano Trevisan for his artistic rendering of the green space reutilization images.

1. Introduction

Venice lacks systematic knowledge of its existing green spaces. In the Venetian Lagoon as a whole, many of the outlying islands have large areas of green space, but the older city of Venice itself has many fragmented pockets of green space that have not been catalogued and are poorly understood. The gap in knowledge about these urban green spaces hinders the potential of these areas. In a city of islands, which has been densely-settled for centuries, enhancing the potential use of these limited green spaces becomes even more significant.

In addition, the popularity of global tourism in Venice has increased the cost of living for Venetians and limited the expansion of jobs to the tourism sector. As a result, many Venetians chose to leave their hometown and farmlands became abandoned (Liversay, 2017). Many arable lands have lost their original characteristic as farmlands and failed to provide enough resources to the locals (Hildebrand, Norcott, Rudge, & Zammataro, 2013). Moreover, multiple projects that would like to reuse existing green spaces do not have reliable data on their condition and location. Without reliable and well-organized data on green spaces, progress towards reutilization will be limited. There is an urgent need to assess each piece of land for the population to make better use of them.

Existing sources of information on green spaces in Venice are scattered among specialized reports or are not specific enough to be useful tools in reutilization plans. Several past projects at the Venice Project Center, such as the *Venice Tree Inventory* (Bennett, Premo & Tavares, 2001) and *Growth in the garden of Venice* (Hildebrand, Norcott, Rudge & Zammataro, 2013), are within the domain of green spaces but with a more narrow focus. Currently, an online scientific atlas database called *Atlante della Laguna*, displays various types of land in the Venice Lagoon (*Atlante della Laguna*, 2012). The website uses color coded tabs to represent data about different types of land. However, this atlas has not been updated since 2012 and lacks fine-grained data necessary for detailed land classification.

This presents a need to add and update green space data to existing resources online and elaborate on the depth of information. This data is urgently needed by Fattoria Urbana Diffusa (FUD). They are working closely with organizations that share the same vision in terms of reutilizing green spaces in Venice, where this detailed data on green spaces becomes crucial.

The goal of this project is to add to the incomplete database by surveying the green spaces and creating an updated atlas with the data collected. We will focus on the island of Giudecca as a prototype for our data collection, and the same method can be expand to the rest of the lagoon in the future. With the detailed knowledge of the land, the team will be able to propose a re-utilization plan to better match land property with potential users. Our objectives are listed as follows:

- To inventory and classify the current green spaces in Giudecca
- To develop options for reutilization of green spaces
- To demonstrate the use of mobile tools to collect information about green spaces

We will investigate each of the green spaces on site to evaluate their attributes and classify based on usage. This information will then be synthesised into an interactive map showing green spaces in Venice. It will be able to display detailed properties when a user clicks into a particular area, and will be able to show categorized data with the use of filters. We also will develop a plugin for GIS software, and a mobile application, to reproduce our methodology. These project deliverables will assist FUD in organizing data and matching land with potential users.

2. Background

Spread across 118 small islands, Venice and its lagoon cover roughly 550 square kilometers of nature and history, forming a dynamic interaction between its civilization and ecosystem (UNESCO, 2017). Although people were aware of the importance of balancing urban development and the environment, few restrictions were enforced by the government until recent years to prevent further damage to the environment. Green spaces are becoming segmented by construction or remain undocumented (Czamanski, Malkinson, & Toger, 2014; Ortalli & Scarabello, 1999). The following sections explore the land usage and recent land developments in Venice, popular green space use, governmental regulations and sustainability measures taken to protect the intactness of green spaces, as well as specific information on the island of Giudecca as the starting point of our project.

2.1 Land Use in Venice and its Lagoon

The Venice Lagoon islands have undergone drastic development over the last century due to the growth in human habitation by 143% and decrease in the vegetated area by 20%. For example, there was a decrease in salt marshes by about two thirds during this period (Igegnoli, 2004). Over time, the usage of these existing green spaces has become inefficient and disorganized in management. Revitalization plans such as the 'Strategic Plan for Venice' approved in January of 2006, have outlined a new direction for the Lagoon in terms of ridding the city of abandoned lands and adding effective green spaces in these areas (Beatley, 2014). This plan contains dynamic ideas, such as creating connections to the mainland via green spaces, that would make use out of abandoned waste dumps. The need for similar strategic plans throughout the entirety of the islands is apparent.

2.1.1 *Current Usage and Data Gap*

A 2001 IQP report on the minor islands in the lagoons of Venice shows the majority of land has no current use (Nicole Buzzell, Amanda Connor, Seth Merkel and Christopher O'Malley, 2001). The most current detail on green space usage is the Atlas of the Lagoon of Venice, or *Atlante della Laguna*, which was last updated in 2012 with contribution from the Lagoon and Territory division of The Municipality of Venice Observatory. This color coded map displays the types of green spaces such as salt marshes, rail networks, and bodies of water. Additionally, the map provides overlays of subcategories that add detail to the areas concentrated in the initial space. These subcategories include residential structures, urban parks, and abandoned areas, among others.

2.1.2 *Recent Developments in Land Usage and Trends*

The purpose of reutilization plans such as the 'Strategic Plan for Venice,' mentioned in the introduction to this chapter, is to eliminate unused and abandoned land by creating mindful

additions to the areas. The plan outlines implementations such as the transformation of the San Giuliano Park from an urban waste dump into a green space. This new park area would additionally serve the purpose of connecting the island to the mainland in a natural way (Beatley, 2014). Furthermore, this plan provides solutions to barren ports and unused factories by suggesting residential and university usage of these space. According to urban planner Alessandra Manzini, there are volunteer groups such of Fattoria Urbana Diffusa (FUD) in Venice that are aware of the usage issue in Venice and have ideas for projects that would utilize the land. However, the underlying lack of data for the green spaces makes moving forward with these plans nearly impossible.

In addition to the existing plans for green spaces in the future, FUD has done successful work on the transformation of land shown in figure 1 below. They saw potential in an area of unused land belonging to the IRE retirement home on Giudecca, and transformed it into a garden that produces crops for a Cipriani hotel restaurant called the Oro restaurant. This farmland provides 30% of the total food needing in the restaurant by way of vegetables and herbs used for meals. However, before signing their contract with the Oro restaurant in the Cipriani hotel, this green space provided produce for 20 restaurants on Giudecca. This one green space created a large impact on Giudecca and inspired FUD to continue looking for more spaces to reutilize in the lagoon. Since its start in 2015, the organization has used a farm-to-table focus to rejuvenate spaces and connect top restaurants with these spaces for experimentation in local unique produce (Fattoria Urbana Diffusa, 2015).

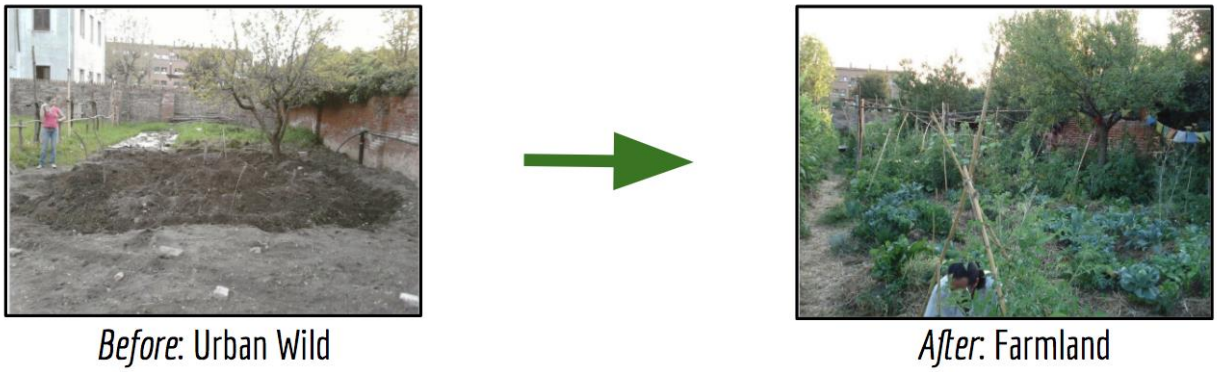

Figure 1: Transformation from Urban Wild to Farmland

2.2 Well-Known Green Spaces in Venice

"Federparchi," the federation of parks and reservoirs, is responsible for the documentation of parks, both regional and national, as well as other green spaces. The federal organization helps manage these areas, and outlines their current use. Currently about 11% of Italian territory is protected, although it is not known how much of it is well documented (Parks.it, 2017). Although there is a considerable knowledge gap about the green spaces in Venice, some of the more well-known parks are documented in detail. It is vital to obtain and organize data to fill this gap in order to eliminate the existence of underused green spaces.

2.2.1 *Protected Green Space in the Lagoon*

Some of Venice's most cherished green spaces include the following: The Island of Sant'Erasmo, which has supplied Venice with fresh fruit and vegetables; the Napoleonic Gardens, which is one of the city's largest parks; and the Island of San Giorgio Maggiore, which is home to the Cini Foundation, responsible for organizing exhibitions and cultural events in the city (Williams, 2012). From "The Reutilization of the Minor Islands of the Venetian Lagoon," a 2001 IQP which focused on gathering data about the minor islands of Venice, we were able to extract a table of minor islands in the Lagoons. This table outlines what the island is called, by whom it is owned, and for what purpose it is being used (Nicole Buzzell, Amanda Connor, Seth Merkel and Christopher O'Malley, 2001). It is important to understand how much of the land is private, as well as how much of the land is not in use. We are certain that the use of land has changed since 2001, but this is the gap in knowledge that we are trying to fill. The following figures show ownership and usage distribution.

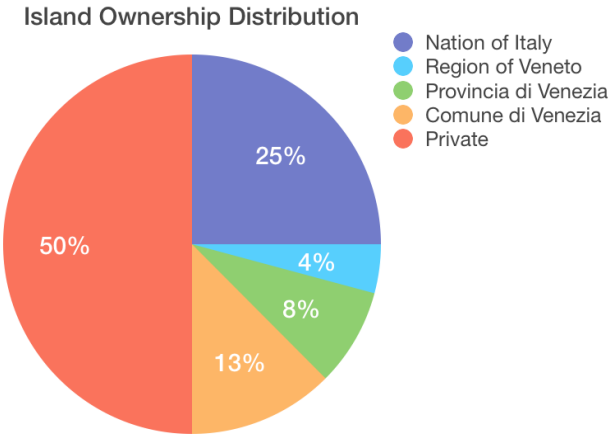

Figure 2: Island Ownership Distribution

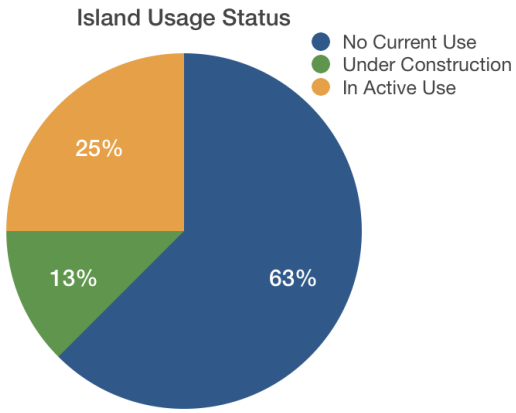

Figure 3: Island Usage Status

Inside Venice, there are several public parks, each with a unique history and purpose. Parco delle Rimembranze is a park located in Castello, the largest subsection of Venice. The park, translated as "Remembrance Park," is named in memory of the men who lost their lives in World War One. In fact, the park holds a tradition that every tree is planted in memory of a fallen soldier (Williams,2012).

Giardini Papadopoli is a botanical garden and children's playground which was inaugurated in 1834. The park was once used to host festivities for the nobles of the 19th century. A large part of the park was destroyed and repurposed in 1933, and in 2012, the park suffered damage from a earthquake. Since then, there have been initiatives to rescue the park by renovating as much of it as possible (Bramblett, 2013).

San Giulino Park has a plethora of features to offer to its residents. The 183 acre park features a bicycle rental station, a children's playground, a free skating rink and a soccer field, as well as a restaurant on site for a quick bite (Bramblett, 2013).

The aforementioned parks are examples of the land that is put to excellent use. Green spaces in Venice have incredible potential, and can do tremendous good, but as shown in Figure 3, most of it is not put to use. Of course, parks have the most effect on the public, but each form of green space has its own lasting effect on its corresponding clientele.

2.3 Governmental Involvement in Environmental Planning—

The comprehension of legal concerns are essential to the reutilization of green spaces. There are laws and environmental policies already in place regarding urban planning. The Department of Urban Development and the Environmental Department in Venice handle issues concerning the development of islands and city space. At the regional and provincial levels, plans were put in place to regulate the different uses of the land in Venice.

2.3.1 *Environmental Policy*

The European Union (EU) implements some of the world's highest environmental standards, helping to protect nature, the economy, and the health of the EU residents and tourists (Europa.eu, 2017). The EU establishes an environmental framework which countries use in order to create a sustainable environmental plan with country-specific policies. In accordance with EU policies, the city of Venice has an Environmental Department that determines the majority of the environmental regulations.

The Environmental Department in Venice is responsible for environmental risks, as well as the environmental regulations. They also monitor energy use and conservation along with the industrial activities within the Lagoon. The department conducts research in order to find the most effective environmental policies. (comune.venezia.it, 2017) They are also interested in protecting the unique ecosystem of the Lagoon's environment, and weighing the effects of the urbanized lands, which will affect our criteria for determining space potential and options for reutilization. This criteria will need to take into account all of these policies restricting the uses of some of the green spaces.

2.3.2 *Department of Urban Planning and Zoning Laws*

Pieces of land that cross over the boundaries of provinces are under the responsibility of the regional government. The regional government, which for Venice is called Veneto, is ranked below the national government, and it governs specific regions of Italy. As a result, the region of Venice created a plan called "Piano di Area per la Laguna e l'Area Venezia" (P.A.L.A.V.), which holds the regional level plans regulating the uses of different areas of land, including the Lagoon area.

P.A.L.A.V. classifies the entire Venice Lagoon area with a high ecological risk. It states that lagoon islands and green spaces must be used for the aim of preservation, yet compatible with human action. (Turismo.it, 2000) This means that although the land should be preserved, it can also be utilized to the point that humans are constantly improving upon it. For example, the

green space can still be a park, as long as the land is being preserved. Because of this aim of preservation, P.A.L.A.V. prohibits land movements, excavations, and landfills. This also means that if a structure or piece of land is modified, it must keep the same basic designs or infrastructure that was there before; the lands must be preserved, not upgraded.

The Department of Urban Development proposed the provincial plan called Piano Territoriale Provinciale (PTP), which is more detailed than the regional plan P.A.L.A.V. Because the regional government is of higher status than the provincial, the regional government has the power to approve or reject provincial plans. This plan identifies areas of high environmental value with the aim of preserving the nature of the provincial territory and of provincial special protection areas. (Tourismo.it, 2000) If a certain piece of land is under special protection, there will be instances that we cannot reutilize a green space in the way that we intended. For example, if our team wanted to reutilize a green space as a park, but there was special protection conserving that land, a public park would no longer be possible.

2.4 The Island of Giudecca

The island of Giudecca serves as a model for data collection and reutilization on other islands in the Venice Lagoon. Figure 4 shows Giudecca in 1847; full of farmland and greenery. Much of this agricultural space was overtaken by factories and boat yards after the industrial revolution. What follows is a brief history of Giudecca as well as the current gaps in knowledge with respect to the Giudecca database.

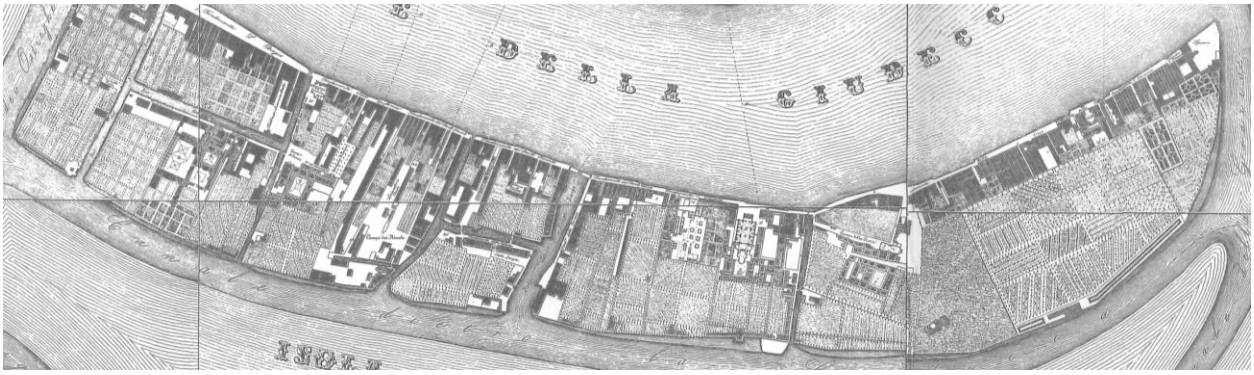

Figure 4: Historical Map of Giudecca form 1847

2.4.1 *History of Giudecca*

Giudecca is composed of a collection of eight islands and is home to roughly 5,000 residents. The islands are separated by the Grand Canal across from the Dorsoduro district; a sestiere of the city of Venice and of which it is administratively a part. Historically, Giudecca is home to large houses with gardens. Many churches were built with great historical significance especially during the Cinquecento (1500s), part of the Renaissance in Venice. The island then became an industrial area in the early 20th century with factories and boatyards. Much of the industrial focus went downturn but some of the signs of industrialization still exists today.

Giudecca has not become a tourist attraction, in contrast to parts of the city on the other side of the canal. As a result, it is now frequently regarded as a quiet residential area of largely working class housing (Ve.NICe. Immobiliare Cera, S.R.L., 2015).

In part due to its relatively isolated position compared to the rest of Venice, Giudecca has opportunities to pilot new approaches to green space management. Michele Savorgnano, the founder of FUD, created a "farm-to-table" food-supply plan on Giudecca. He reached out to the owner of a local retirement home and they agreed to convert that backyard into a vegetable garden. The food produced in this garden is then brought to the Cipriani Hotel, located in an adjacent property on Giudecca, providing fresh goods to hotel guests while returning revenue to the garden.

2.4.2 *Gaps in Giudecca's Green Space Database*

An important data source in planning this project is *Atlante della Laguna,* the online atlas. It specializes in creating layered maps representing various types of land. Shown below are the land use map created by *Atlante della Laguna* (Figure 5) and the Google satellite image of the island of Giudecca (Figure 6). Each colored block in Figure 5 represents a type of land usage. For instance, yellow colored blocks means grass, green dotted areas are parks, and reddish pinks are anywhere from urban mixed usage to residential areas. When compared with the Google satellite image, one can clearly tell that many green spaces are missing in Figure 5 and it lacks the level of detail on small scale gardens. For example, the two yellow circles on the left are covered by plants in the satellite image while the land use map shows the entire pink block as urban mixed use.

Figure 5: Land Use Map of Giudecca by *Atlante della Laguna*

Figure 6: Google Map Satellite Image of Giudecca

Although an incredibly powerful source, there are some improvements that can be made. Below is shown a map of the trees on the Giudecca island.

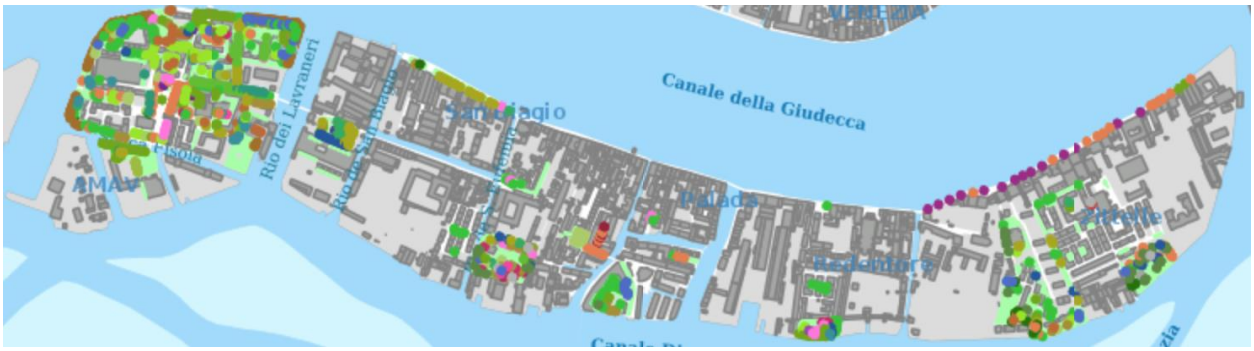

Figure 7: Atlante della Laguna Map of the Trees

Here it is clearly visible that the Atlante della Laguna is detailed in some maps, but is not equally detailed throughout. Additionally, the map is not interactive as of now. In other words, clicking on a specific color, does not reveal the type of land that is being examined. Many colors on the map are similar but have different meanings, which makes it extremely difficult to interpret the map correctly, not to mention the greater struggle for colorblind people. After acquiring the database of Atlante della Laguna and noticing some gaps in green space data, we sought out to help as best as we can.

3. Collecting and Organizing Data on the Current Green Spaces of Giudecca

The goal of this project was to map and classify green spaces in Giudecca, a group of islands in Venice, in order to identify options for reutilization that matches the land with potential users. We also developed online tools to assist our project sponsor, Fattoria Urbana Diffusa (FUD), and similar organizations, to apply these techniques to other green spaces. Our goal was achieved through the following objectives:

1. To inventory and classify the current green spaces in Giudecca
2. To develop options for reutilization of green spaces
3. To demonstrate the use of mobile tools to collect information about green spaces

Our project focused on the islands of Giudecca. These islands would serve as a prototype for methodology testing in order to show how our process can be applied to Venice and the entire Lagoon.

We collected data over seven weeks, from mid-October until mid-December. The collected GIS (Geographic information system) data was incorporated into an interactive web application that displays information about the following types of green spaces: private gardens, urban farmland, urban wilds, and parks. Our team worked with FUD to create a criteria from

which each green space was graded. Space specific reutilization options were recommended for public areas where we collected data, based on a flowchart that we developed.

Figure 8 provides a visual representation of our objectives. The following sections describe the methods we adopted in order to achieve each of the objectives listed above.

Figure 8: Methodology Flowchart

3.1 Methodology of Data Collection

We inventoried and classified the green spaces in Giudecca by collecting data using a rubric that we created with the help of Venetians and environmental experts. The rubric is broken down into the following attributes that make up a green space:

- Biodiversity (number of species)
- Littering
- Upkeep
- Soil Quality
- Hygiene and safety (including animal dropping)
- Invasive Species

The attributes are in order from most important to least important when surveying a green space. The total score that a green space receives leads us to the current purpose of the green space and the land condition. This data was inputted and organized into the Quantum Geographic Information System (QGIS) application and matched with the polygon that outlined the boundaries of the space we were analyzing. In addition to the attributes, data on the boundaries of the space, ownership status, notes on vegetation, and additional comments were recorded.

3.1.1 *Classification of Green Spaces and Use of Classification Tools*

In order to classify these lands, we looked at the data that we collected about the green space and placed it into one of the following categories as displayed in Figure 9:

- Private Gardens
- Parks
- Urban Wilds
- Urban Farmlands

Figure 9: Types of Green Spaces

We used our classification scale (excellent, good, fair, poor) to grade these spaces. Knowing the condition of each green space, as well as the features of each space, allowed us to properly classify these pieces of land. In addition to helping in classification, this also helped us when developing our options for reutilization, which will be discussed in section 4.1.1.

The classification flowchart shown in figure 10 asks many questions about the green space, and the resulting classification places the green space into one of our four categories: urban wild, urban farmland, park, or private garden. The chart takes certain aspects of the green space into account based on its category. For example, attributes include the size of the land, the quality/condition of the land, and whether the land is public or private. These attributes enabled us to break down the general category of the green space into explicit uses.

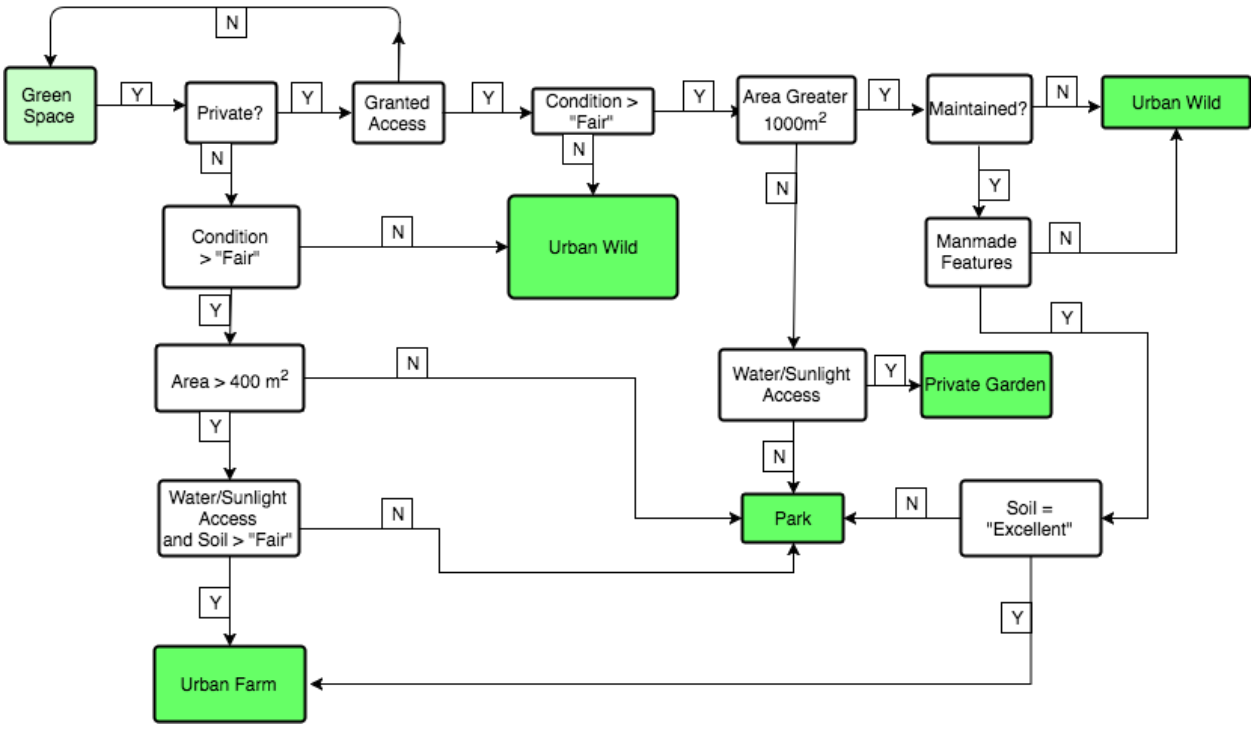

Figure 10: Land Type Flowchart

3.1.2 *Condition Rubric*

We collaborated with Venetian environmentalists in order to create a rubric that would capture the attributes that make for an excellent green space. The rubric consists of a list of attributes that we created after consulting with Leonardo Marotta, PhD, an environmental scientist from Università Iuav di Venezia, who works in the Venice Department of Design and Planning in Complex Environments. We also received input from Michele Savorgnano, a local farmer, and Alessandra Manzini, a student of Leonardo's and Urban Planner herself. We used the input from these three people to calculate weights of each attribute based on importance.

3.1.2.1 *List of Attributes*

Each attribute describes the quality of a green space, and has a list of four different descriptor per attribute. The descriptive words in the rubric allow for classification to be done by anyone with the app and with higher clarity. Each description has a point value associated with it organized from high to low for the given attribute. The table with the letter breakdowns can be viewed in Appendix H.

The categories with the greatest weight were determined to be the biodiversity in terms of vegetation and the amount of littering in the space. Both attributes received a weight of four. The biodiversity of the space shows how well the soil can support growth. A high score in biodiversity, a land containing over 50 diverse species, is rare in Venice and is present mainly in farms and gardens. Littering also holds a high weight because it shows how often and how well

the space is maintained. It also can provide insight on the surrounds and how the population near the green space views it.

Upkeep and Soil quality both received a weight of three. Upkeep involves the maintenance of the green space in terms of land care. This would assess how well the grass is cut and the amount of barren ground that is present. The soil quality is important in determining what can be grown on the land and adds to the aesthetics of the area. It is rated visually and by touch, based on color and moisture. The highest level of soil quality is described as "dark brown and moist", while the lowest would be "sandy, rocky and light brown".

The attributes that were determined to be of the least importance were 'hygiene and safety (including animal droppings)', and 'invasive species'. Both attributes received a weight of one. Hygiene and safety was defined by our team as a rating of the dangerous elements and the pollutants of a green space. For example, one green space that we surveyed on Giudecca contained sewage treatment materials and sewage waste left in the open. Not only would this be very unsafe for the public, it is also very unhygienic and the contamination would be hazardous to come into contact with. A space such as this would receive a rating of 1, the lowest grade, and be described as "contaminated" with "dangerous elements" in our rubric. The Invasive species is defined by our rubric as the percentage of weeds or unwanted vegetation in the space. This is a good indicator of the maintenance levels and upkeep of the land. Usually a high weed ratio means the land is most likely to be abandoned or poorly maintained while a low weed percentage is generally a sign that there is someone in charge of care for the land.

3.1.2.2 *Descriptive Scale of Conditions*

In order to present this data in a mathematical sense, we made our own descriptive scale based off the Likert Scale[1], shown in Figure 11 (Fern, 2016). This allows us to have consistent scoring methods for each green space that we analyze.

Figure 11: Descriptive Land Condition Classification

In order to determine the final score for the condition of a specific green space, we went through the rubric and selected the description that best depicts the land for each attribute to obtain the point value (4 for excellent, 3 for good, 2 for fair ,and 1 for poor) of that description. We then multiplied that point value by the weight of that attribute (1, 2, 3, or 4). All of these

[1] The Likert Scale is widely used when obtaining responses in a questionnaire. The scale typically gives three, four or five options (all of which are related on a spectrum) to any desired question. For example, "How satisfied are you with our service?" might have "Satisfied," "Neutral," and "Dissatisfied."

point values from the descriptions are summed, and the total number of points determines the condition that it falls under. A green space that falls under “excellent” would have the highest, or close to the highest possible score for all attributes. A “good” level space would be one step down from excellent in terms of scoring. This level would have slight deterioration and would have slightly less than ideal conditions for all attributes in our table. Additionally, a green space rated as “good” could be seemingly very healthy, but could show many signs of littering or some other deteriorating condition, thus it cannot be classified as excellent.

The “fair” level would show obvious signs that the land is not ideal. In terms of safety of the area, a “fair” level would be starting to show signs of safety hazards and waste that would be considered unhygienic. The soil quality would not be conducive to growth and amount to large areas of barren land. A green space that is considered “poor” would have the worst status on our rubric and be nearly beyond repair. When the land is about 70% barren and the soil unable to sustain environmental growth, the reutilization of these “poor” areas are examined in terms of development. Although these areas may look irreversibly destroyed, they show more potential when considering purpose. For example, soil boxes or raised beds could create a garden out of an area that is almost completely barren.

3.1.2.3 *Determining Proper Weights for Attributes using MATLAB*

Initially, weights were chosen based on our perceived notions of how Mr. Savorgnano graded lands. This approach worked reasonably well, but was lacking any kind of evidence based justification. To rectify this, the team made a form that both Alessandra and Michele filled out, separately. The form asked the sponsors to give the land a score based on the rubric, and then an overall score from one to ten. A score of ten indicates a perfect score, and a score of one is abysmal. Additionally, both sponsors ranked pictures of land from best to worst. This was done in order to test whether or not the sponsors had similar opinions of land. Overall, the test proved successful, as both sponsors were similar in their rankings. If the two had drastically different results, this would have posed a problem. The results of this form can be found in Appendix I

Once the form was filled out, and the breakdowns of both sponsors were available, the weights were calculated using MATLAB . In order to do this, the breakdown of grades of Michele’s form were put into one matrix, and the overall grades for each land were put into another matrix. The same thing was done with Alessandra’s data. The two breakdown matrices were combined into one, as were the two overall grade matrices. A linear regression was done using the regress() command, to obtain proper weights. Based on the confidence of the results, obvious outliers were removed, and the procedure was repeated. After removing the outliers, we obtained our weights shown below in figure 12. For simplicity reasons, we rounded the weights to whole numbers for our calculation. The MATLAB code responsible for these calculation can be found in Appendix I.

```
Weights of Attributes:
Biodiversity (Number of Species) = 4.4522
Littering = 3.7155
Upkeep = 3.009
Soil Quality = 2.948
Safety & Hygiene = 1.1386
Invasive Species = 1
```

Figure 12: MATLAB Calculation Results

3.1.3 *Data Organization in QGIS*

To collect data on the physical boundaries of the land, we used an application called QGIS. We created columns for each of the important pieces of data notable for each space, which can be viewed in Appendix J. Notes on unique attributes to each green space were taken in the comments section of the application, while the main focus was on the vegetation and land condition. For example, instead of saying that there is grass, we specified what percentage is covered in weeds and what percentage is grass. Additionally, we clarified how well maintained and how clean each space was. In addition to assessing information outlined in the rubric, we also collected information on the boundaries of the green space, the vegetation, and additional comments that will lead towards the steps towards reutilization.

For each green space, we had two people classify lands together in order to ensure consistency. We first took pictures of the spaces and recorded the scores for each attribute of the rubric. After added up the scores, we gave the space an overall classification as discussed in section 3.1.2. In this initial data collection we also determined the ownership status of the space, either public or private. Using google satellite map layer and QGIS projections, we found the area of the space. With this information, we went through the general flowchart in order to identify the current usage of the space.

A limiting factor to collecting data was the weather. Since many green spaces were surrounded by high walls, we needed to use our drone in order to obtain a view of the spaces. However, due to its light weight, our drone cannot operate in strong winds or rainy weather, limiting our window for data collection. In addition, occasional strikes on the public transport system limited our access to the island of Giudecca.

3.2: Results of Analysis of Current Spaces

We surveyed over 230 green spaces on Giudecca, over double what was expected (shown in Appendix A). This is because many collectively owned lands were separated into smaller sections and had to be inventoried individually, which was not visible from Google Satellite. Approximately 70% of the spaces by area that we surveyed were considered to be in good or excellent condition. However, the majority of current green space types were classified by our team as urban wilds and parks. Though urban wilds tend to have the most work to be done in

order to create an aesthetically pleasing space, they also have the most potential and the most options for reutilization.

At every green space, we used our rubric to create a condition score that we would use for classification. The rubric takes into account all the attributes that are important for green spaces and reutilization according to the urban specialists and environmentalists that we consulted, including Alessandra Manzini, Leonardo Marotta, and Michele Savorgnano, and combines the scores for each attribute into a single grade. Figure 13 below shows the results of our data collection organized by the green space condition grade.

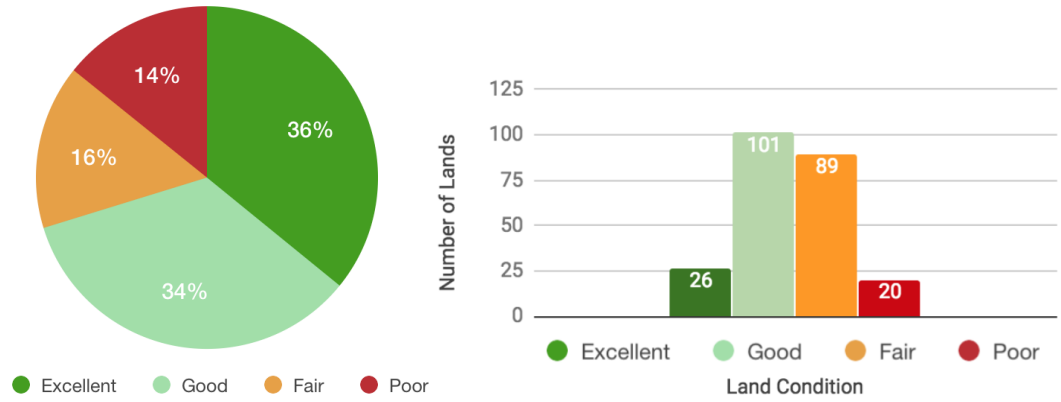

Figure 13: Distribution of Condition by Area and by Count

From the pie chart and the bar chart we can see that, both by area and by number of green spaces, most of the green spaces are in decent condition. However, when we overlap this data with the land type distributions, most urban wilds fall into the “fair” and “poor” categories. Since urban wilds are lands that are most likely to be abandoned or underutilized, we hope to transform those lands into the “good” and “excellent” conditions and make better use of them. Figure 14 below shows the distribution of the land condition on a google satellite image.

Figure 14: Map of Green Spaces by Condition

Based on our data on the types of lands shown below in Figure 15, most of the green spaces on Giudecca are classified as parks and urban wilds (48% and 39% by area accordingly). But by parcel, urban wilds takes up almost half of the total number of lands surveyed. The reason being that most of the urban wilds are small patches of green on sidewalks besides a few major abandoned factories. This means that many of the green spaces on Giudecca are overlooked, and

just by some having some care as easy as cleaning up the space, the entire island could look much nicer. In addition, larger scale revamps could be done on bigger urban wilds such as abandoned factories or boatyards left from the industrial era, and provide new purpose in the modern days.

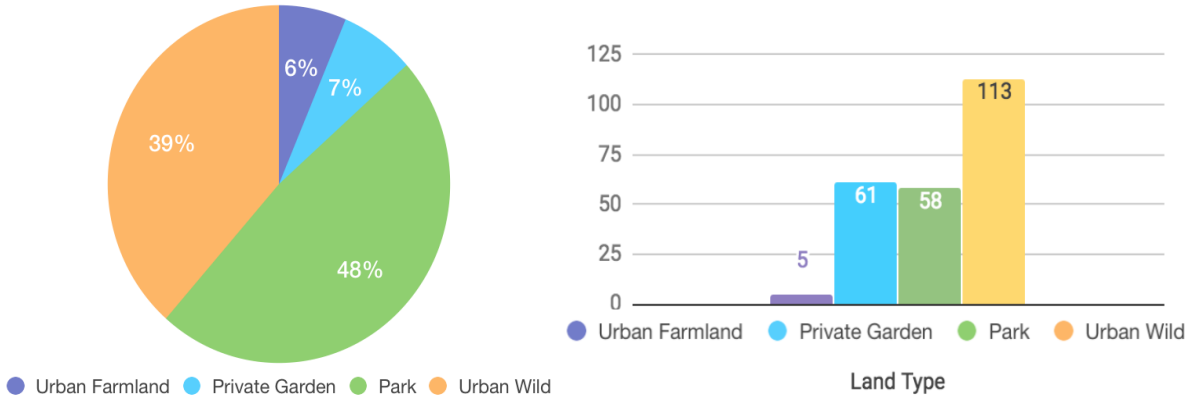

Figure 15: Distribution of Land Type by Area and by Count

4. Reutilization of Green Spaces on Giudecca

This chapter examines the process of identifying possible new uses of green spaces on Giudecca. It includes the creation of reutilization flowcharts, determining ownership information and the next steps for reutilization, distribution of the types of green spaces on Giudecca and what they can be used for, as well as a few practical examples on what can be improved on the green space. At the ends, there are some exceptions to our flowcharts, which are case by case green spaces that we classified separately.

4.1 Methodology of Reutilization

The reutilization process started with the analysis on the data collected and the creation of reutilization flowcharts. As mentioned in section 3.1.1, the flowchart in Figure 10 contains criteria that would be relevant in all green spaces, and narrows the possibilities for land types based on the space. In this way, we could quickly identify green spaces as well as perform an identical analysis for each space. Upon visiting the area, we collected data based on the criteria that is established in this section. Following the establishment of land type, we consulted a different flowchart that outlines the potential uses for each land type. Though many spaces cannot be transformed into an entirely different land type due to the government regulations mentioned in the background, small scale changes can often make a huge improvement to green spaces.

4.1.1 *Reutilization Flowcharts*

To provide a framework for specific reutilization plans for green spaces, we created a comprehensive flowchart to identify land usage in the general sense as mentioned in section 3.1.1 (Figure 10). In addition, we also made sub-flowcharts (Appendix F-H) for reutilization so that once we classify lands into one of the four categories, specific options can be proposed based on what the current land type is.

Three of our categories (urban wild, urban farmland, and park) have their own flowchart, with questions for that particular category. Private gardens are an exception, without a separate flow chart, because the usage of each private property is at the discretion of its owner. As an example of the three specialized flowcharts, if a green space has been categorized as “park,” then the surrounding area will be analyzed using the “park-specific” flowchart.

Upon compiling the classified and graded green spaces, the space was immediately given a suggested usage via the system of flowcharts that we created. In some cases, the usage was unique to that specific area and we strayed slightly from the flowcharts. We left private gardens without options for reutilization as the owners should maintain their green spaces as they see fit. We performed a qualitative analysis for each green space with the collected data. This analysis identified the course of action that will better utilize the area, and what changes must be made to reach the potential of the space.

At the start of the project, we consulted with Michele Savorgnano of FUD to determine what he looks for in a green space, and to better understand his vision. We visited lands that were in critically poor shape, as well as lands he thought might have the purpose of farming for the community. From the information that we received, farming seemed to have the greatest impact on the community and the most important to FUD. This stems from the fact that much of the work that FUD has done has been in creating productive gardens out of unused spaces. However, only a few of the spaces that we visited on Giudecca fell under this category.

4.1.2 *Determining Ownership Information for Potential Reutilization*

Ownership status, namely public or private, will determine what can be done on the piece of land. The Italian Cadastre (the Italian land registry) can identify how each space is registered, which we used to determine our restraints in terms of land reutilization (Citta' di Venezia, 2010). Specifically for the island of Giudecca, there are two ways to obtain this information: through the Cadastre, or through connections of local liaisons such as the Venice Project Center (VPC) and FUD.

As a member of the Permanent Committee on Cadastre in the European Union (PCC), Agenzia della Entrate, the revenue agency of Italy, organizes territory information for investment and tax purposes (Agenzia della Entrate, 2017). Under its services, it provides means for citizens to lookup cadastral data by tax code. Once provided with the tax code of a property owner, obtained by our team through the Venice Project Center and their connection to the city council, and the cadastral area where the search is to be carried out, we can obtain information about properties situated throughout Italy. This online search function provides personal details of the property owner, the location of the property, and further property details. However, this search can only be carried out for properties that have data stored online (Agenzia della Entrate, 2017).

A limitation of this method is that it requires registration with tax payer information, and may be limited only to Italian citizens. There is also a monetary cost for each unique search, which adds up to a huge amount if we lookup every single property. Additionally, the data that we receive would be privacy sensitive information, so we would not be able to publish this data or add it to our application.

Upon analysis of ownership information in green spaces, we came to the realization that the first piece of information we required in order to make decisions on spaces was its accessibility to us, the researchers. Initially, we sought out to get maps of green spaces, or properties, that showed ownership as defined by the government. However, as discussed shortly, these maps were not easy to obtain. We decided that for the purpose of this project, we would outline what lands are accessible openly, with the help of a drone, and inaccessible. This type of classification would work well in other lands, as even if a land is public, or government owned, it may have closed off access if it is fenced off or closed off for whatever reason. These maps allow other researchers that want to survey or update information on Giudecca or other lands, to see what they can easily get access to.

Alessandra Manzini, who works as an urban mapping specialist interested primarily in the user interface side of the application, shared with us a land registry layer in QGIS which outlines the boundaries of each property. This data is a helpful reference as it tells us which green spaces belong to one set of property. However, it doesn't include any information on the ownership status.

We found that QGIS expert Piero Toffolo, a VPC employee, had access to the ownership status of each individual piece of land from his past projects. The process is somewhat complicated and only returns one property at a time, so we resorted to making on-site decisions for spaces that are distinctly public (parks, for example) or private (backyards). Following the completion of data collection in Giudecca, we consulted Mr. Toffolo to confirm ownership status on green spaces that were not clear while collecting data.

4.2 Results of Reutilization Options

Upon completing our database of green spaces, a set of filters were created based on the current type of each green spaces and what they can be potentially used for. We found that urban wilds had the most potential for reutilization, though multiple green spaces that were classified as parks or farms have room for improvement. For the purposes of our project, parks will remain parks due to its registration with the city of Venice, but there is still room for improvement such as converting to recreational area or animal sanctuary. Current farmland would also remain unchanged because maximizing agricultural space is vital to the self-sufficiency of Giudecca. However, projects such as farm to table or community outreach program can still be carried on to widen the use vacant farmland. These transformations are outlined through our app and through our reutilization flowchart. Smaller green spaces and lands that are owned by the city of Venice would have more feasible reutilization options. For example, some options are simply a matter of maintenance or adding park benches to make the space more aesthetically pleasing. Further investigation was done on a few examples green spaces that were considered to have the highest potential for reutilization with the most impact. The following sections outline these plans and explore necessary information for practical implementation.

4.2.1 *Reutilization Options for Urban Wilds*

The team followed the flowcharts in order to create recommendations for each individual green space. However, the most prominent transformations came from urban wilds due to their current lack of use. Urban wilds with high scores in the surroundings and biodiversity attributes have a very large potential for change. Many of the urban wilds we discovered in our data collection had a condition of fair or poor, thus needing larger amounts of work in order for them reach their full potential.

Figure 16: Map of Urban Wilds Reutilization

Shown above is a figure of all of the urban wilds that we've classified. We've color-coded each of the land types that the urban wilds can be transformed to. Unlike lands classified as parks, private garden, or farmland, which most likely stay as their respective categories, urban wilds have the potential to completely transform into one of the aforementioned categories, as well as a new category called "Development."

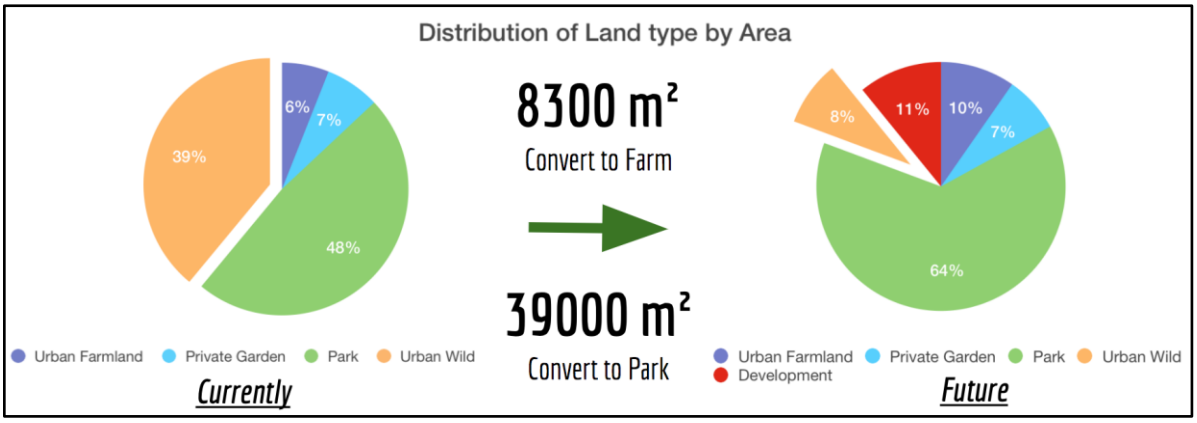

Figure 17: Area of Transformation from Urban Wild to Other Land Types

Development is dedicated to lands that are in such poor condition that we don't suggest that they be reutilized for greenery. Therefore, urban wilds are the lands that urban planners can fully take advantage of. As can be seen in figure 17**,** we've proposed that about 11% of previously classified urban wilds be transformed into development. An example transformation will be discussed in section 4.2.2.1.

4.2.2 *Options for Reutilization on on Giudecca*

There were many green spaces on Giudecca that we found could be reutilized. However since changes to larger spaces have a greater impact than those of smallers ones, we focused more of our analysis on the larger spaces. We have identified one green space of each type of land (urban wild, park, farmland, and garden) that we found to have the highest potential and proposed our plans for how each land could be improved upon. These case studies are discussed in detail in the following sections as examples of possible reutilizations. In analyzing these case

studies, we first looked up the Cadastre information for each green space using the methods mentioned in section 4.1.2. We received information including the owner of the specific green space, or the department that directly manages the space, as well as whom to contact. We also looked up the city master plan and checked the feasibility of implementing those changes to green spaces. This information will help volunteer groups that continue our project and implement these changes.

Although what follows are just a few examples of potential reutilization options, if all of the recommendations that we made from the research of this project were to be implemented, over 100,000 m² of land would be improved upon, and an additional 50,000 m² could be completely transformed. If the entirety of the 8300 m² we proposed for farmland were used in this manner, this land could provide food for over 250 restaurants.

4.2.2.1 *Transform to Park*

Figure 18: Location of Centro Teatrale Di Ricerca

The Centro Teatrale Di Ricerca (Figure 18), a square owned by the Comune di Venezia that contains multiple art galleries and studios for young artists, has green spaces behind it that are currently under utilized. Due to the consistent theme of art and music throughout the square, this area would be ideal for a reutilization project involving a transformation of an unused park to a recreational area. The space was originally classified by the team as in “good condition” but is considered an urban wild by our classification standards since the land is seemingly abandoned. This warranted the decision of suggesting the creation of a recreational area with an overall theme of music and the arts. By using the surroundings as inspiration when implementing manmade features to the space, we can ensure that the space will be widely used with a more relevant purpose.

The first steps for reutilization would be to set up regular maintenance to make the space more aesthetically pleasant. Currently, the space is mostly weeds and is poorly cut, so at the very least mowing the green space would make a difference. The space would also require a few benches or tables for students to work outside and the public to gather. In terms of incorporating the music and aspect, outdoor sculptures could be placed on the green space. Not only would this help with the aesthetics, it could also serve to inform the public of the new space by setting up a program where local artist could be selected to create a piece for the space. This would

incorporate the surroundings and the art studios in this square by helping them in their careers and reutilizing the space simultaneously. The suggested reutilization options would need to be approved since the space is owned by the city of Venice. The end goal of the reutilization of this space would be to create a functional recreational area for students to draw inspiration from.

4.2.2.2 *Transform to Farmland*

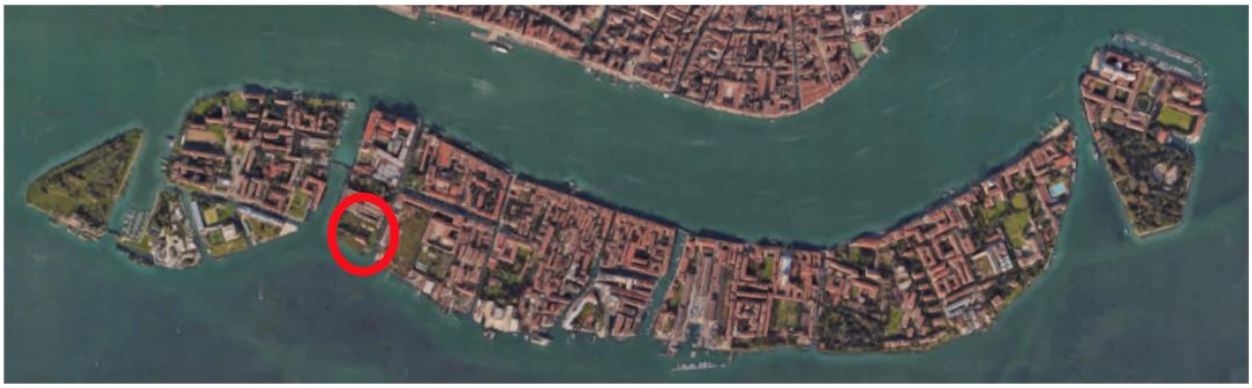

Figure 19: Location of the Abandoned Brick Factory

The western side of Giudecca, as shown in Figure 19, has undergone significant development in terms of housing units, but the reminisce of the industrial past can still be seen in the abandoned buildings around the island. There is a large abandoned green space behind what used to be an old brick factory, which would be a top example of a space that could be transformed into farmland. In the top left corner of the space there is a small area that has already been reutilized into an occupied garden in "good" condition (shown in Figure 20 below). The entire land is owned by Società' dell'Acqua Pia Antica Marcia Societa' per Azioni con sede in Roma (Real Estate Property, 2016). This is the company is in charge of the construction of the housing units directly behind this green space. Because this piece of the land is in considerably better condition than the rest of the space, we classified them as two separate spaces. The larger space was classified currently as an urban wild in "fair" condition. Ideally, we would extend the garden to the majority of the land in this space to create a large hydroponic farm to help make Giudecca a more self sustaining island.

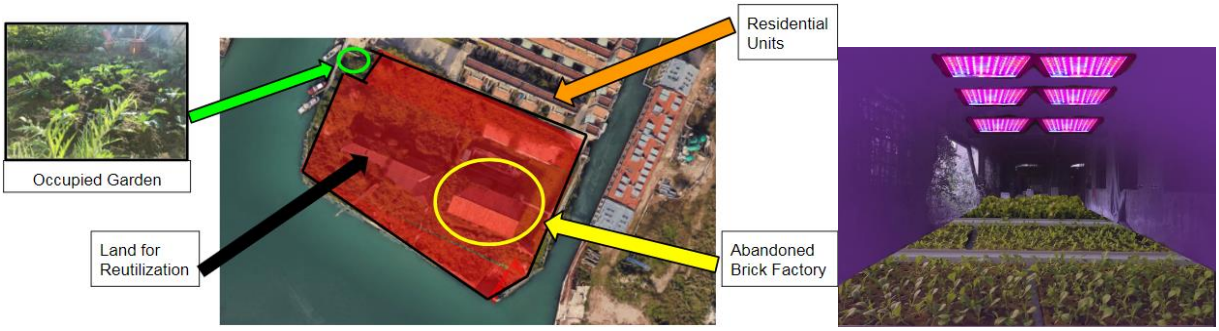

Figure 20: Reutilization of the Abandoned Brick Factory

Reutilization would start with contacting the construction company. This company has gone bankrupt since starting the construction of the housing units so we would need to start with

contacting the lawyer involved in the bankruptcy case. Next, we would consider the maintenance of the area as well as soil testing. We would need to determine what, if anything, can be grown in this area. Most likely, the soil is too damaged for agricultural growth. In this case, we would remove all the weeds and plants currently growing in the area and implement raised beds to grow crops in usable soil. Additionally, there is a old brick factory building in the middle of the space that can not be torn down due to the laws for historical sites.

However, we can make good use of this space by converting it into a hydroponic farm. Essentially, we would create a greenhouse of sorts that would have the ability to produce crops at a fast rate in a small area. This would mean adding lights and heat as well as setting up the plants with water and nutrients. Although this may initially be costly, the farm would generate a high quantity and have a large profit. The overarching goal for this green space would be to setup a farmland area that would give Giudecca the opportunity to be self sufficient in certain types of produce.

4.2.2.3 *Transform to Recreational Area*

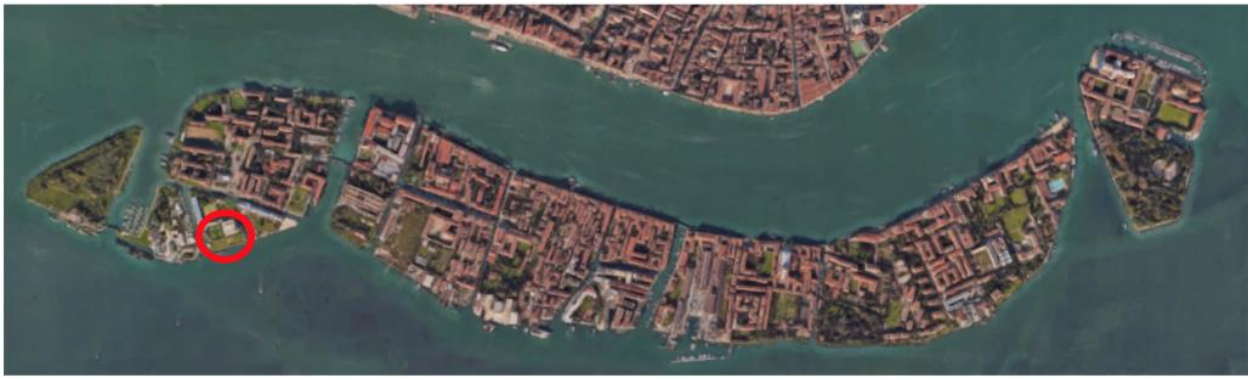

Figure 21: Location of the Sports Complex

The island of Sacca San Biagio, an island on the far western portion of Giudecca, has mainly sporting complexes and residential buildings. There is a large green space that is owned by the Comune di Venezia on the edge of the island which is currently unused (Real Estate Property, 2016). There is a swimming pool, basketball courts, and tennis courts around this area. The space was determined to be a park in "fair" condition by our general flowchart (shown in Figure 22 below). When classifying this area, the team decided that the best reutilization option would be a recreational area. Due to the location overlooking the water and the size of the green space, as well as the sportive theme of the entire island, we decided with Michele Savorgnano that the recreational area could be an obstacle course for kids. This would create an attraction for the island and help bring value to the area.

Since the area was well maintained, the reutilization process would begin with contacting the city to organize approval for this use and funding for the adventure park. Ideally, the park would include multiple structures such as rock climbing and log walking. According to Mr. Savorgnano, this addition could pull the area out of the stereotype of poverty and help to generate money to improve the area. The suggestion would most likely be given to the city to

find the appropriate company to complete the construction process. Additionally, the space would be enhanced with a centralized walkway leading to the green space so in order to attract more customers. Currently, there is a small grassy path that leads to the area on the side of the tennis courts. We would add a brick walkway that makes it clear to pedestrians that this area is not abandoned. A fence would be added to the edge of the land in order to keep kid's toys from falling into the water and ensure the safety of children playing in this area. The inclusion of a dock for boats would allow for water access and parking, as well as attract people to the green space. Due the high cost of the maintenance of these reutilization options the problem of financial support could be solved with the implementation of a restaurant as pictured in the photoshop image below. The restaurant and the obstacle course could use a portion of the profits towards the upkeep of the green space. The goal for this space would be to create an athletic attraction to make use of an abandoned space as well as raise money for improvements in the community.

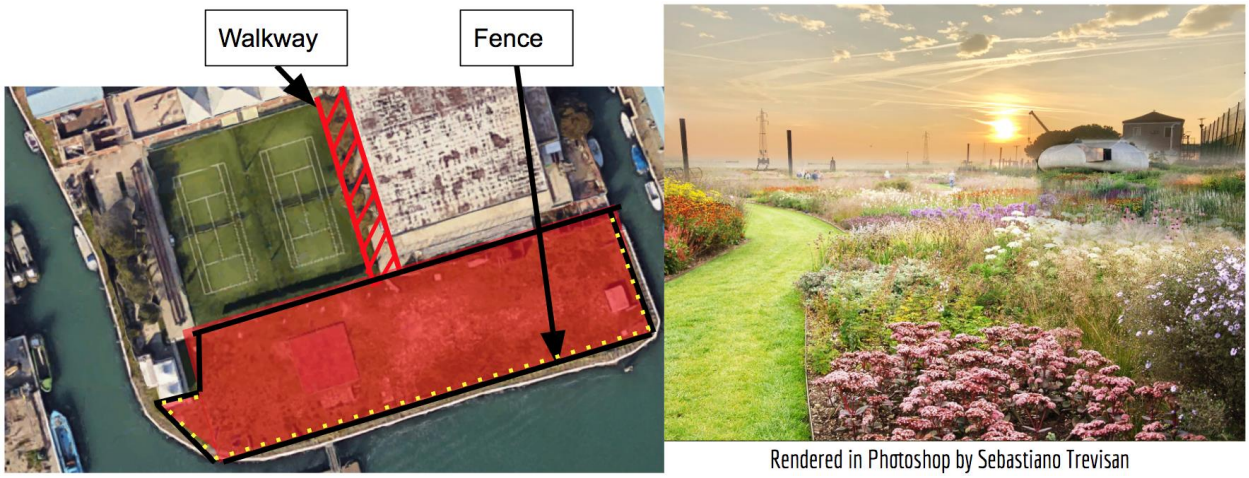

Figure 22: Reutilization of the Sports Complex

4.2.2.4 *Transform to Community Outreach Garden*

Figure 23: Location of Santissimo Redentore Monastery

Inside the Church of the Santissimo Redentore, a monastery on the eastern side of Giudecca, there is a large green space near the entrance. The monastery is and this green space is owned by the Provincia Veneta dei Frati Minori Cappuccini, which is the organization of the friars (Real Estate Property, 2016). The space was classified by the team as "excellent condition" and it is currently considered a farm according to our flowchart. The farm is used only to feed the monks that live in the monastery. We found using our reutilization flowcharts that the suggested option for transformation would be to create a farm-to-table urban farm setup. The excellent land condition and the restaurant that is within 200 meters of the church aided in this decision. After calling the restaurant we were informed that they do not already receive produce from the monastery. However, after speaking with the monastery, it was clear that the monastery would not be interested in making a profit due to the values of the church. Additionally, they would not want people to be entering the church regularly for this purpose. Our next option for reutilization was to use this area as community outreach garden. This would incorporate the farming aspect but would be more ideal for the church's purposes.

In order to implement this suggestion, we would start by determining a plot in the green space that would be ideal for the types of produce that would be grown. Next we would identify programs in Giudecca that give fresh produce to people in need. We would then incorporate the community by creating a volunteer service for delivering the produce to the programs or directly to the people in need. We would also need to reach out to the church for volunteers in this project starting with the current caretakers of the garden. For this green space, the goal would be to create a community garden experience that suits the needs of the community while creating a use for the empty plot of land in the monastery.

5. Development of a Web Application and its use in Data Collection

Once we leave Venice, it is important that our data is well managed and is able to be used in the future. The use of a web application is the best way to manage our data in order that our project can be continued in the future. This method has proven successful in several past projects in terms of allowing members of the community to add information to keep the app updated. (Devine, J.W., Lundgren, M.P., Vouldjeff, D.M., Wey, J.L., 2017).

When speaking with the sponsor about the app, the need for a simple, user friendly interface became clear. The goal of this application as a deliverable is to allow for the continuation of our project through the islands of the lagoon and the mainland.

5.1 Methodology of App Development

We contacted Nicola Musolino, a Software Engineer of the VPC, to help us incorporate our data into a project that the VPC has been working on called "The City Knowledge Console" (CKC). This console displays different types of data visually on a map. Currently the CKC is

used for a large variety of projects to display information geographically. For example, there is a map of the all the bridges in Venice. The bridges are displayed as points on a map, and the user can click on a point to read more information about it and can even add more points if desired. The CKC seemed like the perfect platform for us to use, as we were trying to display our data geographically for other people to view and edit.

5.1.1 *Web Application*

In essence, the application that we created is a data collection tool. It is used to collect and store the data that we collect on each green space. For this reason, the app's main function is to communicate with a database management tool called Firebase. This is the tool used by many of the projects at the VPC. In order to do this, we needed to write code in HTML to display the webpage aspect of the app, and JavaScript to add the functionality and communication with the database. Since the VPC often uses these types of applications for their project, we were given some starter code to which we modified to our specific needs. From there, we added our own functionality, which included importing Google Maps and importing a drawing manager in order to outline each green space on Giudecca with a polygon.

5.1.2 *Conversion of QGIS Data into Web Application*

Once all the data was collected and categorized, we created a way of displaying the data comprehensively for all users. The data that we collected is useful to our database, but it must be presented according to the needs of the user. For this aspect of our project, Alessandra Manzini was looking for a way to interactively display the data, that allows the user to both see and filter the data, as well as add data of their own.

It is often useful to display only specific pieces of information, depending on the needs of the user. For example, if someone is looking to use the space for recreation, he or she does not care about space that is good for development and should be able to select land that we classified as good for recreation. For this, we created different layers out of our initially uniform base layer. This process essentially creates new JSON files which are then parsed by the CKC. When the user selects a filter, the CKC parses the JSON file linked to that selected layer, and overlays the green space polygons onto the map. In this way, we can apply the visuals shown in section 4.2 but in a format more widely used than QGIS, namely Google Maps.

Additionally, the user can add polygons of their own by drawing directly on the screen. Using their mobile phone's GPS, it will be easy to find the green space on the map. When finished with the polygon, the user is prompted with a form, which determines the grade of the land and potential options for reutilization based on his or her responses. This is especially important, as it allows users to update information after we leave Venice, and can help this project grow and develop.

5.2 Results of App Development

When beginning to develop the app, the team thought it would be useful not only to create the web application, but to also create a QGIS plugin. Many landscapers and urban planners use QGIS in their work every day. So, creating a plugin that QGIS users can simply install will make their experience easier when it comes to adding data. This section below will describe the specifics of how the web app and the plugin work.

5.2.1 *Data Collection using the Web App*

We tested our web application that we created through data collection. The web application allows the user to outline a green space by drawing a polygon around it. Just as in Google Maps, our map can be shown in satellite or street view in order to better see the land on the map. When drawing a polygon around a particular green space, the user can zoom in just as you can on Google Maps to get a more precise outline of the green space when drawing the polygon.

Once the polygon is drawn, a form will appear on the screen asking for the attributes about the green space, which we have defined in section 3.1.1.2. This will also have a comment section where the user can write general notes about the land if he/she wishes. The form can be found in Appendix B. Then once the form is submitted, three additional read-only fields are populated on the next page (shown in Appendix C). These fields calculate the condition of the land, the final score of the land, and a potential reutilization. All three of these fields obtain their information by going through our flowcharts from chapter 3.

After the form is filled out and the last page with the additional fields are shown, the data is saved to that polygon that was drawn. If the user wants to come back later to view the data again, the user would be able to by simply zooming into the desired polygon and clicking on it. The form with the attributes and the results will show up for easy viewing. With this web app, our project will be able to be extended to the mainland and the lagoon area. Users can be added so that anyone who wishes to continue our project can do so easily.

5.2.2 *QGIS Plugin*

It is common that urban planners and architects use QGIS to collect and view data about existing lands. QGIS is an incredibly powerful tool, open source, and free to use. Open source software allows for anyone to change and add features to the program, and QGIS allows for

developers to create plugins to extend the functionality of the base program. We took advantage of this feature, and put our programming skills and methodology to use by developing a plugin that classifies land and populates the data fields automatically. The user has to select a polygon, fill out our form, and the attribute table (the page where data is stored) is automatically updated with the condition of the land and possible reutilization options. The condition and reutilization options are calculated based on our rubric and flowcharts that were discussed in the Chapter 3 of this report. A screenshot of the plugin can be found in Appendix K.

This plugin can be used to greatly increase the speed of data collection by having the program automatically calculating everything, as opposed to the researcher having to go through the flowcharts and rubrics manually. Although the plugin can be improved upon, its functionality is complete, and we are leaving the code to the Venice Project Center to add features if they so choose.

6. Conclusions and Recommendations

As one of our main achievements of this project, we inventoried and classified over 230 green spaces on Giudecca, and provided options for reutilization. We created a land condition rubric and a series of reutilization flowcharts as our methodology, which we also programmed into a web-based application and a QGIS plugin. We separated green spaces into groups based on their current land type and looked at the green spaces with the highest reutilization potential for each type. We discussed potential improvements to be done for each piece of land and outlined the next steps for implementation. In this process, we noticed the prominent relationship between science and technology.

When improving upon technology of any kind, one can start by looking into nature. Many technological advancements can be traced back to inspiration from the natural world. Without the technology involved in mapping and organizing data, we wouldn't have the resources to start reutilization projects. Technology is vital in connecting people and organizing information in easily accessible, user-friendly ways. The intermingling of science and technology is a a key element in our project that make the reutilization of green spaces possible.

In the future, this project may be continued by other users who will add to our database of green spaces across the Venice Lagoon and the mainland. This may require some new classifications for land when these methods are applied to other areas where the type of green spaces differs drastically from the ones surveyed on Giudecca. In addition to expanding the database, the web application may be used by the residents of Venice to locate green spaces for leisure, or by city planners to determine possible forms of reutilization.

6.1 Recommendations on Furthering the Project

There are a few aspects in the data collection process which could be improved upon if similar projects were to be carried out in the future. First, when we were in the field surveying green spaces, we stored all the data in QGIS we produced a green space layer with the data. We developed an application that could do the same process on a web server, but since it wasn't completed until later in the term, most of the data collection was already done. However, this tool could help future projects if more data needs to be collected. Instead of converting QGIS data into the web application, new information could be added directly to the app and stored online. Furthermore, our land condition rubric has been key to our classification and has been revised numerous times based on inputs from three professionals on Giudecca. Nonetheless, the rubric could still be improved upon with inputs from other professionals, especially if the land differs greatly from what is typical on Giudecca. Lastly, some of the green spaces were inaccessible while we tried to collect data. If we knew from the start, arranging visits in advance with the help from the local liaisons could have lead to a larger and more complete data set.

Additionally, to better utilize the green spaces, a green space renting service could be put in place, similar to a project called iGreenGo. This project rents out green spaces that are privately owned for events, while also recommending activities that can be done nearby and on

the space. The project is still in its infant stages, and could potentially use the information gathered in our project to further its development.

Another similar community land access advocacy program known as 596 acres was brought to our attention. Based in New York City, the idea of 596 Acres started with an online map of publicly owned vacant land in Brooklyn. Upon discovering the amount of vacant lots that exist in the community and the unharnessed potential hidden in plain sight throughout the city's neighborhoods, the organization started advocating through social media to seek means of helping neighbors gain access to vacant lots and restore their community resources. While in Venice, our team was able to get in touch with one member of 596 Acres and learned about the opportunities of revitalizing abandoned community space. We believe this could be an applicable model for public green spaces in Venice. If an extension of our project or a project similar to ours were to be carried out for next year, these changes to the data collection methods and reutilization methods would help the project move forward more efficiently.

6.2 Recommendations to Fattoria Urbana Diffusa

In terms of green space exploration, an app makes it easy to see which green spaces are appropriate for a specific task, but doesn't allow for an immersive experience. The way to add an interactive experience could be QR Codes placed around Venice (or Giudecca as a proof of concept), that make a green space treasure hunt or walking tour. A code would be scanned, and would tell you relevant information about an adjacent green space. It would include some history and pictures, and would tell you where to find the next QR code. This can be implemented by creating websites for the green spaces surveyed this year, and then linking a QR code to the site URL. This concept could be continued in its own project in the future to be carried out by Fattoria Urbana Diffusa.

QR codes are just the first step towards an immersive experience of green spaces. Mr. Savorgnano brought to our attention the idea of a screenless experience, where the user walks around with a headset and is able to directly interact with green spaces as he or she approaches the space. For example, as the user approaches mint leaves, they might get a notification in their ear saying there are mint leaves to their right. This is a fresh take on green space exploration, but unfortunately with the way current GPS works in Venice, this would be nearly impossible. Often times, using GPS in Venice is difficult due to the tall buildings and narrow streets interfering with the signal. If if the issue of positioning were to be resolved, the aforementioned experience would become a more realistic option. One way to approach the problem is by using Wi-Fi beacons to triangulate and calculate position in a similar fashion to GPS. These beacons would be on the ground, creating less of an opportunity for interference with the signal. The drawback to this approach is the overwhelming cost this would bring to the city. Although a Wi-Fi tax may help mitigate the cost, financing this idea is out of our area of expertise. However, Fattoria Urbana Diffusa can work with these ideas in order to make the screenless experience that Mr. Savorgnano had mentioned a reality.

Lastly, Fattoria Urbana Diffusa can work with the Venice Project center to extend research on hydroponics in Giudecca. FUD and the Venice Project Center can collaborate on the research carried out at the Venice Architecture Biennale and possibly implement these techniques (Hydroponics at venice architecture biennale, 2012). Since the VPC is relocating to Guidecca, it is more feasible to test methods of growth and apply them to spaces such as the abandoned brick factory that we outlined. Additionally, the new space for the VPC is ideal for testing ideas such as farming robots and drone usage. The use of technology and robotics could further our project and make the inventory and classification process more efficient, thus allowing for a broader range of green spaces to reutilize and a larger database. With a more efficient data collection process, the focus of the project can shift towards reutilization options and implementation of such options.

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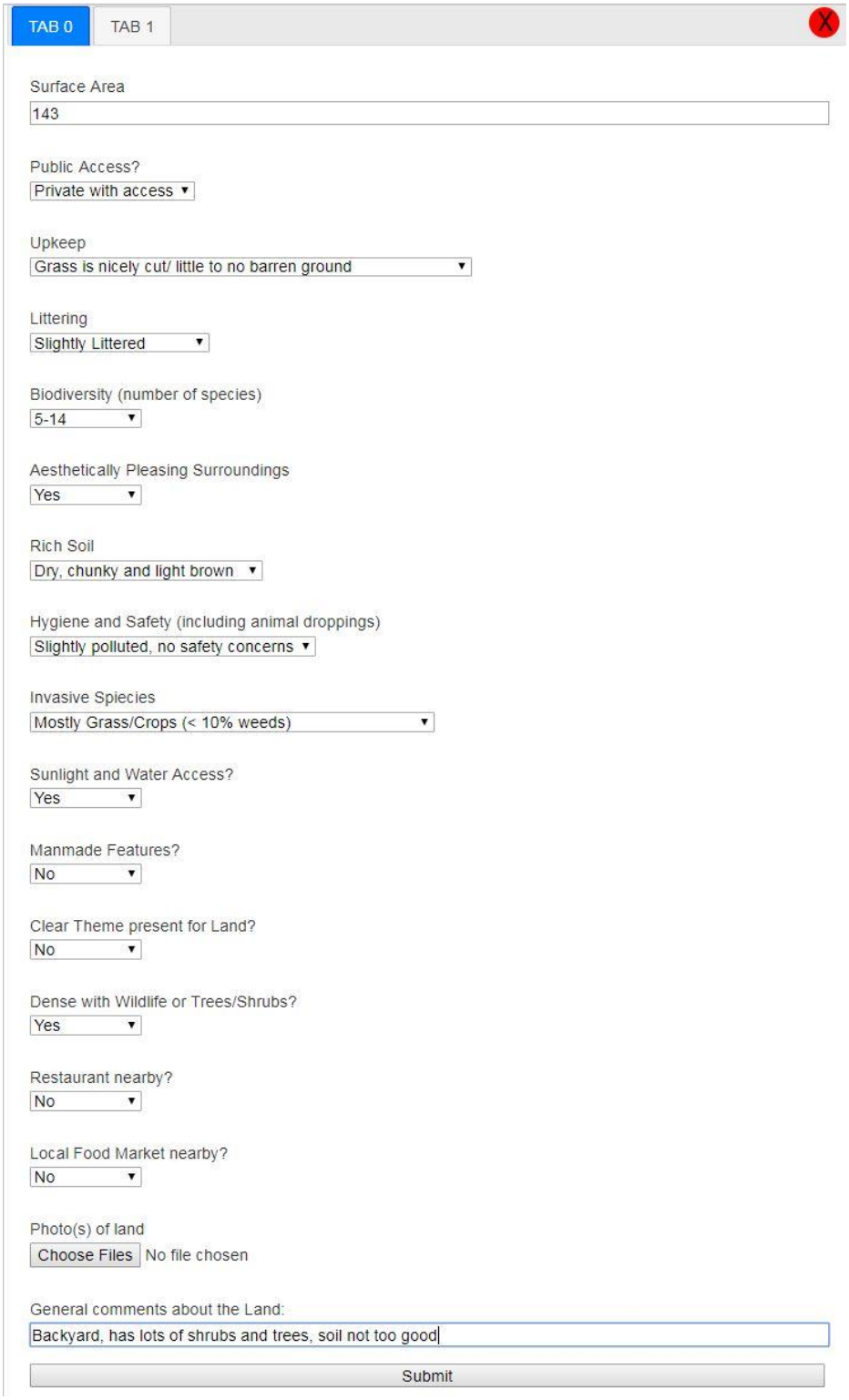
Appendices

Appendix A

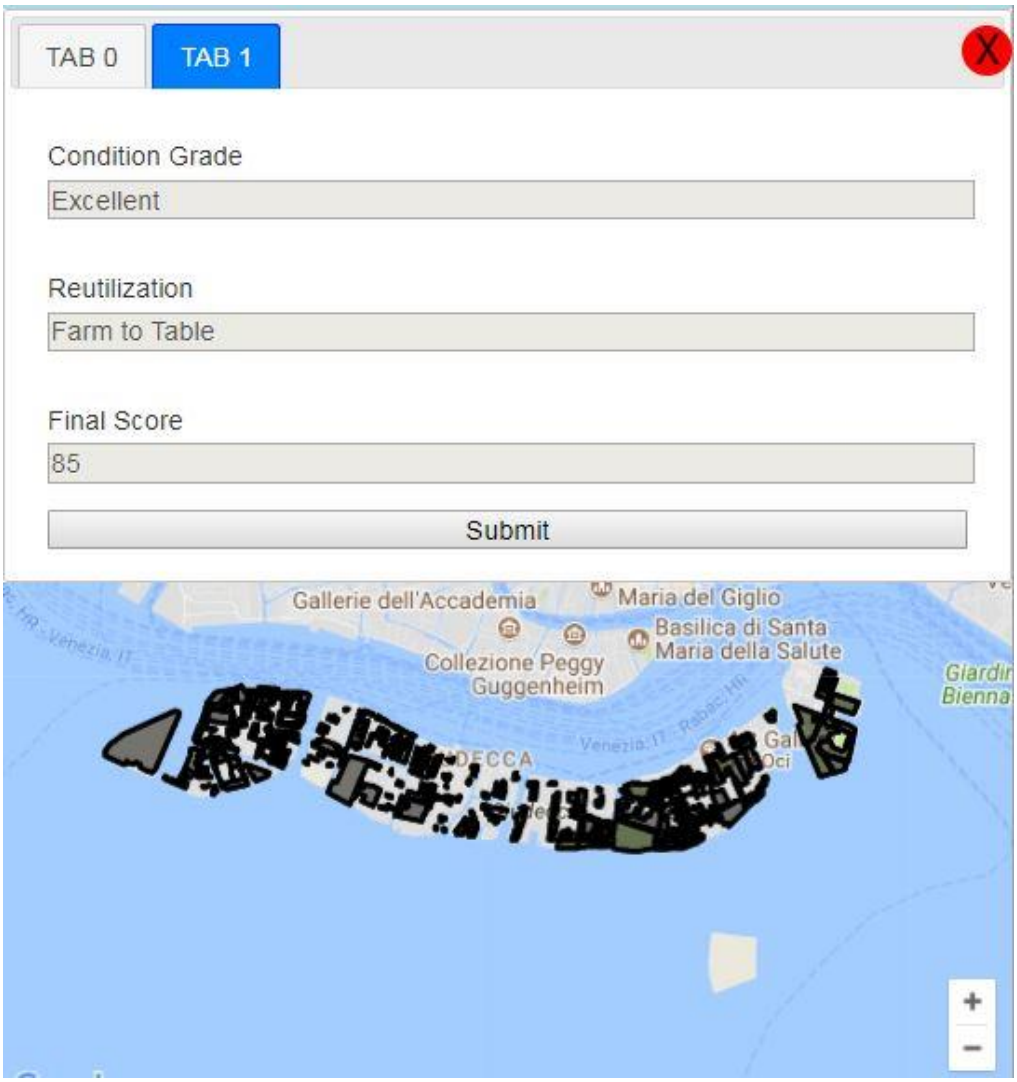
Giudecca Island with green spaces mapped using QGIS

Appendix B



Screenshot of the web application form

Appendix C



Screen shot of the web application return screen

Appendix D

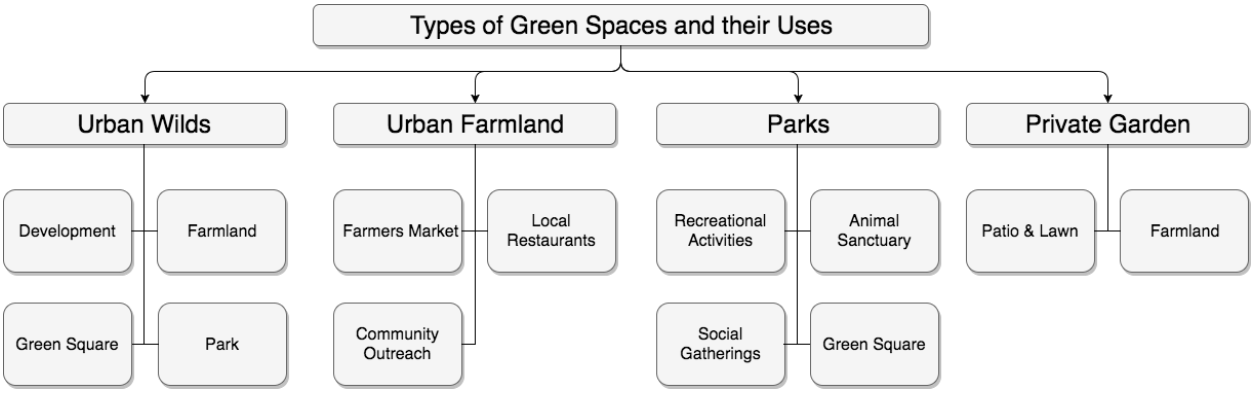
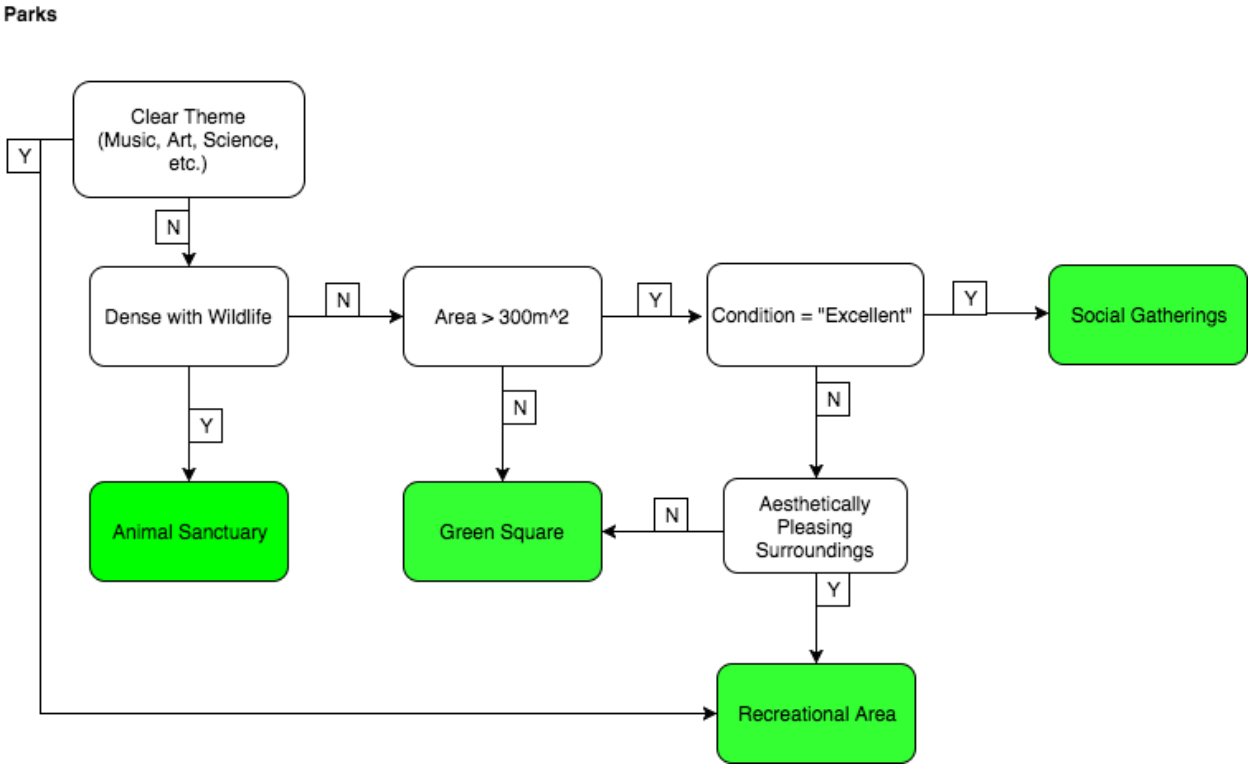


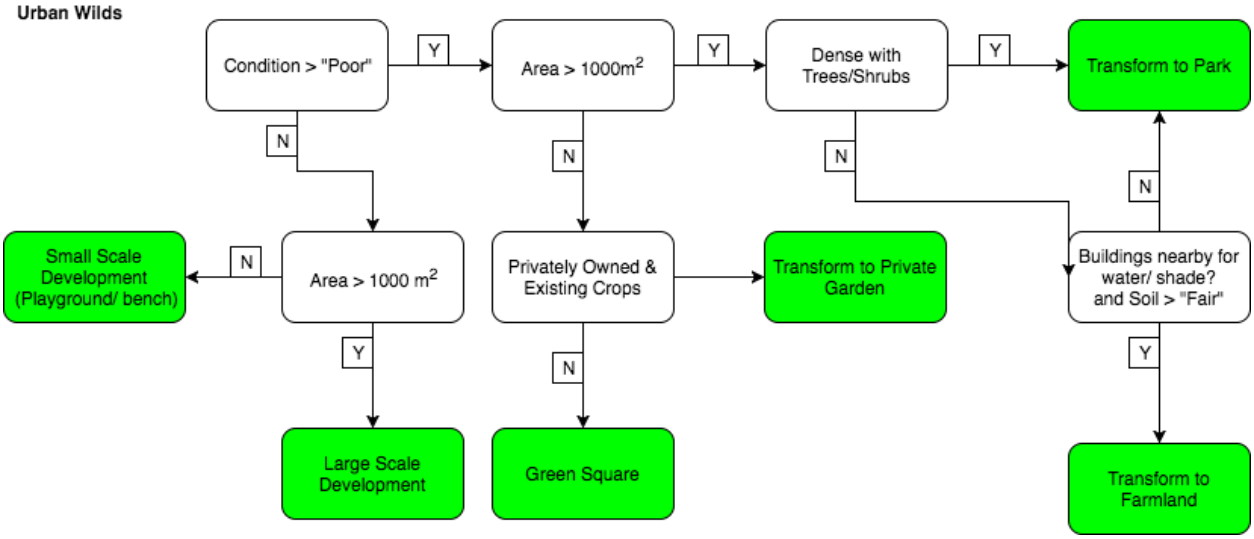
Diagram outlining potential uses of each category of green space.

Appendix E



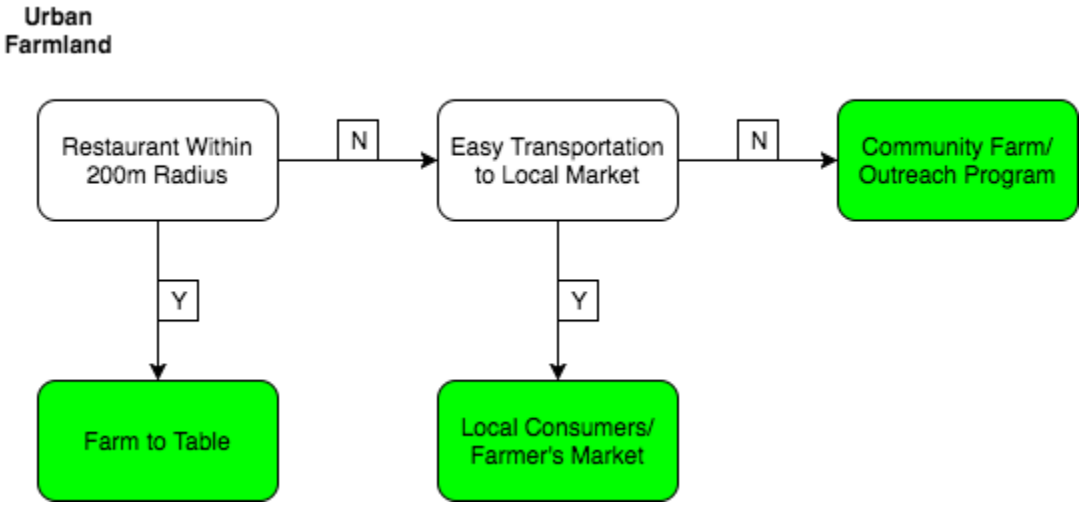
Parks Specific Reutilization Flowchart

Appendix F



Urban Wilds Specific Reutilization Flowchart

Appendix G



Urban Farmland Specific Reutilization Flowchart

Appendix H

Rubric for Classification Score

Weight	Attributes/Score	4 “Excellent”	3 “Good”	2 “Fair”	1 “Poor”
3	Upkeep	Grass is nicely cut/ little to no barren ground	Grass is poorly cut/ some barren ground	Few signs of maintenance/ lots of barren ground	No signs of maintenance/ completely overgrown or barren
4	Littering	Not Littered	Slightly Littered	Considerably Littered	Severely Littered
4	Biodiversity (Number of Species)	50 or more Different Species	15-49 Different Species	5-14 Different Species	Less than 5 Different Species
3	Soil Quality	Dark brown and Moist	Brown and soft	Dry, chunky and light brown	Sandy, rocky and light brown
1	Hygiene and Safety (including animal droppings)	Clean, no safety concerns	Slightly polluted, no safety concerns	Unhygienic, marginally unsafe	Contaminated, Dangerous elements
1	Invasive Species	Less than 10%	10% - %25	25% - 70%	70%-100%

Total Points:		55-64	41-54	27-40	16-26

Appendix I

MATLAB CODE:

```
%Matrix of results from Michele's Form
xM = [4 4 4 4 4 3 3;3 4 2 3 3 2.5 2;3 4 1 4 4 4 2;2 2 3 2 2 3 3;4 4 4 4 4 2 4;3 4 2 4 4 3 1;4 4 4 4 4 2 2;2 1 1 1 3 2 1;2 2 1 2 1 4 1;2 2 3 1 3 3 3;3 3 2 3 3 3 2;4 4 3 4 4 3 4;];
```

```
%Matrix of results from Alessandra's Form
xA = [3 3 3 3 3 3 3;3 3 2.5 2 2.5 2.5 2;3 4 2 4 4 4 1;2 2 4 2 3 3 2.5;3 4 3 3 2 2 2.5;2 3 3 2
3 3 1;2 4 3 3 2 2 1.5;1 3 1 3 3 3 1;1 3 1 1 4 4 1;2 3 3 1 3 3 1;2 3 2 3 3 3 2;3 4 3 3 3 3 1.5;];
%Matrix of results of Alessandra's final score for each land
yA = [7;7;7;6;7;5;6;4;4;5;7;7;];
%Matrix of results of Michele's final score for each land
yM = [9;7;6;7;10;6;8;3;3;4;5;9;];
%Matrices holding the combination of Michele's and Alessandra's data
xMA = [xM;xA];
yMA = [yM;yA];
%Preform regression on Michele's, Alessandra's, and the combination of
%both's, repectively
[mCoeff,conf,r] = regress(yM,xM);
[aCoeff,confA,rA] = regress(yA,xA);
[maCoeff,confMA,rMA] = regress(yMA,xMA);
%Removing the Alien Species from the list of criteria as per Michele's
%recommendation
xMnoAlien = [4 4 4 4 4 3;3 4 2 3 3 2;3 4 1 4 4 2; 2 2 3 2 2 3;4 4 4 4 4 4;3 4 2 4 4 1;4 4 4
4 4 2;2 1 1 1 3 1;2 2 1 2 1 1; 2 2 3 1 3 3;3 3 2 3 3 2;4 4 3 4 4 4;];
xAnoAlien = [3 3 3 3 3 3;3 3 2.5 2 2.5 2;3 4 2 4 4 1;2 2 4 2 3 2.5;3 4 3 3 2 2.5;2 3 3 2 3
1;2 4 3 3 2 1.5;1 3 1 3 3 1;1 3 1 1 4 1;2 3 3 1 3 1;2 3 2 3 3 2;3 4 3 3 3 1.5;];
%forming the new matrix to hold Michele's and Alessandra's data
xMAnoAlien = [xMnoAlien;xAnoAlien];
%Forming a maatrix after removing obvious outliers
xMAnoAliennoOut = [4.0000    4.0000    4.0000    4.0000    4.0000    3.0000;
   3.0000    4.0000    2.0000    3.0000    3.0000    2.0000;
   3.0000    4.0000    1.0000    4.0000    4.0000    2.0000;
   %2.0000    2.0000    3.0000    2.0000    2.0000    3.0000;
   4.0000    4.0000    4.0000    4.0000    4.0000    4.0000;
   3.0000    4.0000    2.0000    4.0000    4.0000    1.0000;
   4.0000    4.0000    4.0000    4.0000    4.0000    2.0000;
   2.0000    1.0000    1.0000    1.0000    3.0000    1.0000;
   2.0000    2.0000    1.0000    2.0000    1.0000    1.0000;
   %2.0000    2.0000    3.0000    1.0000    3.0000    3.0000;
   %3.0000    3.0000    2.0000    3.0000    3.0000    2.0000;
   4.0000    4.0000    3.0000    4.0000    4.0000    4.0000;
   3.0000    3.0000    3.0000    3.0000    3.0000    3.0000;
   %3.0000    3.0000    2.5000    2.0000    2.5000    2.0000;
   3.0000    4.0000    2.0000    4.0000    4.0000    1.0000;
   2.0000    2.0000    4.0000    2.0000    3.0000    2.5000;
```

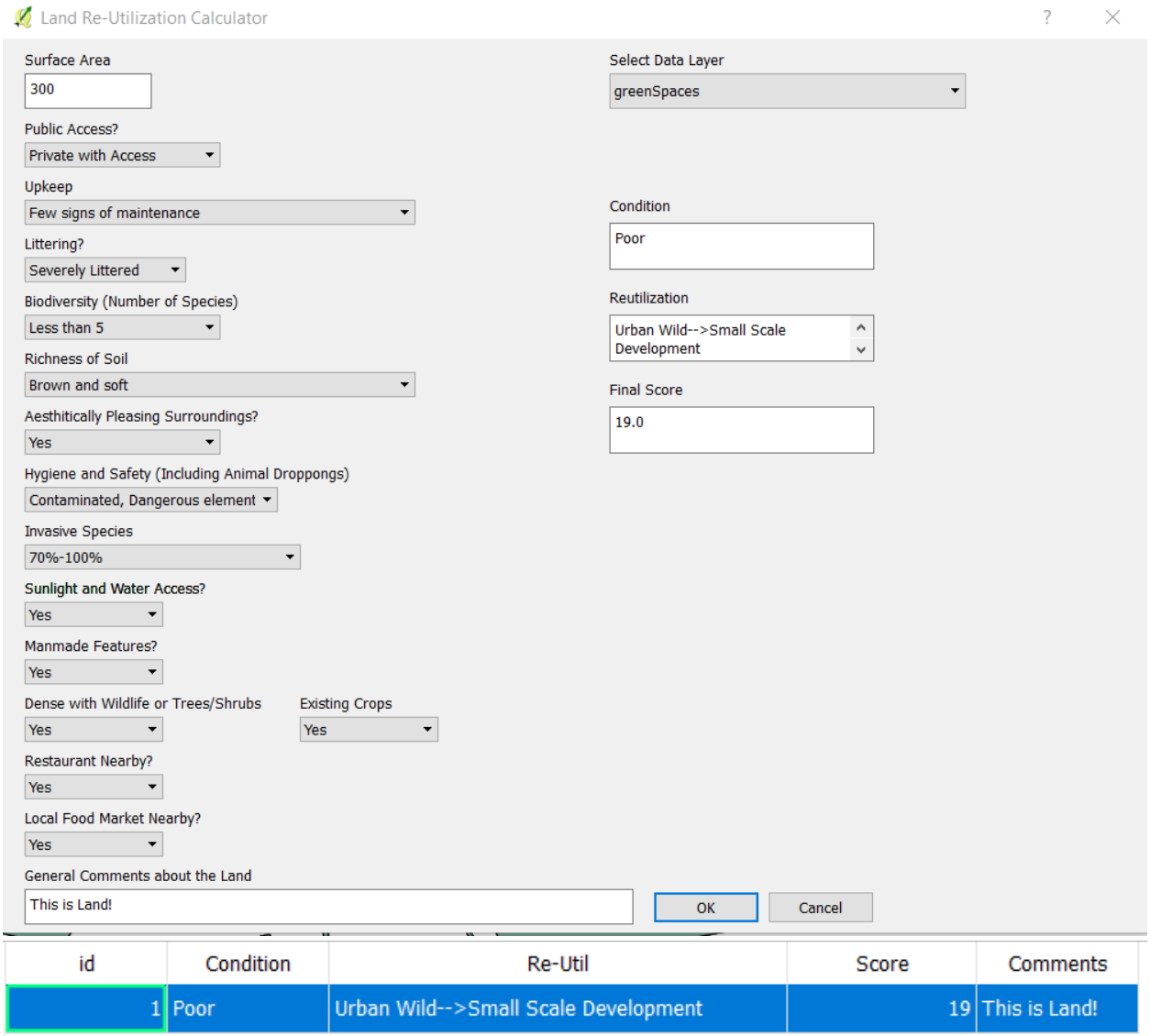
```
    3.0000    4.0000    3.0000    3.0000    2.0000    2.5000;
    2.0000    3.0000    3.0000    2.0000    3.0000    1.0000;
    2.0000    4.0000    3.0000    3.0000    2.0000    1.5000;
    1.0000    3.0000    1.0000    3.0000    3.0000    1.0000;
    1.0000    3.0000    1.0000    1.0000    4.0000    1.0000;
    2.0000    3.0000    3.0000    1.0000    3.0000    1.0000;
    %2.0000    3.0000    2.0000    3.0000    3.0000    2.0000;
    3.0000    4.0000    3.0000    3.0000    3.0000    1.5000;];
yMAnoAliennoOut=[9;7;6; %7;10;6;8;3;3;% 4;% 5; 9;7; %7;7;6;7;5;6;4;4;5;%7;7;];
 %perform the new linear regression
[maCoeffnoAlien,confMAnoAlien,rMAnoAlien] = regress(yMA,xMAnoAlien);
[maCoeffnoAliennoOut,confMAnoAliennoOut,rMAnoAliennoOut] =
regress(yMAnoAliennoOut,xMAnoAliennoOut);
%make a matrix to hold the weights; flip the raw values, sort
%them, and scale them.
weights = flip(sort((maCoeffnoAliennoOut * 10)/1.4629));
%print the weights
fprintf('  \n');
fprintf('Weights of Attributes:  \n');
fprintf("Biodiversity (Number of Species) = " + weights(1) + '\n' + "Littering = " +
weights(2) + '\n' + "Upkeep = " + weights(3) + '\n' + "Soil Quality = " + weights(4) + '\n' +
"Safety & Hygiene = " + weights(5) + '\n' + "Invasive Species = " + weights(6) + '\n')
```

Appendix J

pkuid	landuse	name	ownership	condition	vegetation	area	theme	reutilization	comments	scoring	access	sum
140	private garden		private	B	grass, weed…	839.19…	N/A	N/A	this is a private garden that is …	(12 + 12 + 8 + 9 + 4 +…	Limited	48
142	urban wild		private	C	grass, weed…	628.41…	N/A	green square	severly overgrown	(3 + 12 + 8 + 3 + 2 + 1)	None	29
143	private garden		private	B	grass, weed…	165.93…	N/A	N/A	private garden in decent condit…	(9 + 16 + 8 + 6 + 2 + 3)	None	44
144	private garden		private	B	grass, weed…	187.33…	N/A	N/A	This is a private garden. It is w…	(9 +16 + 8 + 9 + 4 + 3)	None	49
145	urban wild		public	D	grass, weed…	160.56…	N/A	small scale development	significant animal droppings. …	(6 + 8 + 4 + 3 + 2 + 2)	Full	25
148	urban wild		public	D	grass, weed…	56.908…	N/A	small scale development	significant animal droppings. …	(6 + 8 + 4 + 3 + 3 + 2)	Full	26
149	urban wild		public	C	grass, weed…	104.43…	N/A	green square	significant animal droppings. …	(6 + 12 + 4 + 3 + 3 + 2)	Full	30
15	urban wild		public	C	grass, weed…	52.734…	N/A	green square	similar patch of green space, …	(3+12+4+6+2+3)	Full	30
150	private garden		private	B	grass, bush…	838.81…	N/A	N/A	This is a private garden. Most …	(9 + 16 + 8 + 6 + 4 + 4)	Limited	47
151	urban wild		private	D	grass	2915.7…	N/A	large scale development	currently under construction	(3 + 8 + 4 + 3 + 1 + 1)	Limited	20
152	park		private	A	grass, weed…	1280.8…	N/A	social gatherings	the is a patch of green by the r…	(12+16+12+9+4+4)	Limited	57
153	urban farmland	FUD's …	private	A	grass, weed…	5350.0…	N/A	farm to table	this is farm where our sponsor …	(12+16+16+12+4+3)	Limited	63
154	urban farmland	Ciprian…	private	A	grass, weed…	1786.1…	N/A	farm to table	this a piece of farmland owned…	(12+16+16+12+4+3)	Limited	63
155	park	Bauer …	private	A	grass, shrub…	8043.2…	N/A	social gatherings	the bauer hotel has a huge gre…	(12+16+12+12+4+4)	Limited	60
156	park	Ciprian…	private	A	grass, trees	3778.6…	N/A	social gatherings	This is the best hotel on Giude…	(12+16+12+9+4+4)	Limited	57
157	park	Ciprian…	private	B	grass, trees	1742.1…	N/A	green square	This is the best hotel on Giude…	(12+16+4+9+4+4)	Limited	49
159	park		private	A	grass, weed…	2523.7…	N/A	social gatherings	this is nice garden area behind…	(12+16+12+9+4+4)	Limited	57
16	urban wild		public	C	grass, weed…	123.45…	N/A	green square	this green square is slightly big…	(6+12+8+6+3+1)	Full	36
160	urban wild		private	C	grass, weeds	31.324…	N/A	transform to private garden	this is barely a green space, th…	(3+16+4+6+4+1)	None	34
161	urban wild		private	C	grass, weeds	29.376…	N/A	transform to private garden	this is someone's backyard, b…	(3+12+4+6+2+1)	None	28
162	private garden		private	B	grass, weed…	37.631…	N/A	N/A	this is a much nicer private gar…	(6+16+8+6+4+3)	None	43
163	private garden		private	B	grass, plants	247.95…	N/A	N/A	this is a really nice private gar…	(12+16+8+9+4+4)	None	53
164	park	Ciprian…	private	A	grass, shrub…	2504.1…	N/A	social gatherings	this is the pool side of the Cipri…	(12+16+12+12+4+4)	Limited	60
165	private garden		private	B	grass, bush…	243.42…	N/A	N/A	this seems to be a private bac…	(12+16+8+9+4+4)	None	53
166	private garden		private	B	grass, trees,…	114.39…	N/A	N/A	this is a private garden with tall…	(12+16+8+9+4+4)	None	53
167	urban wild		private	B	grass, bush…	1103.9…	N/A	transform to park	this is an above average privat…	(9+16+8+6+4+3)	Limited	43

Screenshot of the QGIS attribute table

Appendix K



Screenshot of the QGIS plugin window

Appendix L

PROGRAMMED FLOWCHART IN PYTHON SCRIPT

```
app.initGreenCalc = function(ctl){

	var upkeep;
	var littering;
	var sur;
	var soil;
	var safe;
	var weeds;
	var finalScore;
	var letterGrade;
	var area;//int
	var access;
	var manmadeFeatures;//boolean
	var sunlightWater;//boolean
	var reutilizationGeneral;
	var reutilizationSpecific;
	var bio;
	var clearTheme;//boolean
	var wildlife;//boolean
	var restaurant;//boolean
	var local;//boolean

	ctl.initVars = function(data){
		upkeep =		data["Upkeep"];
		littering =		data["Littering"];
		sur =			data["Aesthetically Pleasing
Surroundings"];
		soil =			data["Rich Soil"];
		safe =			data["Hygiene and Safety (including
animal droppings)"];
		weeds =			data["Invasive Spiecies"];
		sunlightWater =	data["Sunlight and Water Access?"];
		access =		data["Public Access?"];
		area =			data["Surface Area"];
	    manmadeFeatures = data["Manmade Features?"];
	    bio =				data["Biodiversity (number of
species)"];
	    clearTheme =	data["Clear Theme present for Land?"];
	    wildlife =			data["Dense with Wildlife or Trees
and Shrubs?"];
	    local =			data["Local Food Market nearby?"];
	    restaurant =	data["Restaurant nearby?"];

	    if(manmadeFeatures != null)
	       manmadeFeatures = data["Manmade Features?"].trim()=="Yes";
	    if(area != null)
	       area = parseInt(data["Surface Area"]);
	    if(sunlightWater != null)
```

```
            sunlightWater = data["Sunlight and Water
Access?"].trim()=="Yes";
           if(clearTheme != null)
               clearTheme = data["Clear Theme present for
Land?"].trim()=="Yes";
               if(wildlife != null)
                       wildlife = data["Dense with Wildlife or Trees and
Shrubs?"].trim()=="Yes";
               if(local != null)
                       local = data["Local Food Market
nearby?"].trim()=="Yes";
               if(restaurant != null)
                       restaurant = data["Restaurant
nearby?"].trim()=="Yes";
               if(sur != null)
                       sur = data["Aesthetically Pleasing
Surroundings"].trim()=="Yes";
       }


       ctl.determineGeneralReutilization = function(){
               if(access.includes("Public")){

                       if(letterGrade == "Excellent" || letterGrade ==
"Good"){

                               if(area > 400 && sunlightWater && soil > 2){
                                       return reutilizationGeneral =
"Urban Farmland"
                        }
                               else{
                                       return reutilizationGeneral = "Park";
                       }
                       }
                       else if (letterGrade == "Fair" || letterGrade ==
"Poor"){
                               return reutilizationGeneral = "Urban Wild";
                       }
                       else
                               console.log("we have errors");
               }
               else if(access.includes("with")){ // private with access
granted
                       if(letterGrade == "Excellent" || letterGrade ==
"Good"){
                               if(area > 1000 && upkeep > 2 &&
manmadeFeatures && soil == 4 ){
                                       return reutilizationGeneral = "Urban
Farmland";
                               }else if(area > 1000 && upkeep > 2 &&
manmadeFeatures ){
                                       return reutilizationGeneral =
"Park";
                               }else if(area > 1000 && upkeep > 2){
```

```
                                        return reutilizationGeneral = "Urban
Wild";
                                }else if(area <= 1000 && sunlightWater){
                                return reutilizationGeneral = "Private
Garden";
                        }else if(area <= 1000 && !sunlightWater){
                                return reutilizationGeneral = "Park";
                        }
                        else
                                return "Urban Wild";
                        }
                        else
                                return reutilizationGeneral = "Urban Wild";

                }
                else if(access.includes("no access")){//private land with
no access
                        //should never get here
                }
                else
                        console.log("Errors have happened, try agaIN");
        }



        ctl.determineSpecificReutilization =
function(reutilizationGeneral){
                console.log("reutil: ", reutilizationGeneral);
                switch(reutilizationGeneral){
                case "Park":
                        return reutilizationSpecific = ctl.parkSpecific();
                case "Private Garden":
                        return reutilizationSpecific = "Private Garden"
                case "Urban Wild":
                        return reutilizationSpecific = ctl.wildSpecific();
                case "Urban Farmland":
                        return reutilizationSpecific =
ctl.farmlandSpecific();
                default:
                        console.log("Something went horribly wrong");
                }
        }

        ctl.parkSpecific = function(){

                //TODO: dont know how to do the "Clear theme"
                if(clearTheme)
                 return reutilizationSpecific = "Recreational Area";
                else if(wildlife)
                                return reutilizationSpecific = "Animal
Sanctuary";
                else if(area>300){
                        if(letterGrade == "Excellent")
```

```
                        return reutilizationSpecific = "Social
Gatherings";
                    else if(sur)
                        return reutilizationSpecific = "Recreational
Area";
                    else
                    return reutilizationSpecific = "Green Square";
                }
                else{
                    return reutilizationSpecific = "Green Square";
                }
        }

        ctl.wildSpecific = function(){

                if(letterGrade != "Poor"){
                    if(area > 1000 && soil > 2 && manmadeFeatures &&
sunlightWater && !wildlife)
                        return reutilizationSpecific =
"Transformation to Farmland";
                    else if(area > 1000)
                        return reutilizationSpecific =
"Transformation to Park";
                    else if(area <= 1000 && wildlife)
                        return reutilizationSpecific =
"Transformation to Private Garden";
                    else//if area <= 1000
                        return reutilizationSpecific = "Green
Square";
                }
                else if(letterGrade == "Poor"){
                    if(area > 1000)
                        return "Large Scale Development";
                    else
                        return "Small Scale Development";
                }
                else
                    console.log("errors are happening");
        }

        ctl.farmlandSpecific = function(){

                if(restaurant)
                    return reutilizationSpecific = "Farm to Table";
                else{
                    if(local)
                        return reutilizationSpecific = "Local
Consumers/ Farmer's Market";
                    return reutilizationSpecific = "Community Farm/
Garden";
                }

        }
```

```
	ctl.determineLetterGrade = function(finalScore){
		if(finalScore >= 55)//81
			return letterGrade = "Excellent";
		else if(finalScore >= 41)//52
			return letterGrade = "Good";
		else if(finalScore >= 27)//23
			return letterGrade = "Fair";
		else if(finalScore < 27)//23
			return letterGrade = "Poor";
		else
			console.log("Something is bad");
	}

	ctl.calculateConditionScore = function(){
		return  3*ctl.upkeepToNumber(upkeep)+
				4*ctl.litteringToNumber(littering)+
				4*ctl.biodiversityToNumber(bio)+
				3*ctl.soilToNumber(soil)+
				ctl.safetyToNumber(safe)+
				ctl.weedsToNumber(weeds);
	}

	ctl.biodiversityToNumber = function(atr){

		if(String(atr).includes("50")){
			return bio = 4;
		}
		// B
		else if(String(atr).includes("49")){
			return bio = 3;
		}
		//C
		else if(String(atr).includes("14")){
			return bio = 2;
		}
		//D
		else if(String(atr).includes("5")){
			return bio = 1;
		}
		else
			return bio = 0;//ensures error since only used in
multiplication in calculateConditionScore()
	}

	ctl.upkeepToNumber = function(atr){

		//best condition of green space, A
		if(String(atr).includes("nicely")){
			return upkeep = 4;
		}
		// B
		else if(String(atr).includes("poorly")){
			return upkeep = 3;
		}
```

```
		//C
		else if(String(atr).includes("lots")){
			return upkeep = 2;
		}
		//D
		else if(String(atr).includes("completely")){
			return upkeep = 1;
		}
		else
			return upkeep = 0;//ensures error since only used in
multiplication in calculateConditionScore()
	}

	ctl.litteringToNumber = function(atr){

		//best condition of green space, A
		if(String(atr).includes("Not")){
			return littering = 4;
		}
		// B
		else if(String(atr).includes("Slightly")){
			return littering = 3;
		}
		//C
		else if(String(atr).includes("Considerably")){
			return littering = 2;
		}
		//D
		else if(String(atr).includes("Severely")){
			return littering = 1;
		}
		else
			return littering  = 0;//ensures error
	}

	ctl.soilToNumber = function(atr){

		//best condition of green space, A
		if(String(atr).includes("Dark")){
			return soil = 4;
		}
		// B
		else if(String(atr).includes("Soft")){
			return soil = 3;
		}
		//C
		else if(String(atr).includes("Dry")){
			return soil = 2;
		}
		//D
		else if(String(atr).includes("rocky")){
			return soil = 1;
		}
		else
```

```
                return soil = 0;//ensures error
        }

        ctl.safetyToNumber = function(atr){

                //best condition of green space, A
                if(String(atr).includes("Clean")){
                        return safe = 4;
                }
                // B
                else if(String(atr).includes("Slightly")){
                        return safe = 3;
                }
                //C
                else if(String(atr).includes("unsafe")){
                        return safe = 2;
                }
                //D
                else if(String(atr).includes("elements")){
                        return safe = 1;
                }
                else
                        return safe = 0;//ensures error
        }

        ctl.weedsToNumber = function(atr){

                //best condition of green space, A
                if(String(atr).includes("Mostly")){
                        return weeds = 4;
                }
                // B
                else if(String(atr).includes("Some")){
                        return weeds = 3;
                }
                //C
                else if(String(atr).includes("Most")){
                        return weeds = 2;
                }
                //D
                else if(String(atr).includes("All")){
                        return weeds = 1;
                }
                else
                        return weeds = 0;//ensures error
        }


}
```