



# WPI

# Exploring the Causes of Depopulation in Venice:

The Role of Job Diversity and Quality, Housing Affordability and Availability, and Transportation speed and efficiency on the exclusion of residents.

An Interactive Qualifying Project submitted to the faculty of Worcester Polytechnic Institute in partial fulfillment of the requirements of the Degree of Bachelor of Science.

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# **Authorship**

The authors of this final report are Alex Bolduc, Bridget Redgate, Irune Sesma, and Thomas Walsh. Each student specified above contributed equally to the completion of this report. Chapters were divided into multiple sections and distributed equally to each team member. When a member finished writing their section, the entire team reviewed and revised each section to ensure all ideas and comments were addressed, leaving the team with one coherent report.

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# **Abstract**

Through this project we produced a data repository that organizes a wide variety of data about the drivers of depopulation. This data has been collected over time and the repository will preserve it in a centralized location for future projects, researchers, and Venetian residents to utilize. This repository also contains many visualizations created by the team to display the data in a more meaningful and easy to understand way. We designed our website with the user in mind, creating the story of Venetian population trends through graphs, charts, maps, and animated visualizations. Along with our repository we made recommendations for future students on how to update and improve the repository. These recommendations include new data sources that would be useful, advice on different visualizations that could be created from current and new data, and ideas to improve and sustain the permanence of the repository. We left instructions on how to edit and update the specific visualizations we created alongside our recommendations.

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# Chapter 1 Introduction

From 2006 to 2019, the global tourism industry nearly doubled in size from \$767 billion to \$1.465 trillion and increased dramatically in numbers of visitors and frequency of travel (UNWTO, 2021). The influx of tourists to major cities worldwide has had negative consequences on the quality of life for both their residents and local establishments. As of 2019, there were barely 53,000 residents in historic Venice, but every day an additional 66,800 tourists fill the streets, along with the 20,500 commuters who travel to the city for work (Bertocchi & Visentin, 2019). This is a prime example of how tourism in Venice is overwhelming the streets and thus the residents of the city.

This kind of overtourism can be characterized by seasonal increases in short-term visits that have permanent, adverse effects on the lifestyles of full-time residents. The problem manifests itself in many ways, including the overcrowding of streets and plazas, the increased cost of living for amenities such as housing, and stress on local resources such as water and power (Milano et al., 2018). Overtourism can impact the resident's wellbeing, such as the mental drain of constantly having to accommodate tourists with travel times, restaurant wait times, and general noise/activity levels in the city. The uncontrolled flow of tourists can be detrimental and have long-term effects on the community.

Keeping track of metrics regarding population and demographic trends, or changes in housing prices over time allow researchers and policymakers to understand what is happening in the city and what needs to be addressed. Collecting and organizing data also allows for reflection on actions taken and policies implemented. If a policy is implemented but the data shows it has had negative effects on a certain aspect of the city, it may be more beneficial to repeal or revise the policy.

As part of its Horizon 2020 grant, the European Union funded a partnership, SmartDest, with the goal of understanding the social exclusion of residents and other difficulties that arise due to increased tourism. This partnership is between eleven universities and the SerenDPT innovation center, which are spread across eight European and Mediterranean cities. SmartDest

embarked on a three-year research endeavor to learn how tourism contributes to urban transformation and produces social imbalances. They aim to understand and mitigate these issues and develop strategies to develop tourism in a more sustainable manner (SmartDest).

We aim to contribute to the SmartDest project in order to explore the main causes of depopulation and provide interactive visuals for a real-time dashboard that is easily accessible to researchers and residents. To meet that goal, we have identified three objectives. First, we will develop a strategy to regularly acquire and maintain important datasets from a variety of official sources. Second, we will analyze and visualize trends in historical data regarding Venice's population, job diversity, housing, and mobility. Third, we will design and test an online repository of vital metrics contributing to depopulation, to be used in ongoing and future research. A repository will centralize the data we collect and creative visualizations which will make the data both more accessible and understandable.

# Chapter 2 Background

Venice has a long and storied history, and for decades this history has drawn people from all over the world to the unique city. While tourism has been an important part of the city's economic stability, it also impacted its residents. At its peak back in 1951, Venice housed nearly 175,000 full-time residents. Now, as of 2019, the city is home to less than a third of those numbers, with approximately 53,000 residents (Bertocchi & Visentin, 2019). Research collected to explain the cause of the rapid decline in Venice's population indicates that the dynamics of tourism have played a large role (Casagrande, 2016). In this chapter, we investigate Venice's relationship with tourism, and highlight how cities can use data collection and visualizations to identify and adapt to population trends.

## 2.1 History of tourism in Venice

Tourism is one of the world's largest economic sectors, creating jobs and opportunities in cities all over the world. However, left unmanaged, tourism can grow unsustainably and cause more harm than good to the visitors and residents. Venice is a thriving cultural center, bustling tourist destination, and is consistently ranked the most beautiful city in the world. Venice was also the first city to be inducted as a UNESCO World Heritage Site in its entirety (*Venice and Its Lagoon*, 2018). Venice is also home to some of the most magnificent and distinctive canal architecture in the world. There are 126 islands seated in the shallow Venetian lagoon linked by over 400 bridges (*Venice, Italy*, 2017). However, the city is a mere  $6.3 \text{ km}^2$  stretching about 2.3 km from north to south and 4.3 km east to west.

Prior to the 1950s, "tourism was an activity reserved to the economic elite," and Venice was already a popular tourist destination (Van Der Borg, 1992). As tourism became more accessible to the mainstream population, opportunities to experience Venice skyrocketed. In 1963 approximately 750,000 tourists arrived in the historic center each year, and two decades later in 1983 it nearly doubled to approximately 1,335,000 (Van Der Borg, 1992). Over time, Venice's local economy has shifted to such a degree that in order to support itself, a minimum of

31,000 tourists a day must come to Venice to keep the tourism industry and most of the city's economy afloat (Da Mosto et al., 2009).

There are merits to having a tourist-based economy, and it can be incredibly lucrative for a city or municipality to bring in a large percentage of revenue from tourism each year (Ekanayake & Long, 2012). However, completely relying on any one sector or industry introduces the risk of an economic downturn if that sector should fail or falter. During the COVID-19 pandemic, international and domestic tourism was brought to a halt. Many of the global tourist hotspots were hit hard by this lockdown, and Venice is no exception. In fact, in a city where tourists in 2016 spent approximately €3.158 billion, there were no tourists to patronize businesses and hotels (Rosin & Gombault, 2021). This revealed vulnerabilities in the local economy and highlighted the extent to which local residents and locally-driven businesses have been displaced.

## 2.2 Residential Population Trends

Venice's resident population has been shrinking at a consistent rate since the 1950s. Understanding and combating this problem is one of the greatest challenges that Venice faces. As we have addressed previously, at its peak of population Venice was home to approximately 175,000 residents, but now houses only 53,000. Over two-thirds of Venice's residential population has left the historic city over the past 70 years or so, and there are a number of factors at play that have led to this mass migration, which can be seen below in Figure 1.

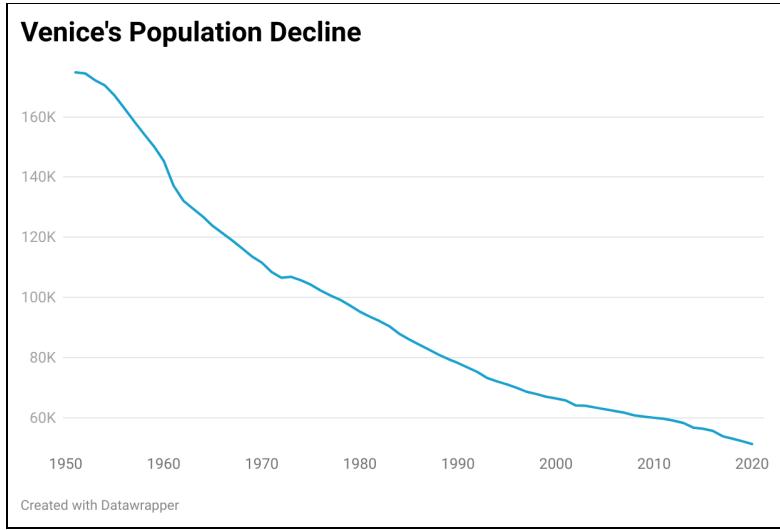


Figure 1: Decline of Venice residential population since its peak in 1951 (Movimento demografico, 2021)

Past research has indicated that “economic factors and logistical constraints” drive away residents (Casagrande, 2016). Problems such as increased prices for groceries and everyday goods, and inflated housing costs have created an environment where the only option for the poor and the middle class was to leave Venice (Salerno & Russo, 2020). The decline in residential population falls alongside a steady increase in the number of tourists that come to visit the historic city of Venice. According to the last five years of tourism data (2015-2019), total arrivals in the city are increasing on average 4.6% per year (*Yearbook of Tourism Data 2019*, 2019). With an ever-increasing non-resident population, Venice has struggled with issues such as the overcrowding of public ways, vandalism, and crime (Seraphin et al., 2018). These concerns are always present in tourism-heavy areas, however tourism in Venice is reaching a tipping point that is driving long-term residents out of the city.

Overtourism occurs when there are too many visitors to a destination and the quality of life deteriorates to an unacceptably low level, often affecting not only the residents of the area, but the tourists as well (Goodwin, 2017). A wide variety of destinations have been experiencing overtourism for some time now. In some cases, anti-tourist demonstrations have occurred, some of which have had threats and violence (Goodwin, 2017). Tourism has not just affected the most

famous destinations like Venice and Barcelona, but locations on every continent, in big cities, national parks, and small island states (Dodds & Butler, 2019).

Tracking the tourism industry in Venice shows that visitation has nearly doubled since the early 2000's, with hundreds of thousands more people entering each year as seen below in Figure 2

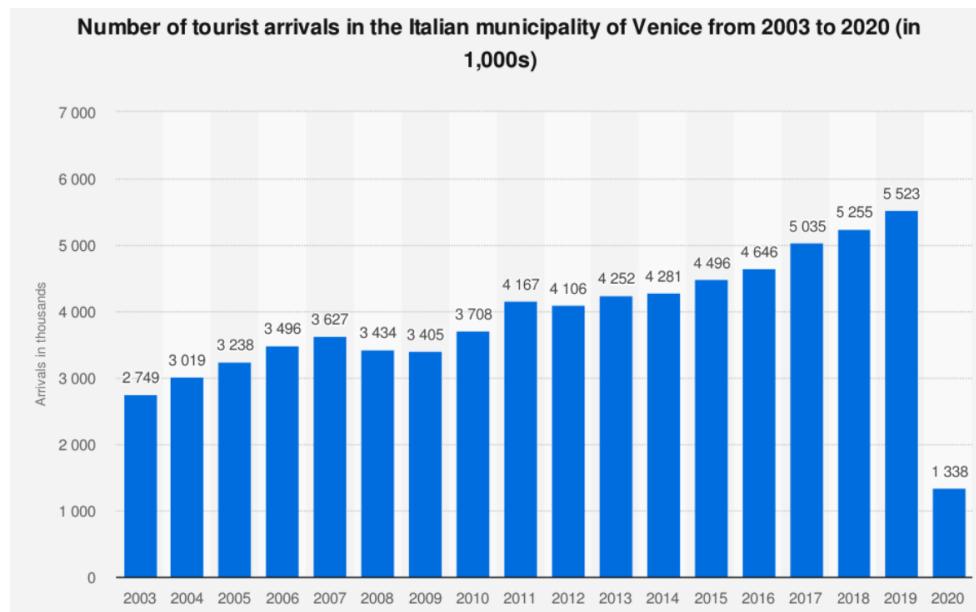


Figure 2: Yearly tourist arrivals in Venice 2003-2020 (Sistema Statistico Regionale, 2021).

While Venice has seen dramatic numbers, other smaller destinations with less capacity or less tourism management have been damaged by the addition of only a few hundred visitors in the same time span (Dodds & Butler, 2019). With the pandemic limiting tourism all over the world, an opportunity has presented itself to reimagine a more sustainable path for stressed cities.

## 2.3 SmartDest

The exclusion of residents, specifically in Europe and the Mediterranean, created an initiative to tackle some of the root causes of local displacement in cities characterized as “city hubs.” SmartDest, a European Union-funded project, brought together an innovation center and

eleven European and Mediterranean universities to strengthen opportunities for urban residents battling overtourism. The project has a total budget of €3.1M to pursue their objectives of reanalyzing the positive and negative consequences of tourism in a city.

SmartDest's goal is to conduct research and gather relevant data to find imbalances between tourists and residents. Through small implementations of science and the use of data analysis they aim to show the relevance of these issues and how much impact a new policy can make. To contribute to the project, researchers in each city will compile data about the current state of their respective locations and start proposing solutions to address the problems they found. These solutions can then be discussed, debated, and possibly implemented to tackle said issues.

## 2.4 SerenDPT

A secondary partner, SerenDPT, is a "benefit corporation" that focuses on developing Venice through research, technology, and creating technology related jobs in Venice. SerenDPT is leading the Venice case study as part of SmartDest as they have experience doing research in the field of tourism and its effects on the city (SerenDPT, 2020). Once SerenDPT collects the Venice-specific data, various projects and datasets will be shared with SmartDest. They can choose to share it with other countries where the deliverables could be replicated in cities that need help (SmartDest, 2020).

## 2.5 Potential Drivers of depopulation

To understand what is driving residents out of Venice, we investigated three different aspects of Venice life that have changed negatively due to increased tourist population. Here we address the lack of job diversity, affordable housing availability, and mobility issues that residential Venetians face that may explain why they are leaving.

### 2.5.1 Job diversity

Tourism has always been an essential part of the job industry due to the Italian city's unique nature and extensive history. In 1901, services for visitors made up just over half of the job market in Venice. However, tourism has increased steadily since the early twentieth century. Tourist arrivals have almost doubled in the last fifteen years alone, resulting in a drastic shift in Venetian economy. By 2020, services for visitors comprised over seventy percent of the job market (Camera di Commercio Venezia Rovigo, 2020). This trend created an economy dependent on the consistency and approval of the travelers.

The service sector broadly encompasses many different aspects of the economy such as transportation, tourist services, and hospitality. Despite the increase of tourism related jobs, some sectors have declined in growth. In 2015, hospitality encompassed 18.5% of jobs. In 2019, it decreased to 17.2% and finally in 2020, it was only 15.95% of the job market. Hospitality appears to be steadily decreasing, however, tourist services including travel agencies and rentals show a steady increase despite COVID-19. Airbnb's expanding presence in Venice contributes heavily to the number of rentals. Tourism services increased from 11.4% 2015 to 15.8% in 2019 to 16.1% in 2020. Excluding commerce, the other job sectors such as mining, athletics, and agriculture each consist of 5% or less of the workplace in Venice (Camera di Commercio Venezia Rovigo, 2020).

When thinking of Venice, one of the first words that comes to mind is "gondola". Transportation is crucial in any city, but Venice's unique water-based system is the only means to get around the island. The water taxis and gondolas have made up around ten percent of the services for visitors since 2015 (Camera di Commercio Venezia Rovigo, 2020). Transportation is crucial in Venice for two reasons. Due to the lack of job diversity in the historic city, some residents commute to mainland Italy for their jobs. Conversely, some people work in the city, but reside outside the center due to increasing housing costs. While the findings show a decline for 2015 to 2020, the stay at home order and curfew imposed in 2020 would affect the findings (Camera di Commercio Venezia Rovigo, 2020).

## 2.5.2 Housing availability

The median price of owning a home in Venice is about €300,000, but jobs in Venice are largely found in the tourism industry. In 2017 the average couple earned around €44,000. With that income, they could secure a loan for a home worth around €180,000, just over half the price of the average home at the time (Cerce, 2017). This discrepancy is forcing residents to move out of the historic part of Venice for more affordable housing on the mainland.

Currently, there are enough beds in Venice for 131,247 people in approximately 38,000 residences (Città di Venezia, 2010). There are only 50,500 people living in the city, leaving many buildings vacant. However, in the last decade, Venice has seen a massive shift from ancestral family homes to temporary stays such as Airbnb rentals. Corporations and real-estate investors are buying up the vacant homes, and turning them into rental properties. This transition has driven up the sale prices for these properties further making it more difficult for residents to own property in the city. Airbnb listings are becoming more and more popular; in 2017 there were 5,200 listings for about \$100 a night, much more than the average Venetian could afford to rent (Boigenzahn, 2016).

## 2.5.3 Mobility infrastructure

Unlike any other city in the world, Venice has a unique transportation network. There are two main modes of transportation throughout the city: the public water bus system or on foot. The Municipality of Venice transit company owns the system for the water buses through pre-established routes that connect the other nearby islands apart from the historic city (ACTV, 2015).

Transportation via the water by either public or private boat is limited by canal and stop location and parking availability. Due to this, a large portion of the population walk to their destinations, and from a practical standpoint, going from point A to point B on foot can be challenging. There are only four bridges that span the Great Canal, and due to high traffic of pedestrians, bottlenecks occur causing mobility to suffer. By comparison, a 4.8 km distance in Venice from Piazzale Roma to Sant'Elena can take 60 minutes, while in Boston, MA, traveling

that same distance can take 12 minutes (Brofford, et al, 2013). Figure 4 below, presents the comparison with other well-known cities. The combination of water-based transport and narrow pedestrian walkways paired with a large influx of tourists results in an unpleasant mobility experience.

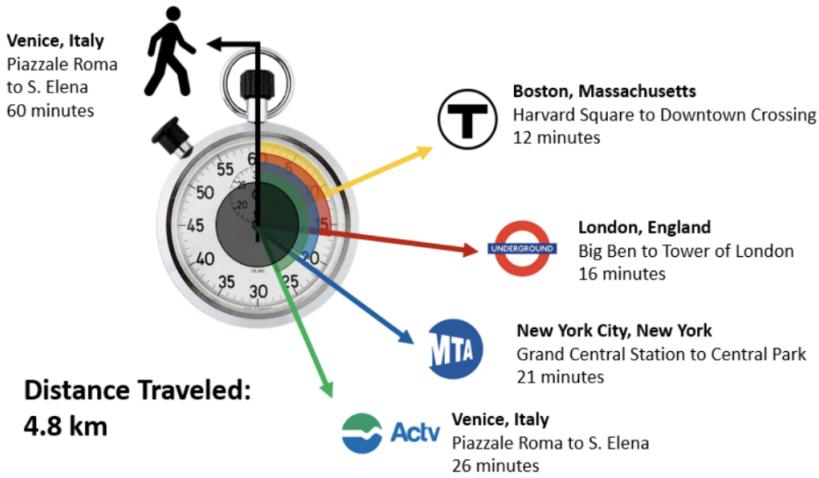


Figure 3: Infographic explaining comparable transit times between major cities (Brofford, et al, 2013)

# Chapter 3 Methodology

The goal of our project was to create a centralized data repository regarding Venice and the socio-economic factors that are believed to be driving residential depopulation. To accomplish this goal we developed the following objectives to help to guide our work.

1. Develop a strategy to acquire and maintain important datasets from a variety of official sources.
2. Analyze and visualize trends in historical data regarding Venice's population, job diversity, housing, and mobility.
3. Design and test an online repository of vital metrics contributing to depopulation, to be used in ongoing and future research.

Creating the repository was the end result and is the major deliverable from our project, but each step along the way was vital to the project's success. What each objective entailed and how we approached them is detailed below.

## 3.1 Understanding and Planning Visualizations

Before we dove into gathering data and creating visualizations we had to decide on what aspects of Venetian life we wanted to portray as contributing to depopulation. We were guided by our sponsors to look into three major factors of Venice life that they believed were linked to residential depopulation: housing, mobility, and job diversity. Throughout further discussions with our sponsors we were able to narrow down different metrics and trends within these categories. These metrics would later become interactive visualizations on our repository, but we first had to look into various data visualization methods and determine which would be most effective.

To gain further insight into data visualizations we studied the work of groups who have completed similar projects both in Venice and elsewhere. A team from the Massachusetts Institute of Technology constructed a similar website highlighting aspects of overtourism in Venice, featuring housing, job diversity, and transportation. We took their work on overtourism as inspiration for our visualizations, utilizing some of the same techniques and technologies they used.

We also reviewed the work of The Clivio Observatory (OCIO), a project that analyzes the housing issues and gaps in Venice. They publish visualizations related to overtourism and housing that would be useful for our data repository. Some of these visualizations were outdated and, in our view, did not effectively portray the correct message. To remedy this we took the data that they published alongside their visualizations and decided to recreate them with a more effective replacement.

## 3.2 Collecting Data

Having decided on a set of visualizations to include in the data repository we needed to understand and collect the data that is necessary to create them. SerenDPT has been collecting data on various aspects of Venice and Venetian life for a long period of time. We were given access to this data which gave us a good starting point for our initial visualizations. SerenDPT also assisted in getting data from an AirBNB watchdog, "Inside AirBNB" that has been tracking short term rentals across the globe since 2015. SerenDPT purchased their entire Venice dataset for our use in making more visualizations.

The Inside AirBNB data was distributed as a set of approximately 60 comma-separated value files (CSVs) which contained every AirBNB listing in Venice for each month. Each of these listings had 106 different attributes related to it. For our needs we only had to use 5 of the fields for each listing so we needed a way to both aggregate and narrow down the data. To do this we developed a python script that would combine all of the CSV files and cut out the unnecessary data fields for each listing (see appendix A). With this we were able to not only

combine the 60 files into one but also shrink 6.6 GB of data into a single 20 MB file that we would later use for our visualizations.

There was some data that we needed to make certain visualizations that were not published or organized in any way. They were, however, available scattered around various websites. The best example of this was Google’s “busyness” ratings of various points of interest (POIs) across Venice. Google puts out this data in the form of a bar chart in their information sidebars for a given location (see figure 4 below). Displaying the data like this is effective for end users looking for how busy a location is, but it is not helpful for a new data visualization.

To combat this we reverse engineered one of Google’s application programming interfaces (APIs) that is used behind the scenes to populate the sidebar. This gave us access to the raw numbers behind the bar charts. To collect all of these numbers together to form dataset necessary for a visualization we wrote a python script that took in a list of POIs, grabbed all of the busyness numbers for each hour of every day of the week, and exported them to a file that could then be used for visualizations. Instructions for how to use this script are included in appendix B.

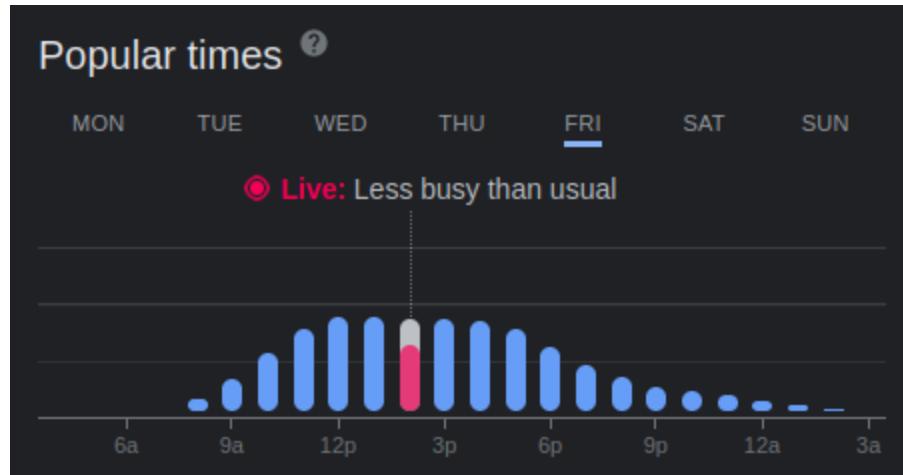


Figure 4: Google’s “Busyness” chart for St. Mark’s Square

We also used a script to collect housing data from immobiliare.it (see appendix C). The script was able to gather average housing data for rent and sale prices for different

neighborhoods in Venice. We were able to collect data from every month dating back to 2013. One of the limitations of utilizing data collection for data collection is that oftentimes the data that is available is less detailed than that which is aggregated and published formally. In this instance we were not able to get a finer division of housing prices, we were forced to work with the areas that were supplied by immobiliare.

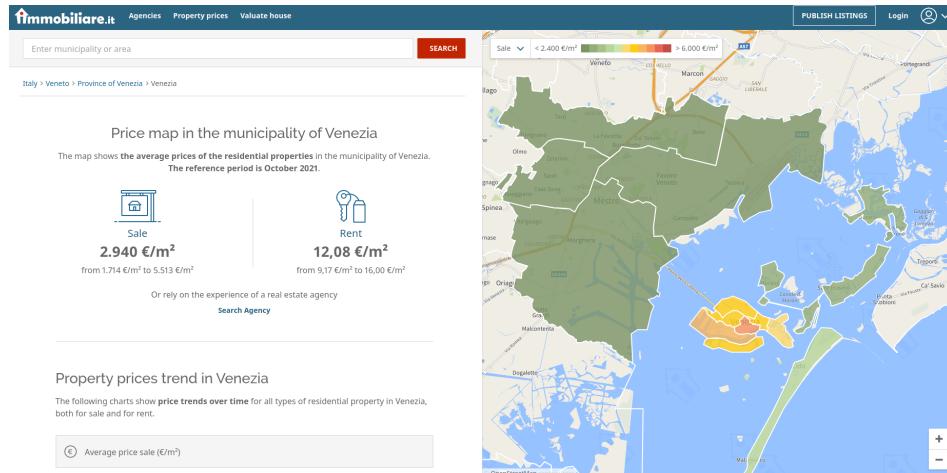


Figure 5: Immobiliare website with median rent and sale prices

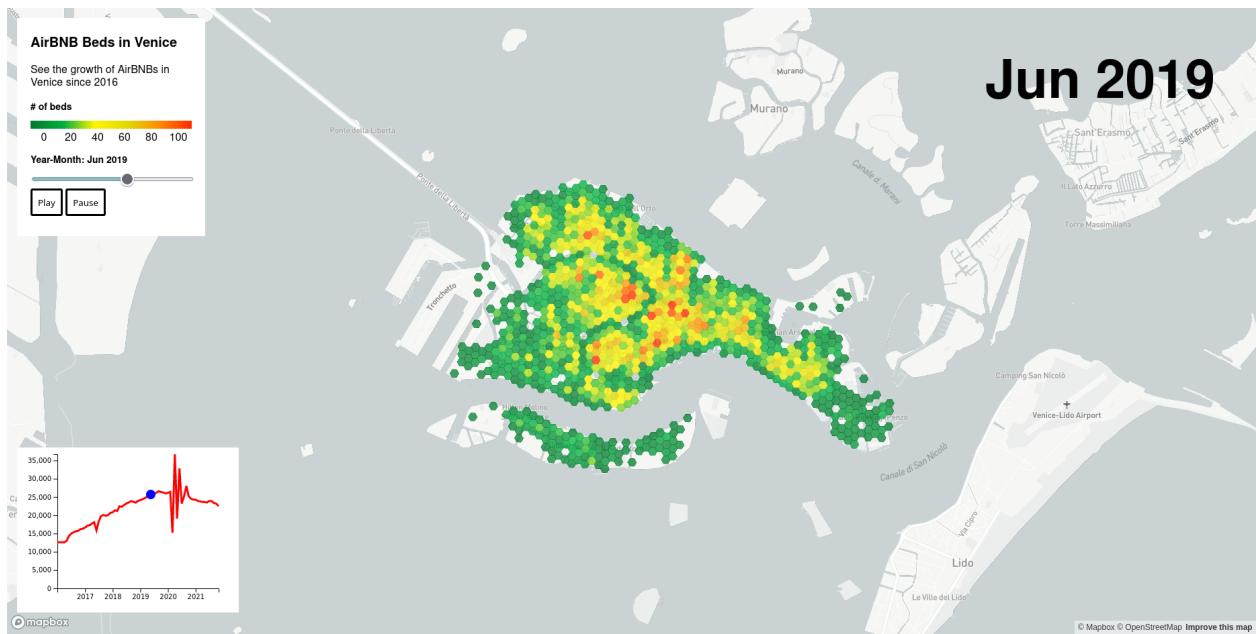
Data collection was an ongoing process throughout our project, as we worked through different visualization designs and ideas different data would be necessary. We would then use the different techniques discussed above to get the data we needed.

### 3.3 Historical data analysis and visualization

Throughout the project we experimented with different software to assist us in making our data visualizations. Some of our visualizations were made using Tableau, a powerful data visualization software commonly used in enterprise scenarios. Tableau allowed us to quickly and easily experiment with different types of graphs and visualizations and gave us lots of control of how the graphics looked and what we could portray. One of the limits that we ran into with Tableau was its inability to effectively animate a graphic we wanted for some of our graphics.

To overcome that limitation we looked outside of tableau and found Flourish. Flourish is an online data visualization service that, like Tableau, allows us to quickly create graphics from an uploaded dataset. However, Flourish gave us different visualization options that Tableau lacked. Graphics like the overnight residents versus daily tourists bar race are animated over a time period of about 20 years, a feature that Tableau lacked. Flourish also did have some drawbacks. We were forced to sacrifice some of the deeper control that Tableau offered us, but we were still able to achieve everything that we needed to with Flourish.

Finally, there were some visualizations that we were unable to create to our liking in either Flourish or Tableau. Because of this we resorted to making the visualizations by hand using HTML and JavaScript. Most of these kinds of graphics involved an interactive map of Venice which we then overlaid with data to create the graphic (see Figure 6).



*Figure 6: Custom graphic utilizing Mapbox JS library to show Airbnb availability over time*

To achieve this we utilized Mapbox's JavaScript library to manage the map and data positioning aspects of the graphics. Making the visualizations from scratch gave us the greatest amount of control and flexibility to do whatever we wanted. For example we were able to create

an animated timeline for AirBNB beds across the island to show the increase of AirBNBs over the years.

### 3.4 Designing a centralized data repository

When we started to assemble our visualizations we needed to establish an organizational layout for our website. We decided that each of the factors of depopulation that we identified previously would be their own menu heading that was then divided into various sub pages regarding different aspects of each factor. We felt that this would be the most intuitive and useful way to organize our analysis and visualizations for an end user. Visualizations, when completed, were then sorted into the subpage that we deemed most appropriate. Once the visualizations were organized to their respective pages we provided added context and analysis to each page through small snippets of text.

We also aggregated all of the literature and data sources that we used into a single references page that had both a classic bibliography and an interactive one created with zotero. The interactive bibliography allowed us to tag our sources with different keywords related to what sections of the website they had information on.

# Chapter 4 Results

In partnership with SerenDPT, a contributor to the SmartDest project, we have collected and organized existing data publications to centralize this data for easier access in future research. We achieved this by creating a website that serves as a data repository and displays various historical data in creative visualizations that help explore multiple aspects of the depopulation issue. We hope that our online repository gives researchers a more structured and organized location to find and best utilize important data.

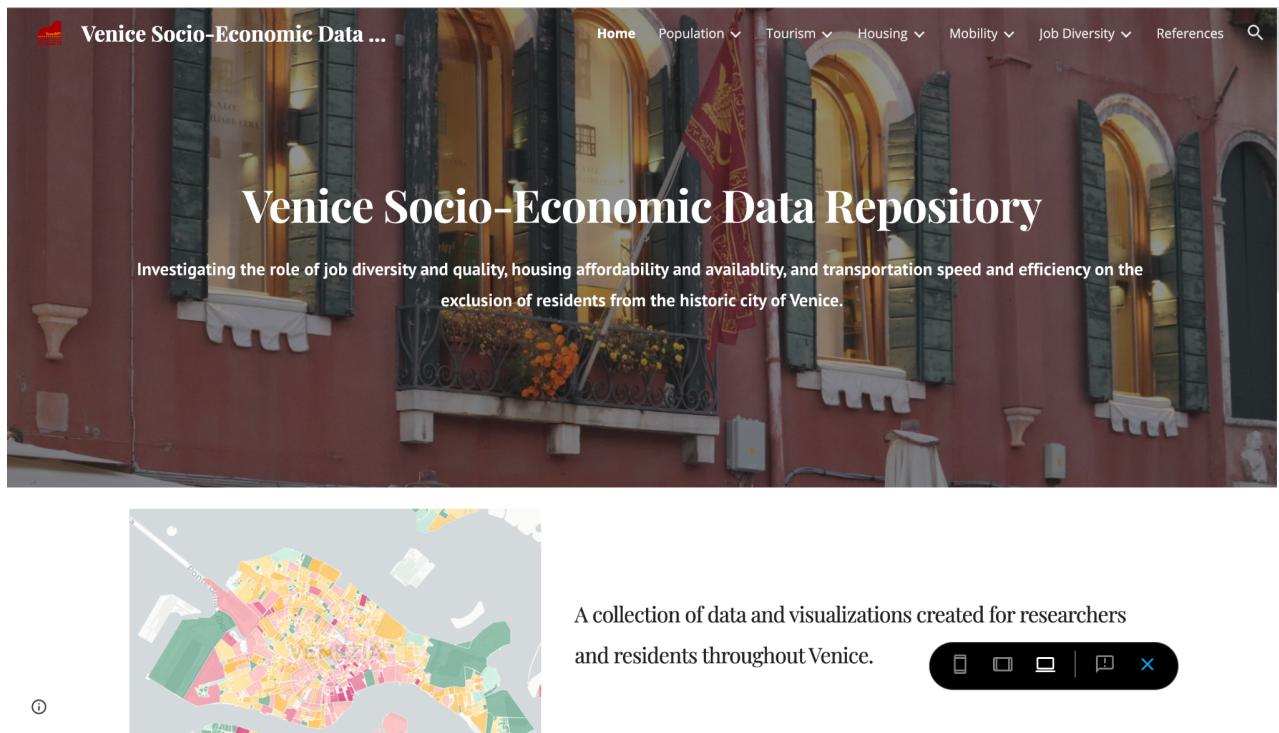


Figure 7: Home page of the Venice Socio- Economic Data Repository

Inside the Data Repository there are interactive graphs and visualizations in the different categories created to explain the root causes of depopulation. The figure below is one of the interactive heat maps that shows the growth of AirBNB Beds over time around the Historic City of Venice. The great aspect of the heat map is that it includes data over a long period of time and

is able to show areas of the map where the concentration of beds is higher. The colors were chosen as well with the idea that red accounts for more beds and green accounts for less beds of AirBNBs; this way whoever uses the map can also see the representation in colors and not just numbers.

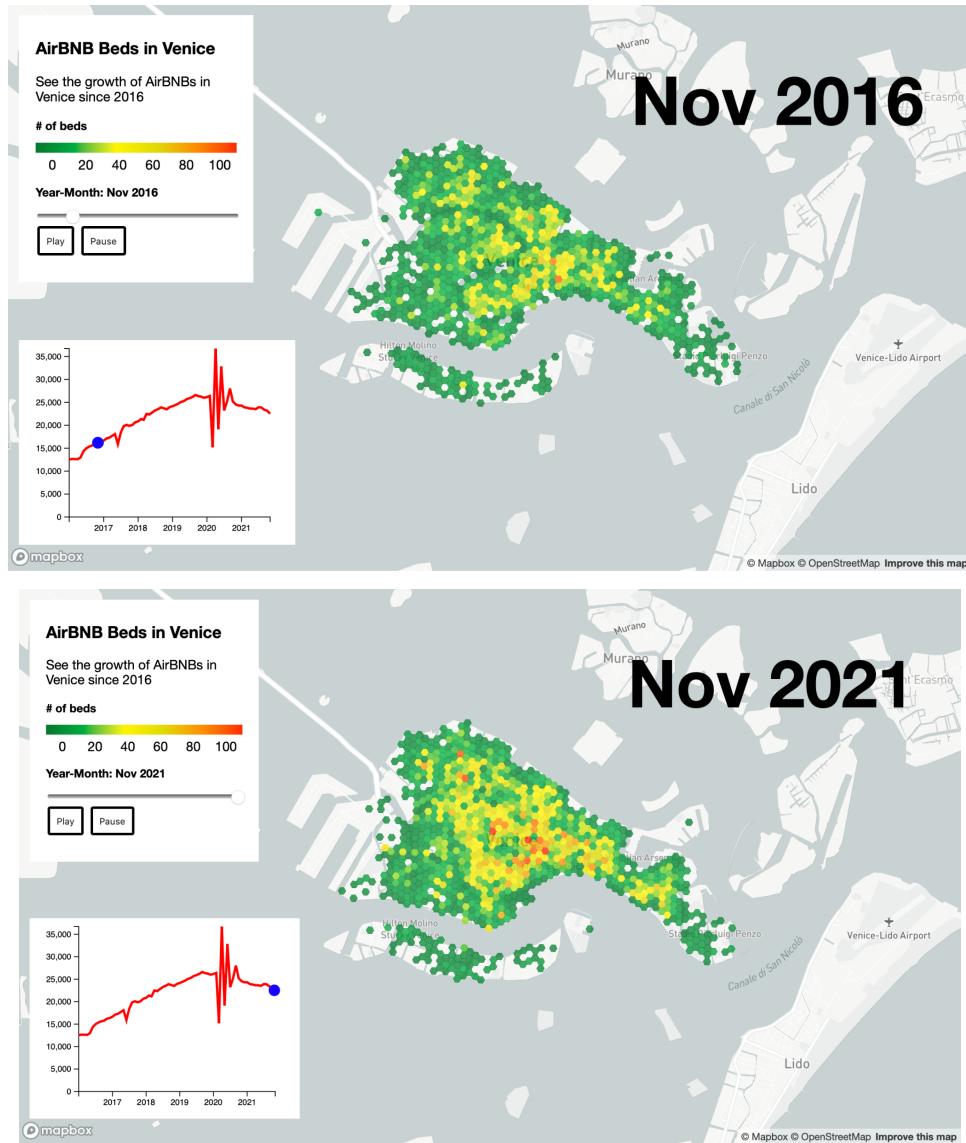


Figure 8: Growth of AirBNBs in Venice since 2016

Below, there is another example of the interactive visualization we have created; the graph explains the increase of tourism over the years with the orange line and the decrease of the resident population with the blue line. These are the colors that we chose to represent those

categories throughout the repository, so that it adds meaning that can be consistent throughout the website.

In the data repository, the lines are animated along the x-axis to better show the changes in each of the lines over time. To add a better understanding to the graph, we have created a written part about tourism on the left, so that users also have other background information. This has been done in most of the sections of our Data Repository.

Tourism is one of the world's largest economic sectors, creating jobs and opportunities in cities all over the world. However, left unmanaged, **tourism can grow unsustainably** and cause more harm than good to the visitors and residents. Venice is a thriving **cultural center**, bustling tourist destination, and is consistently ranked the **most beautiful city in the world**. Venice was also the first city to be inducted as a UNESCO World Heritage Site in its entirety (*Venice and Its Lagoon*, 2018). Venice is also home to some of the most magnificent and distinctive **canal architecture** in the world. There are **126 islands** seated in the shallow Venetian lagoon linked by over **400 bridges** (*Venice, Italy*, 2017). However, the city is a mere **6.3 km<sup>2</sup>** stretching about **2.3 km** from north to south and **4.3 km** east to west.

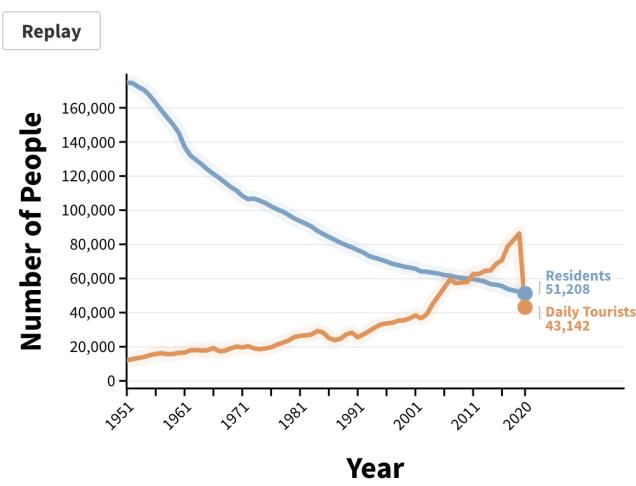


Figure 9: Example of the Tourism Section in the Data Repository

In addition to our online data repository we created a booklet to accompany this report which can be found on our website. The booklet contains a summary of the most important results that we found throughout our research. It contains static versions of our graphics and longer form explanations and analysis that explains our findings related to the driving factors of depopulation in Venice.

# **Chapter 5 Recommendations**

## **5.1 Repository Recommendations**

We have several recommendations for any future research or expansions based on our findings from the creation of the data repository. When developing a strategy to regularly acquire and maintain the critical datasets from the different official sources, there should always be a record of the used sources. In addition, there could be another repository just for valuable data sources categorized by subjects related to Venice's Population and all the factors that are affected by the decrease over time. There can always be more data collection, and it would be helpful if there were more access to different datasets collected recently, showing new patterns in the Venice population.

For the population section of our repository we recommend more in-depth data collection of the city users, such as the number of students in the historic city. Another way to evaluate the current population in Venice would be to get patient counts from primary care physicians. As healthcare in Italy is managed by the government, each individual is registered to a doctor which presumably would be local to their residence. Because of this we could estimate a rough number for city residents based on how many patients doctors around the city have. We also recommend getting more population data throughout history. Finally, we recommend trying to represent the real-time population data on the repository. We currently have a script to pull population data daily, but being able to utilize it visually on the repository would greatly enhance its usefulness.

Moving on to the tourism section, we recommend obtaining real-time data of tourist arrivals from the city either via the SMART control room or the city's tourist tax. This data would pair well with the real-time population data, allowing the counts to complement each other well in one visualization as well as separately. Increased data on tourism hot spots as well as absolute numbers based on location capacities could be used to improve the heat maps created with the data obtained from Google.

To improve the mobility section we recommend future teams obtain records of the number of people that purchase the Venezia Unica card yearly as well as the user data from each boat stop. We looked into getting this data, but did not have enough time to dedicate to achieving this goal. The added data would allow future students to better track busy times at the boat stops as well as total yearly users. Additionally, we suggest creating an interactive graphic which could show the positions of ACTV boats around the city based on the expected boat schedules. This would better allow researchers and Venetian residents to see the congestion of boats throughout the canals, and thus a large part of the mobility issues in Venice.

We recommend future teams to elaborate more on the job diversity section, looking for salary data as well as more historic data about the types of jobs that most Venetians hold. This new data would allow teams to make a greater claim about the lack of job diversity and its effect on the residential depopulation. We also recommend teams look more into the specific companies headquartered in the historic city. This new detailed information would give needed backing to the job sectors data as well as show the expected minimal number of high tech/ high paying jobs on the island.

## 5.2 Recommendations to Combat Depopulation

While most of our research did not include possible remedies for depopulation, we have identified certain problem areas which we believe that if studied further and addressed could help to combat depopulation in the historic city.

First, housing is becoming less affordable in the historic city due to the increase in tourist residences. Services like AirBNB have led the charge for this increase and has resulted in removing potential properties for residents' use, restricting them mainly to tourists. To combat this we recommend potentially limiting the number of new AirBNBs or other tourist rentals that can open in a given year. Also, to assist residents in being able to afford to buy a residence, find a way to minimize or eliminate the down payment required to purchase a house. We found that this can be a large hurdle for most homebuyers in the historic city, and by minimizing it it may entice people to stay in the historic city, rather than leaving.

In the realm of job diversity it would be beneficial for the city of Venice to look into investing in new economic opportunities like technology and engineering. Investing into these areas would help bring these types of jobs into the area and bring these types of jobs to the city. Jobs in technology and engineering would increase possibilities for higher wages for the residents of the historic city and thus increase the population in the city that can afford to live there.

Finally, for mobility, we recommend the city look into minimizing commute times both within the historic city, and to and from the mainland. Now, many residents of the city have to work on the mainland which requires them to commute to and from on a daily basis. This commute can be long and tiresome for some residents and by minimizing this, it removes another burden that is driving people to leave the city.

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# Appendices

## Appendix A - (Script to merge InsideAirBNB Data)

Download code from SerenDPT github or from [Google Drive](#)

1. In the Generating GeoJSON folder make sure there is a “data” folder with all of the inside AirBNB folder as described in the script.
2. Run the script, it should output a “beds.geojson” file with all of the correct data
3. Move that geojson file in the same directory as the beds.html file
4. Upload geojson and html file to the github pages repo [here](#)

## Appendix B - (Google Scraping Script)

Download code from SerenDPT github or from [Google Drive](#)

1. Start in the POI Data folder
2. Run the poi.py script to gather the data on the different points of interests
  - a. **Use a VPN or Proxy because it's possible you'll be blocked by Google**
3. This should output json files in an “out” folder
4. Run the viz.py script to generate busyData.geojson
5. Put busyData.geojson in the same folder as busyMapbox.html
6. Upload geojson and html file to the github pages repo [here](#)

### Notes

- You may have to get a new API key from mapbox and update the key in the scri

## Appendix C - (Script to scrape Immobiliare data)

Download code from SerenDPT github or from [Google Drive](#)

1. Run ‘rentSale.py’ to collect the data and output to a geojson
2. Keep the geojson in the same directory as rentsale.html
3. Upload geojson and html file to the github pages repo [here](#)