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**Coastal Flooding and the Business Community: A Stakeholders'
Assessment on selected localities in the Maltese Islands**

**Daniel Spiteri
21MAGE003**



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St Julian's, Marsalforn, and Xlendi.

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Abstract

Resilience of coastal communities is increasingly required to adjust to the effects of climate-change and its coastal-related threats. Climate change is a major global issue that is leaving adverse consequences on the environment, economy, and health of urban coastal lowlands. Flooding risks from both sea level rise and increase in the frequency and severity of storm surges are considered amongst the most threatening consequences associated with climate change. This study aims to assess the level of socio-economic preparedness to flooding impacts from sea level rise and storm surges as evaluated and perceived by three selected categories of stakeholders: the business community, local councils, and specialised experts from the government sector. Five coastal towns (three from Malta and two from Gozo) were selected as representatives of highly active commercial zones: Gżira, Sliema, St Julian's, Marsalforn and Xlendi. Data collection involved 160 business surveys, five surveys with local councils, and interviews with twelve representatives from government organisations. The methods used included the collection of elevation data for each locality and then plotting the businesses' distribution in relation to their height above sea level. This was followed by a mixed method questionnaire for all three targeted audiences; however, the experts' interviews were mostly of a qualitative nature. This study shows that there is a knowledge gap about the level of perspectives and preparedness about coastal flooding amongst small coastal businesses. The main finding which emerged from the business community suggests that there are no contingency or strategy plans in place for potential flooding impacts from sea level rise and storm surges, and the risks of driving owners out of business is high. The second key finding was that due to the high commercial activities found in these localities, most business owners remain reluctant to relocate to other areas. From a local government perspective, it was discovered that all local councils significantly lack the resources they need to effectively manage coastal flooding within their locality, forcing them to completely rely on the central government for future resources. From a central government perspective, it seems that all interviewed experts operate within a narrow-defined set of responsibilities and could only answer for their respective roles. Thus, the approach to address coastal flooding is still fragmentary and no inter-governmental or cross-sectorial discussions have ever been concretely delivered to date. These findings call for the need of more triangulation of efforts

between the three stakeholder sectors to create a more co-ordinated plan of action on how to address the threat of coastal flooding.

Keywords: coastal flooding; sea level rise; storm surge; coastal businesses.

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1. Chapter 1: Introduction

1.1. Introduction

This chapter provides background information on climate change in general as a repercussion to global warming. It then moves on to specifically assess the vulnerability and risk assessments of sea level rise and storm surge flooding particularly on small islands states in the following order: worldwide, the Mediterranean and finally the Maltese islands. In addition, this chapter explains the justification why the author of this research decided to pursue the research that he did. More importantly, this chapter explains the aim and set of objectives that were setup to achieve that aim. Finally, this chapter describes the structure of this dissertation along with a brief description of what each chapter entails.

1.2. Background

The (Intergovernmental Panel on Climate Change, 2013) was one of the first scientific bodies to officially report that the world was facing one of its greatest threats of all time - the climate change crisis - and that human activities were largely found to be responsible for altering the Earth's energy budget by greenhouse gas emissions, changes in land surface properties and increasing concentrations of radiatively active hazardous gases and aerosols in the atmosphere. (Intergovernmental Panel on Climate Change, 2013) provided scientific evidence of climate change derived from land, oceans, atmosphere, and cryosphere. Observational evidence and ice records depicted those concentrations of hazardous greenhouse gases such as carbon dioxide (CO₂), nitrous oxide (N₂O), methane (CH₄) and so on., which have drastically increased over the last few centuries. The UK's (National Centre for Atmospheric Science, 2019) claimed that natural disruptive events such as coastal flooding and storms are evidence of the extent to which weather and climate may affect our daily lives. (Shaftel et al., 2021) report how in the last two decades sea level rise nearly doubled, posing a significant submersion threat to islands and low-lying areas across the globe. These coastal threats seriously undermine the physical and socio-economic assets for communities who have been surviving on the functioning of these assets, but are now becoming vulnerable by inadequate preparation and/or adaptation strategies (Oktari et al., 2020).

Actions to forecast and mitigate the impacts of coastal hazards are among the main targets in the 2015–2030 Sustainable Development Goals (SDGs) and the Sendai Framework for Disaster Risk Reduction (SFDRR). Specifically, Goal 13 of SDGs, calls for concrete actions to address the impacts of climate change.

1.3. Vulnerability of Islands to Sea Level Rise and Storm Surges

Intergovernmental Panel on Climate Change (2012) focuses its impacts research on Small Island Developing States (SIDS) which are designated as small island nations which having low-lying coastal zones and share development difficulties. Like Malta, these nations face distinctive disadvantages due to their small geographical size, vulnerability to natural hazards, remoteness, and insularity. Their economy is based upon tourism, agriculture, and fisheries – all of which are adversely affected by climate change, especially sea level rise. Small island states are islands that may experience inundation, erosion, and saline intrusion; this will eventually lead to a decrease in agriculture food productivity, economic losses, population displacement, disease pattern changes and ecosystem disruption due to extreme weather events.

Years of infrastructural and economic development advances can be easily undone by one single extreme weather event. Due to their limited financial, skills and labor resources and underdeveloped infrastructure, it will take several years for these islands to recover. Natural disasters usually result in loss of capital assets and obstruct the production and distribution of the flow of goods and services in the economy, further aggravating the financial burden on these islands. Both the short- and long-term effects of climate change on these islands will hamper the economic and infrastructural development of the affected countries. GDP, foreign trade, and public finances will suffer, leading to an increase in public debt and poverty.

Galassi and Spada (2014) reported that by 2040-2050, the minimum total Mediterranean basin was expected to increase by 9.8cm with the possibility of a maximum of 25.6cm in sea level rise. According to (Aucelli et al., 2018) coastal flooding and erosion are the main hazards affecting coastal areas especially those found in low-lying areas which also have the highest probability of experiencing damages from storm surges. According to (Ice2sea, 2014), the

European population, currently stands at around 70 million and 14 percent live in coastal regions. It is estimated that approximately 10 million people would have to relocate further inland when sea level rises. According to the (National Oceanic and Atmospheric Administration, 2019), an increase in sea level would result in more severe and harmful storm surges which will be pushed further inland and end up in high-tide flooding.

1.4. Malta's Flood Risk Assessments

The (Malta Resources Authority, 2013) Article 2 of the Floods Directive defines 'floods' as the temporary covering by water of land not normally covered by water. This term is a generic term to include floods from rivers, mountain torrents, Mediterranean ephemeral water courses, and floods from the sea in coastal areas, and may exclude floods from sewerage systems. Article 2 also specifies that for a flood risk to exist, there must be the combination of a flood event and relevant receptors (human health, economic activity, the environment, and cultural heritage).

When the report discussed seawater flooding, the MRA mentioned that sea water flooding is uncommon in the Maltese Islands and usually occurs when high tide is coupled with heavy rainfall. Seawater flooding is not possible from high tide alone as our tides are extremely low. When coastal flooding occurs from the sea, it usually results in some flooding along some roads that are situated directly at the water's edge, and that only lasts for a few hours until the road dries up (Malta Resources Authority, 2013). Having said that, this report failed to account for future climate change predictions pertaining to sea level rise and storm events, which is that sea level will continue to rise and storm events will be more frequent and intensive throughout the year. The situation laid out by the MRA in this report could drastically change, especially in those heavily developed low-lying areas. The MRA also failed to account for the combined effects of tidal ranges and sea level rise, because even though the Maltese Islands have low tidal ranges, as sea level rises, so do tides, which adds another contributing factor to seawater flooding.

The Maltese Islands' risk assessment pertaining to coastal flooding and severe weather reported that coastal flooding leaves secondary hazards in its wake, due to floating debris

such as structural debris due to wave smashing, sediment, and boats that break their moorings (Karagiannis, 2015). This debris is carried inland imperiling human lives and other structures. As for extreme weather events, this report acknowledged the fact that with climate change, events such as hailstorms and thunderstorms are expected to increase in intensity and frequency. In addition, storms' flash floods are also expected to increase. The Strategic Plan for the Environment and Development (Planning Authority, 2015) agreed with (Karagiannis, 2015) report that extreme weather events are predicted to increase both in intensity and frequency, therefore flooding is also expected to increase.

The report by the Seventh National Communication of Malta under the United Nations Framework Convention on Climate Change (Aquilina et al., 2017) identified several areas within the Maltese Islands that are designated as high risk to climate change such as infrastructure, water resources, agriculture, ecosystem, tourism and so on. A wide variety of impacts were listed, including inundation, coastal erosion, loss of beaches and damages derived from high winds, storm surges and waves. Moreover, extreme weather events could also impact those coasts along the Maltese Islands that are made up from Blue Clay. The previous reports identified vulnerabilities pertaining to sea level rise such as ports, roads, coastal infrastructure, and protected areas. From a tourism perspective, it was reported that climate change impacts regarding tourism are still unknown, and that further research is required. One of the most notable spots is Malta's Grand Harbor which hosts a variety of coastal infrastructure (historical buildings, port infrastructure, roads and so on), quays for cruise liners and tourism facilities, such as the Valletta Waterfront is entirely made up of catering establishments and retail outlets all geared for tourism.

1.5. Research Justification

After a period of extensive research carried out for the author's undergraduate dissertation (Spiteri, 2019), it was noted that local studies that specifically investigate the impacts of sea level rise and storm surge flooding on Maltese coastal town businesses remain scarce. This incremental research scenario provided an opportunity for the development and identification of a research gap that necessitated further investigations and other sites. For the author's own undergraduate study (Spiteri, 2019) four localities were chosen Marsaskala, Marsaxlokk, Imsida, and Birżebbuġa, due to their economic importance to assess the impact

of sea level rise and storm-derived flooding as evaluated by local councils and the business community. A mixed method approach (i.e., open and closed ended questions) was used while conducting the interviews with all four local councils and with the forty business establishments within these localities (10 in Marsaskala, 14 in Marsaxlokk, 6 in Imsida, and 10 in Birżebbuġa). The results highlighted that all local councils are aware about sea level rise, but not all acknowledge it as a threat to their respective towns. As for contingency plans, three out of four councils have no plans whatsoever. Looking at the business scenario, not all business owners have heard about sea level rise and storm derived flooding with the majority did not take into consideration the risk that projected sea level rise may bring upon their businesses, both prior to setting up the business and for current operations. Moreover, none of the business operators have any plans to combat sea level rise.

The main factor that sparked the author's interest in this study was that climate change is now a global topic that triggered extensive major studies worldwide. However, most studies studied the impacts of climate change on the environment, health, society, and the economy and they usually address global factors. This left a research gap globally but especially on a local level as usually, in the Maltese Islands, small and medium enterprises are included when the Maltese government conducts nationwide studies on the economic impacts of climate change. This research gap was the triggering and motivational factor for the author to carry out this research.

For this MA dissertation, it was therefore considered feasible to expand on and refine the work by exploring the issue in five other different localities across Malta and Gozo. The chosen localities for Malta are Gżira, Sliema, and St Julian's, all located in the central eastern part of Malta (see Figure 1.1) with similar geographic characteristics, and all are renowned for frequent coastal flooding. The following three points further justify this research justification:

- i. Relevance for today's needs in terms of socio-economic intensification on the coast;
- ii. It is critically important for local studies particularly at locality-based level;
- iii. Tapping into a research gap currently lacking in studies.

The Climate Action Act published in Chapter 543 of the Laws of Malta (The Government of Malta, 2015) is Malta's primary law on climate change. This Act aims to contribute to the

mitigation of climate change by regulating anthropogenic emissions of greenhouse gases (GHGs) as well as protecting and boosting greenhouse gas sinks and reservoirs. This Act legally binds EU member states to comply with 1992 United Nations Framework Convention on Climate Change (UNFCCC), the 1997 Kyoto Protocol, and the 2015 Paris Agreement. Within the Act, the Climate Action Board (CAB) was established and represents academic institutions, government entities, civil society, and the businesses to combat climate change. It aims to introduce ownership pertaining to climate action governance across both the public and private sectors.

As part of the EU, the Maltese Islands have numerous legally binding targets to meet by 2020 and 2030 as part of the EU climate change targets. The Act does not only regulate greenhouse gases but also addresses climate change preventive and adaptation, by forcing the government to act by implementing reduction and avoidance measures to manage the inevitable antagonistic climate change impacts. The aim of such measures is to reinforce resilience and reduce vulnerability. This Act incorporates stakeholder assessments; hence therefore it strongly justifies this research. Another strong justification is the Maltese Islands Storm Water Master Plan that is only limited to just flash floods while sea level rise and storm surge flooding have been overlooked.



Figure 1.1 – Location of the five chosen localities within the Maltese Islands (Source: Briguglio & Busuttil (2008))

1.6. Importance of Coastal Flooding Research in the Maltese Islands

Attard (2015) reported that sea level is expected to rise by 7, 14, 23, and 30cm in 2025, 2050, 2075, 2100 respectively. This means that as sea level rises, storm surge flooding will worsen as the elevated sea level would reach areas further inland. The Preliminary Flood Risk Assessment Final Report (Malta Resources Authority, 2013) reported that flood events that happened in the Maltese Islands are brought by the reactivation of dry valley systems after rainfall events. Urbanization of the valley's lower section has led to some sections of the valley to being incorporated into current road networks. Surface runoff causes major flooding issues in several localities which are being tackled through various infrastructural projects as part of the national flood relief project. Upon completion, flood risk should be deemed to be at acceptable levels. The implementation of the National Relief Flood Project (NFRP), together with new legislation of rainwater cisterns and the recommendations proposed as part of the National Climate Change Adaptation Strategy, is expected to reduce the vulnerability of susceptible flooding areas derived from climate change.

Currently in the local scene, there is a dire need to integrate coastal flooding by combining sea level rise and storm surges together due to wave overtopping, which is defined as water which due to wave run up or storm surge action is carried over the top of a landform or structure. Most of the coastal towns in the Maltese Islands are designated as low lying with overtopping playing a key role during storm events. As sea level rises, wave overtopping becomes more frequent due to elevated sea level as reported by Sierra (2019). By integrating both phenomena it could represent a breakthrough in integrating disaster risk reduction issues into climate change adaptation.

This study contributes significant new insights on the importance of coastal flooding research in coastal towns across the Maltese Islands in general, but particularly on coastal flooding and businesses in coastal locations. By the end of this study, it should provide new and the latest insights to extend the current academic knowledge at national level, which is currently lacking in the local academic research. As for international level, this study is expected to present a clear image of the current situation that small and medium coastal businesses endure when coastal flooding occurs. It is also expected to deliver the latest findings and perhaps, new discoveries at international and business level, especially to other small islands that share similar characteristics to the Maltese Islands across the globe.

1.7. Aim and Objectives

An aim and a set of objectives were established for this dissertation. These objectives were set up to assist the author in achieving his aim by the end of this dissertation. These are as follows:

1.7.1. Aim

To assess the impacts of sea level rise and storm surge flooding as appraised and perceived by the business community, local councils, and expert bodies.

1.7.2. Objectives

- i. Assist current and future business owners' decision-making process;
- ii. Assist current and future policy makers and infrastructure architects to account for sea level rise and storm surge flooding when developing new policies and infrastructure;
- iii. Assist the government and the business community in effectively addressing and mitigating sea level rise and storm surge flooding;
- iv. Determine what is required in current local policies.

1.8. Dissertation Structure

This dissertation is structured into six chapters, namely:

Chapter 1: Introduction: This chapter provides background information on climate change and coastal flooding. It puts into perspective the phenomenon of sea level rise and storm surge flooding with its two consequences as the focus of this research. This is followed by a brief description of each locality's importance to the local and national economy justifying the reasons why they were chosen. The localities are of strong economic importance to the Islands' economy, so it highlighted the economic effects of these two phenomena in these localities. It points out why the author chose this topic as opposed to other climate change related fields. Within this chapter, the aim and a set of objectives are also outlined, as well as the structure of the dissertation.

Chapter 2: Literature Review: This chapter refers to key scientific studies about the effects of sea level rise and storm surge flooding that are relevant to the research question. This chapter applied a funnel approach to literature review: firstly, the science behind climate change, sea level rise and storm surge flooding were examined at global level and then narrowed down to the European and Mediterranean context. Finally, scientific work about the Maltese Islands was reviewed. All the studies found in this chapter were collected and referenced from reliable scientific sources such as: Intergovernmental Panel on Climate Change (IPCC) which is the main point of reference on the latest climate change studies, European Environmental Agency (EEA), governments, online scientific papers and journals and reports by the National Oceanic and Atmospheric Administration (NOAA), and the US Global Change Program. In

total, this chapter has 105 references which include 63 academic papers, 28 governmental, EU, and other high level scientific organizations, such as the IPCC and NOAA reports, and 12 newspaper articles, of which only two were discussed in detail, with the remaining ten used as a source from where the author extracted selected images that were also backed up by academic sources.

Chapter 3: Methodology: An explanation of the literature review's methodology will be provided followed by the methodology for data collection and site justification. This chapter explains how this dissertation employs two different research methods i.e., a qualitative and quantitative one. Questionnaires were designed for businesses, local councils, and government experts' and their design justified in this chapter. Data analysis was carried out by Excel and SPSS on three data sets. For the businesses data, the quantitative data was analysed through graphs and Kruskal Wallis Test. As for the local council's quantitative data, a colour coded matrix will be formulated with "blue" and "white" assigned to "yes" and "no" answers respectively. Regarding the qualitative data analysis for all the three data sets (businesses, local council, and experts), a thematic analysis approach will be applied via NVivo. Most questions in the expert questionnaires consisted of open-ended based questions only. Also, it is important to note that all questionnaires passed through rigours ethical compliance (UREC/FREC). FREC is there to ensure that while the student is conducting data collection, the Research Code of Practice setup by the University of Malta is adhered to. In addition, FREC also works to adhere to international standards of research and that research is compliant with EU's GDPR regulations that came into effect since May 2018.

Chapter 4: Descriptive Results: This chapter is divided into two sections: the descriptive analysis and statistical analysis. The first part is further divided into three parts (one for each data set) illustrating and discussing the outcomes of the descriptive analysis. The business quantitative data is presented in a graphical format while the qualitative data is presented in a single table consisting of all themes identified in each question. Each locality had its data analysed separately, followed by a full analysis of all compiled data. As for the local council, the quantitative data was analyzed using a color-coded matrix, and for qualitative data a table was created in each question listing all the themes identified. As for the expert interviews, each question was extensively studied to undergo a thematic analysis followed by a report

style analysis explaining the outcome. The second part presents the business data's statistical section (i.e., quantitative data only). To begin with, each locality was analyzed separately followed by a full analysis of all compiled data. For all the Likert Scale based questions, the Kruskal Wallis Test will be used via IBM's SPSS. The p-value and its statistical meaning was discussed followed by an explanation on which hypothesis is retained and why.

Chapter 5: Discussion: The discussion compares the results with the author's own undergraduate study and the literature review. The discussion will discuss why the results differ or agree with what other local and foreign studies found. When discussing the findings with his own undergraduate dissertation, a comparison will be made to see if the findings of the southern localities agree or differ with these five localities and why.

Chapter 6: Conclusion: Limitations that were encountered while carrying out this study were pointed out followed by the author's own recommendations for future studies in this field. In this final chapter, the author dispensed the reasons why this research is important and relevant to today's needs in terms of policy making in relation to the impacts of sea level rise and storm surge flooding.

Appendices: Within this section, 4 appendices have been included and contain additional data supplementing the information provided throughout the dissertation, as it was not feasible to include it into the main dissertation, but due to its extreme relevance, it cannot be left out. The first appendix refers to the literature review having information on global sea level trends highlighting the approximate sea levels during The Geological Record and The Instrumental Record. The second appendix is part of the methodology, as the researcher provided a sample of each expert interview along with the cloud isle data for the construct of the height profiles, as well as a few sample coordinates screenshots of the various business sectors operating in each of the five localities. The third appendix refers to the inferential statistical analysis, as within this section one finds all the statistical results conducted via SPSS for each question per locality and all localities collectively, while the fourth appendix relates to all the experts' interviews transcripts.

2. Chapter 2: Literature Review

2.1. Introduction

This chapter is a roadmap for the literature review of this dissertation. Throughout this section, the author aims to:

- i. Briefly define and go over the concept of climate change;
- ii. Briefly analyze the concept of sea level rise and storm surge flooding;
- iii. Review different studies related to sea level rise and storm surge flooding in relation to coastal town businesses.

Within this section, the science behind climate change, sea level rise and storm surge flooding are discussed by examining scientific papers that will explain the science of these three phenomena on a global and European scene. This is followed by case studies related to the research question and finally look at the local scene where science provided by the local scenario on these three phenomena is discussed together with local case studies related to the research question. The literature review substantiating this research, investigated an under-researched area in relation to the socio-economic dimensions of the impacts of coastal flooding.

2.2. Climate Change

2.2.1. Climate Change Definition and Causes

According to the (Intergovernmental Panel on Climate Change, 2007 pg 6), 4th assessment report the IPCC defines climate change as “any change in the earth’s climate that occurred over a period of time”, regardless if this change was the result of human or natural activity. Greenhouse gases are the main source of global warming, climate change and thermal expansions in the sea surface that result in sea level rise.

In the last four decades, countless studies have been conducted and published about the causes of climate change, such as those by the IPCC, including the regularly updated Assessment Reports with the last AR5 report being published in 2014. The (European Commission for Climate Action, 2014), agrees with the AR5 statement that greenhouse gases along with rising emissions are mainly responsible for climate change. According to this 2014

study, carbon dioxide (CO₂) is the most common and is responsible for 64 percent of man-made global warming; the other gases mentioned below were found to be in smaller quantities. It is very important to note that these gases are more effective in trapping heat inside the earth's atmosphere than CO₂. In fact, methane (CH₄) is responsible for 17 percent of all human-induced global warming while nitrous oxide (N₂O) is only responsible for 6 percent.

Friedlingstein et al., (2020) provided an accurate assessment of the anthropogenic carbon dioxide (CO₂) emissions released into the atmosphere. The authors synthesized data sets of five major components to the global carbon budget: carbon dioxide released from fossil fuels and deforestation, atmospheric carbon dioxide concentration, ocean and terrestrial carbon sinks showing a carbon budget imbalance between the estimated total emissions and the estimated changes in the atmosphere, terrestrial biosphere, and the oceans.

The (European Commission for Climate Action, 2014), highlights how deforestation and fluorinated gases had a significant role in global budget imbalance in recent times. Deforestation has weakened the earth's natural ability to capture carbon whilst fluorinated gases are 23,000 times more potent than carbon dioxide. The European Union imposed harsh regulations on the release of such gases into the atmosphere and these gases are on track to be completely phased out. As a result of this carbon budget imbalance, the current global average temperature stands at 0.85°C higher than that of 19th century, an additional increase of around 2°C prior to pre-industrial times. For this exact reason, world leaders have agreed and sanctioned measures to keep global warming continuously below 2°C.

Greenhouse gases like methane and hydrofluorocarbons have a shorter atmospheric existence than carbon dioxide and their reduction has been seen as a powerful way in slowing down atmospheric and oceanic warming. This has been very evident in the earth system model as designed by (Zickfeld et al., 2017). This model showed that a rather small amount of thermal sea level rise induced by atmospheric short-term gases is harder to reverse when they are compared with their atmospheric warming effect. Greenhouse gases with a short lifespan of only a couple of years have a more long-lasting effect on oceanic thermal expansion as the oceans absorb and discharge heat at a very slow rate.

2.2.2. Consequences of Climate Change: Sea Level Rise and Storm Surges Flooding

In addition to temperature, the (European Commission for Climate Action, 2014) highlighted other notable side effects all related to sea level rise and storm surge flooding. The first side effect was sea level rise due to the melting of ice caps at the Poles and thermal expansion (Ref AR5). Major cities across the globe are at risk of having their coastline eroded and flooded, leading to its citizens migrating inwards to safer environments. The second effect was extreme weather and shifting rainfall as extreme weather events and heavy rainfall are becoming more frequent. This trend could lead to flooding and a significant decrease in water quality, thus decreasing the availability of water resources for some areas. The European Commission for Climate Action and The European Environmental Agency did not account for the consequences of sea level rise on Small Island States. However, such a study was conducted by (Wheeler et al., 2009) and will be explained in more detail in section 2.3.2.

2.3. Sea Level Rise and Storm Surges

2.3.1. Sea Level Rise: Definition and Causes

As defined by the (Intergovernmental Panel on Climate Change, 2013 pg 1142), “Changes in sea level occur over a broad range of temporal and spatial scales, with the many contributing factors making it an integral measure of climate change”. The primary contributors to contemporary sea level change are the expansion of the ocean as it warms and the transfer of water currently stored on land, particularly from land ice (glaciers and ice sheets) (Church et al., 2010). Observations indicate that over recent decades, the largest increase of heat storage in the climate system has occurred in the oceans leading to sea level rising from ocean warming which is a central part of the Earth’s response to increasing greenhouse gas (GHG) concentrations.

According to the (National Oceanic and Atmospheric Administration, 2019), the two major drivers of sea level rise are glacial melting and thermal expansion. Due to an increase in atmospheric temperatures driven by global warming, glaciers across the globe are melting at an unprecedented rate. Ocean thermal expansion is brought about by warming of atmospheric and sea surface temperatures; hence water particles expand to the excess heat

and therefore sea levels rise. A small note from this study is that according to (National Oceanic and Atmospheric Administration, 2019), around 40 percent of the United States population live in heavily populated coastal areas which are daily threatened daily by sea level rise, hazardous storms, shoreline erosion and flooding. (Wuebbles D.J. et al., 2017) of the Fourth National Climate Assessment also agreed with NOAA, as the authors stated that sea level change is driven by a line-up of mechanisms functioning on different spatial and temporal scales driven by two factors: ice melting and ocean thermal expansion.

According to the (National Oceanic and Atmospheric Administration, 2019), there are two methods that are used to measure sea level rise: satellite laser and tide stations. Satellite laser measurements reads the entire ocean's average height whilst tide stations are strategically placed across the globe to gather readings which shows what is going on at a local level. The water height along the coast is measured in relation to one specific point on land. Both technologies can be used simultaneously to help scientists understand how our ocean levels are changing over time.

2.3.2. Storm Surge: Definition and Causes

This definition for storm surges by (National Oceanic and Atmospheric Administration, 2021) is that a "Storm surge is the abnormal rise in seawater level during a storm, measured as the height of the water above the normal predicted astronomical tide". The surge is caused primarily by a storm's winds pushing water onshore. The amplitude of the storm surge at any given location depends on the orientation of the coastline with the storm track, the intensity, size, and speed of the storm, and the local bathymetry.

According to the (National Oceanic and Atmospheric Administration, 2021), storm surge is caused by strong winds during a tropical storm or hurricane. Wind circulation around the eye of the storm or hurricane blows on the ocean's surface producing a vertical circulation. As the storm or hurricane reaches shallow water adjacent to the coast, this vertical circulation is disrupted by the seabed. As a result, the water can no longer go down, so it goes up and inland. So far, the present understanding is that ocean warming is one of the key players in intensified cyclones and storm surges activities thus leading to a heightened vulnerability of

coastlines. Wheeler et al., (2009) assessed the impacts of storm surges and sea level rise on small island states. Coastline vulnerability due to sea level rise and storm surges can be assessed with tools such as GIS (Geographic Information System) by overlying data such as urbanization, population density, GDP (Gross Domestic Product), major cities and so on for zones that are predicted to experience heightened storms and a 1-meter rise in sea level. The results clearly show that the impacts are severe and most likely to be restricted to a small number of countries and a significant cluster of cities at the lower end of the international income distribution.

2.3.3. Global Sea Level Trends

The (National Oceanic and Atmospheric Administration, 2019) provides evidence of how global sea level has been rising at a slow rate over the past century, but this rate has increased exponentially in recent decades. In 2014, the recorded global sea level was around 6.6cm, which was higher than the 1993 average and hence considered to be the highest annual average as per satellite records taken from 1993 till 2014. Sea level rise is constantly rising at the rate of around 0.3cm annually. According to the (National Oceanic and Atmospheric Administration, 2019), local scale vulnerability to sea level rise may be exacerbated or diminished by many local factors such as flood control, land subsidence, erosion, difference in land height, isostatic rebound processes and regional ocean currents.

Intergovernmental Panel on Climate Change (2013) scientists have been trying to model past sea level changes, to try and predict future sea level change. At medium confidence, during the warm period of the Middle Pliocene (around 3.3 to 3 million years ago), records show that global mean surface temperatures were approximately 2°C to 3.5°C warmer than for pre-industrial climate. The Marine Isotope Stage 11 is a geologic temperature record that covered the interglacial period that occurred between 424,000 and 374,000 years ago. During this period, Antarctic ice and tropical Pacific paleo temperature was around 1.5°C to 2.0°C warmer than pre-industrial times. New data and models since the release of AR4 (Intergovernmental Panel on Climate Change, 2007), indicate that during the Last Interglacial Period (LIP), which occurred between 129 to 116 thousand years ago, the global mean annual temperature was 1°C to 2°C warmer than preindustrial times at medium confidence, with the climax of global

annual sea surface temperatures were in the region of $0.7^{\circ}\text{C} \pm 0.6^{\circ}\text{C}$ warmer at medium confidence. There has been significant progress since the AR4 has been released in dealing with the history of sea level over the last 7,000 years. Sea level rise records indicate that from 7,000 to 3,000 years ago, global mean sea level probably rose between 2 to 3 meters to near present-day level. For more information refer to Appendix 1.

The instrumental record is split up into two categories: tide gauge record and satellite altimeter record. The tide gauge record is basically a compound of tidal measurement over the past two to three centuries (1700-2012; 2012 was at the time of writing this report). The second measurement is the satellite radar altimeter which was setup in the early 1990s. According to this data, sea level is highly likely to rise between 1.5 to 1.9mm annually which adds up to an increase of about 0.17 to 0.21 meters between 1901 and 2010. For more information refer to Appendix 1.

2.3.4. European Sea Level Trends

Studies on Europe's ocean and Mediterranean Sea level rise are carried out under the European Union (Ice2sea, 2014) in order to focus and strengthen the EU's level in understanding on the deglaciation of the world's ice sheets and caps along with the impacts that this process will have on sea level rise. According to (Ice2sea, 2014) Fifteen European Union countries have highly developed coastal zones that are presently being affected or will be eventually affected by sea level rise (Appendix 1). The European modelling and observations are based on four scenarios - Antarctica, Greenland, Glaciers and Global - with each of these scenarios further subdivided into two other subcategories: observations and modelling.

Studies on global and European sea level rise show marked differences between local, regional, and global sea level rise estimates due to irregular changes in the ocean's density and circulation (European Environmental Agency, 2015). 70 percent of the world's coastlines are expected to encounter an approximate local sea level change of around ± 20 percent off the present projected global mean sea level (GMSL) change. One of the predictions in this study is that European coastlines are predicted to experience approximately 84cm of sea level rise.

Understanding the combined role of factors which drive extreme total water levels is important as it would strengthen the preparedness and coastal adaptation measures to mitigate coastal flooding impacts. Sea level rise coupled with episodic surge levels amplifies the flooding hazards at variable spatial and temporal scales and increases hazards vulnerabilities. (Fernández-Montblanc et al., 2020) assessed the role of mean sea level annual cycles on extreme water levels along European coastline. The author assessed the contribution of surges and annual cycle of monthly mean sea level in relation to the extreme total water levels and tides based on a 24-year period (1993-2016). In microtidal areas such as the Mediterranean, the Black Sea and the Baltic Sea, the monthly mean sea level factor contribution is mostly larger than tide and as for surges it could be the same. In micro and mesotidal areas like the North Sea, it was discovered that the monthly mean sea level contribution is estimated to be <20 percent of the total water level but >30 percent in the North Sea. No correlation was noticed between the average annual monthly cycle of mean sea level and coastal flooding extreme events along Europe’s coastlines.

2.3.5. Mediterranean Sea Level Trends



Figure 2.1 - Mediterranean Sea Map (Source: Nations Online Project (2019))

According to the (International Polar Foundation, 2019) being a relatively small semi-enclosed sea, the Mediterranean Sea level rise projections are not aligned with the global sea level rise projections. The physiography of the Mediterranean region also plays a role in its response to

sea level rise. The Mediterranean Sea is replenished via rain (1200 km³ per year); other seas like the Red Sea are fed through water which flows through the Suez Canal from North- East Egypt), the Bosphorus Strait (Northeast Greece and North-western Turkey) which is in turn fed by the Black Sea, but most of it comes from the Atlantic Ocean passing through the Strait of Gibraltar (between Northern Morocco and Southern Spain). It is also fed by rivers found in all the three continents (Europe, Northern Africa, and Western Asia (Middle East)) and whose estuaries lie in the Mediterranean Sea. As a result, a rise in any of the world's oceans feeding into Mediterranean Sea may not translate into an equivalent rise in the Mediterranean. On the other hand, the region is connected to the Eurasian continent and hence any rise in storms, water surpluses and torrential rain experienced in this continental area may impact on the hydrodynamic process of the Mediterranean Sea, including that of sea level rise.

Vecchio et al., (2019) evaluated a set of geodetic data to investigate the drivers to local factors in relation to the vertical land motion (VLM) and sea level natural variability (SLNV) to the sea level trend and compare them to a 60-year record of tidal data to analyze its effects on Mediterranean Sea levels. By integrating the vertical land motion and sea level natural variability with the IPCC's, AR5 regional projection of representative concentration pathways (RCP 2.6 and 8.5), (Vecchio et al., 2019) could produce relative sea level rise projections by 2100. The combined effects of VLM and SLNV were found to contribute between 15 percent and 65 percent to sea level variability. Projected 2100 sea level in the RCP 8.5 scenario were found to be highest in Bakar, Croatia ($475 \pm 203\text{mm}$), and Venice, Italy ($818 \pm 250\text{ mm}$). The average land subsidence occurring in the Venice Lagoon is estimated to between $3.3 \pm 0.85\text{ mm}$ up to $8.45 \pm 1.69\text{ mm}$ annually, which is accelerating the local sea level rise projection.

Plataforma SINC (2009) created three anticipated scenarios that look at the effects of Mediterranean climate change for the next 90 years. These three scenarios were built upon the IPCC's global models. The conclusions showed that the Mediterranean Sea will encounter a spike in temperatures and sea level rise. In the long-term scenario, sea levels are projected to increase throughout the Mediterranean at a mean of 3-61cm.

Galassi and Spada (2014) looked at the effects of glacioisostasy, terrestrial ice melt and steric sea level components on the Mediterranean Sea. According to this study, by 2040-2050, the minimum total basin was averaged to increase by ca 9.8cm with the possibility of a maximum

of 25.6cm in sea level rise. According to (Galassi and Spada, 2014), the melting rate of terrestrial ice will outpace the steric contribution, resulting in a hefty regional effect while glacial isostatic alterations will have a minimal effect. The predictions for the Mediterranean Sea are that this sea will encounter an accelerated sea level change by 2050 by using a factor of 1-6 relative to the last observed rates. Figure 2.2 depicts sea level rise projections by 2040-2050 and it clearly shows that these projections are likely to increase for every sub-basin in the Mediterranean. Sea level comparisons between 2040-2050 and the 1990-2000 sea level, show how each basin will experience a significant increase in sea level (Figure 2.3 and Figure 2.4). MIN 50 and MAX 50 refers to the minimum and maximum scenarios of this study.

Table 1
Sea-level projections by 2040–2050 across the Mediterranean sub-basins, decomposed in TIM, GIA and OR components. The total sea-level rise for scenarios MIN50 and MAX50 are shown in the last columns.

Mediterranean sub-basin	TIM AIS (cm)		TIM GIS (cm)		TIM GIC (cm)		GIA (cm)		OR (cm)		Total (cm)	
	MR	HE	MR	HE	MR	HE	ICE-5G	KL05	EA1B	EA1B2	MIN50	MAX50
	1. W Med	3.4	8.2	0.5	1.8	4.6	7.9	0.7	2.1	-2.0	3.4	7.2
2. SC Med	3.2	7.8	0.8	3.2	4.8	8.1	0.8	1.7	1.1	5.0	10.7	25.8
3. S Crete	3.1	7.6	0.8	3.6	4.7	7.9	0.8	1.4	-3.6	3.4	5.8	23.4
4. Levantine	3.1	7.4	0.9	3.9	4.5	7.7	0.3	0.6	0.6	6.0	9.4	25.6
5. Aegean	3.1	7.6	0.8	3.2	4.5	7.7	0.9	2.0	4.7	6.9	14.0	27.4
6. Ionian	3.2	7.8	0.7	3.0	4.7	7.9	1.6	3.0	2.3	8.8	12.5	30.5
7. Adriatic	3.2	7.8	0.5	2.1	4.2	7.2	0.6	1.5	3.0	5.2	11.5	23.8
8. Tyrrhenian	3.3	8.0	0.5	2.0	4.5	7.7	1.3	2.8	-0.7	4.1	8.9	24.6
Weighted average	3.2	7.8	0.7	2.8	4.6	7.8	0.9	1.9	0.4	5.3	9.8	25.6

Figure 2.2 - Shows 2040-2050 sea level rise projections. (Source: Galassi and Spada, 2014)

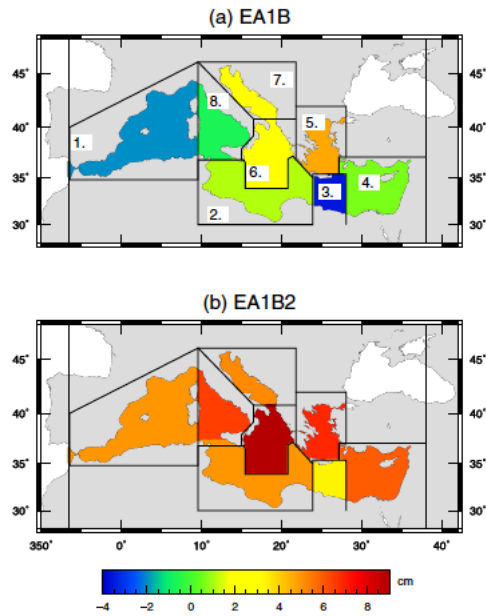


Figure 2.3 – OR borderline by 2040-2050 sea level with a comparison to the 1990-2000. The numbers (1-8) represent the eight Mediterranean Sea sub basins. (Source: Galassi and Spada, 2014)

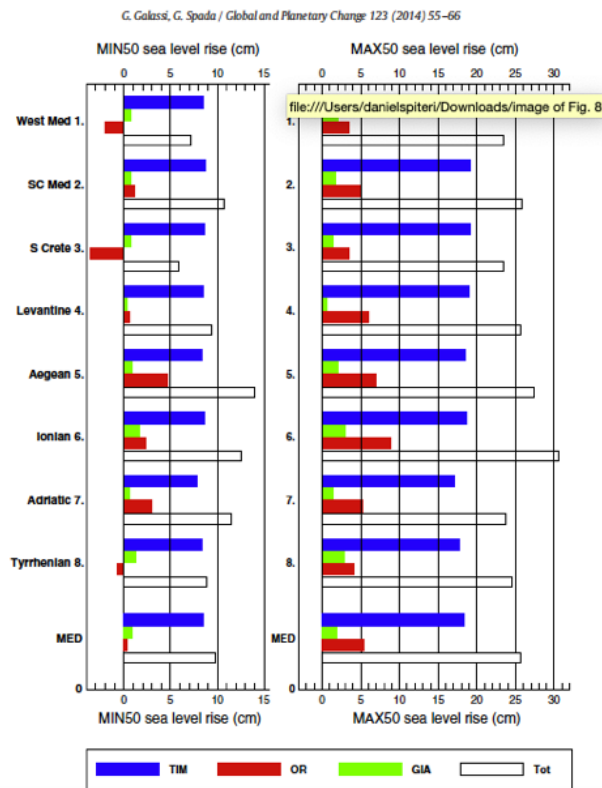


Figure 2.4- TIM, OR, GIA, TOT, and the elements that contribute to the total sea level change in the eight Mediterranean's sub basins (Source: Galassi and Spada, 2014)

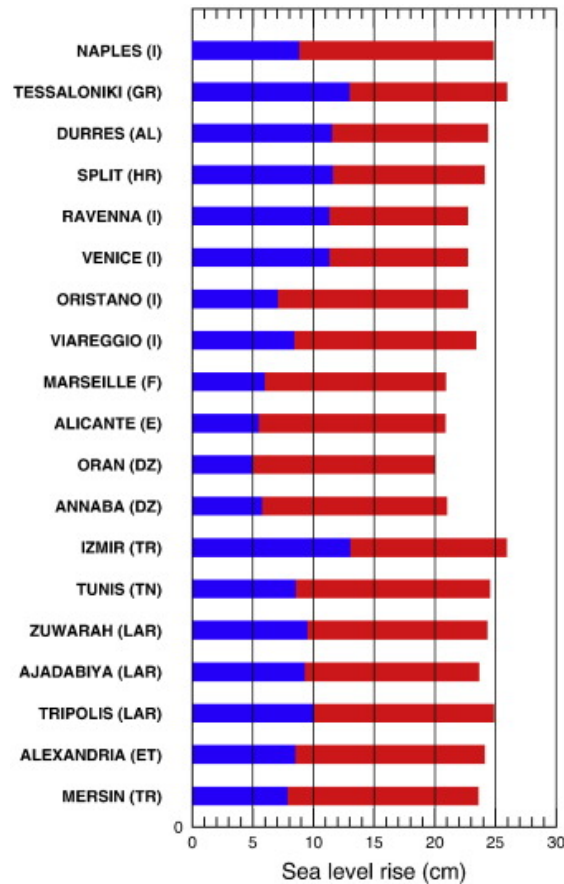


Figure 2.5 - Sea level rise expectations in cm by 2040-2050 because of the combined effects of sea level components in densely populated coastal towns located in the Mediterranean. The blue in the above bar graph represents the minimum 50 whilst the Red represents the maximum 50. (Source: Galassi and Spada, 2014)

Aucelli et al., (2018) wrote that coastal flooding and erosion are the primary hazards affecting coastal areas (especially those found in low-lying areas which also have the highest probability of experiencing damages from storm surges). The likely impacts of coastal hazards are increasing globally due to the rapid increase of socio-economic development which is accelerating the process of climate change. Coastal flooding and erosion processes will continue especially when IPCC's future sea level rise projections are considered.

The adopted models for this paper took IPCC's sea level rise projections and future hazardous scenarios based upon approximated global sea level rise predictions for 2065 and 2100. The estimated calculations were derived from using specific flooding and erosion models executed in hotspot areas. These scenario models have indicated that sea level rise will cause major beach erosion and dune systems along the Molise coast, jeopardizing economic activities and causing serious damages to the ecological systems. This study emphasizes the fact that accurate predictions of future coastal hazard scenarios are fundamental for the

evaluation of long-term coastal risks and the definition of related mitigation and hindrance measures.

2.3.6. Science Community and International Action

World leaders play an important role in combating climate change, and they are setting up high-level conferences annually across the globe. The agenda of these discussions is to look at what active and effective measures can be implemented to address this issue. These conferences are set up annually with the aim to discuss climate change along with its required mitigation measures on a global scale by world leaders. The importance of these conferences is that in each conference, a set of objectives, priorities and protocols are discussed for countries to collectively work towards the same goal. The European Union is also taking a leading role by hosting more frequent inter-governmental meetings, setting up policies and targets that each member of the Union must reach within a specific timeframe. Each member state has been given a specific deadline to reduce their carbon footprint. The EU has already taken the initiative to ban certain substances like CFC's (chlorofluorocarbons), and HFC's (hydrofluorocarbons) and is hoping that these measures will have the desired effect of reducing greenhouse gases and emissions that are discharged into the world's atmosphere. On a smaller scale international conferences are organized by the United Nations annually, discussing the issues related specifically to sea level rise.

2.3.7. Vulnerability to Coastal Flooding; an interplay of different factors

Due to heavy coastal use around the Mediterranean Sea, large urban cities and metropolises are congregated along a narrow coastal strip where any change in sea level or coastal dynamics, such as currents, waves, winds, changes to its landscape due to erosion and so on would disrupt human operations in terms of daily activities like transport, housing, work and so on. A European Union study (Ice2sea, 2014) study highlighted some of these consequences on the coastal economic activity. All the economic activity located within 500 meters from the sea has been valued to be in the region of €500 to €1 billion. Furthermore, approximately 4,750 km² of these economic sites are situated 500 meters off the coastline and are designated to have high ecological value. According to (Ice2sea, 2014) the European

population has more than doubled, currently at around 70 million with 14 percent of them living in coastal regions. It is estimated that approximately 10 million people would have to relocate further inland when sea level rises. All these coastal areas will also undergo erosion, that will enhance the risk of coastal flooding and accelerated elimination of natural sea and man-made defenses. Currently the European Union is creating policies to protect each member state's coastline to lessen the impact on European citizen's lives using available sea level rise projections data.

According to (National Oceanic and Atmospheric Administration, 2019) an increase in sea level would result in more severe and harmful storm surges which will be pushed further inland and end up in high-tide flooding. In the United States alone, the frequency of coastal flooding is estimated to be in the region of between 300 to 900 percent more than it was 50 years ago (National Oceanic and Atmospheric Administration, 2019). (Hino et al., 2019) also assessed the evaluation of observed sea level rise impacts, especially those impacts related to extreme scenarios brought about by tropical cyclones. High tide flooding was reducing customer visits by 1.7 percent, and it was estimated that with an additional rise in sea level of around 3 (7.62cm) and 12 inches (30.48cm), high tidal flooding would reduce visits by 3.6 percent and 24 percent respectively. The economic costs of high tidal flooding are further elaborated in Section 2.4.4.

Factors such as river flow and wave overtopping in a range of flooding scenarios were also modelled as these add up to the cost of coastal flooding events (Prime et al., 2015). In recent years many studies have focused on assessing how an increase in sea level may impact islands and coastal communities. The vast majority of low-lying islands, communities and coasts face a significant risk from sea level rise irrespective if these are rural or urban areas, in more economically developed countries (MEDCs) or less economically developed countries (LEDCs). (Intergovernmental Panel on Climate Change, 2019) also expounds on how sea level rise threatens coastal zones through several coastal hazards such as more periodic and intense coastal floods, destruction of coastal ecosystems, permanent land subsidence due to higher sea level and tides, heightened coastal erosion, impeded drainage systems and saltwater intrusion in ground and surface potable water and soils. This study concluded that many coastal areas across the globe are deemed to be high to very high-risk areas, with most coastal

mega cities severely impacted. (Nicholls et al., 2007) ranked the world's cities most exposed to coastal flooding today and in the future.

If the world fails to meet the United Nations' (UN's) and IPCC's 2°C proposed limit, the financial costs of combating the effects of sea level rise and the loss of revenue by impacted areas would exceed trillions of dollars. The UK's (National Oceanography Centre, 2018) estimated how the impacts from sea level rise and coastal flooding on coastal communities will result in financial and economic hardship. Coastal flooding is estimated to cost approximately \$14 trillion USD (€12.1 trillion) worldwide annually by 2100, with country-based disparities depending on the level of preparedness and the size of coastline. It is believed that China would experience the largest upsurge in flooding costs whilst developed countries such as Europe, USA, Canada, Australia and so on, are in a better position to keep costs down due to their existing infrastructure.

Relative sea level rise and potential submersion risk for 2100 on 16 coastal plains within the Mediterranean Sea were also assessed by (Antonioli et al., 2017). The authors used LiDAR (Light Detection and Ranging) and the Copernicus Earth Observation data from the RITMARE and Copernicus Projects to estimate the potential marine submersion for 2100 for 16 small sized coastal plains located within the Italian peninsula along with four other Mediterranean countries (France, Spain, Tunisia, and Cyprus) who all have different morphological, geological, and tectonic characteristics. Their findings estimated that the expected loss of land for these areas is to be around 148km² (IPCC RCP 8.5) and 192km² (Rahmstorf) from a coastline length of around 400km. Even though Antonioli's study did not assess the Maltese Islands, their findings could provide a clear picture of the estimated loss of land that the Maltese Islands could experience by 2100.

Furthermore (Martzikos et al., 2021) argue that astronomical tides and extreme wave runups brought about by coastal storms may cause not only extreme coastal flooding but also overtopping to coastal structures and ports. This will severely impact port operations and port infrastructures, as evidence by Stone and Orford (2004), Ciavola and Stive (2012), van Dongeren et al. (2018). Impacts depend on the hydrodynamics of each regime with the bathymetry and topography playing a crucial role. For their impact's identification, many

parameters are needed such as storm energy, wave height and period, water level, storm duration and direction, frequency and so on. This framework could be applicable and applied to the Maltese Islands as it could help in indentifying vulnerabilities that need to be addressed to effectivly study, learn, and future-manage coastal flooding and its impact on the islands' coastal localities. (Marfai and King, 2008) conducted a coastal flood management study in Indonesia with the aim of managing coastal flooding. This study found that high water tide, land subsidence and deficient structural measures all play a key role in coastal inundations.

In another study by (Mousavi et al., 2011) global warming is expected to drastically increase hurricane flooding due to sea level rise and hurricane intensification with millions of people across the globe already exposed to coastal flooding from tropical cyclones. (Mousavi et al., 2011) assessed hurricane intensification and sea level rise impacts by using hydrodynamic surge models to illustrate elevation of hurricane flooding plus sea level rise. This model projects a sea-level rise of 0.3 meters by 2030 and 0.8 meters by 2080. For hurricane type surge events, coastal flooding levels are expected to rise by 0.5 meters by 2030s and 1.8 meters by 2080s.

2.4. Exploring Coastal Businesses as Victims of Coastal Flooding

Businesses play a crucial role in their respective communities, however disaster research in relation to businesses has not yet been intensively studied as most studies focused on government agencies, families and households (Zhang et al., (2009). The following thematic sections review literature that investigated the impacts of sea level rise and storm surge flooding on the coastal business community.

2.4.1. Engagement with business communities

Living or operating within proximity of flooding hazards can significantly increase the participants' level of perceptions about flooding hazards. Studies such as by (Akerlof et al., 2016) confirm how a community deliberative event with a small group of discussions about sea level rise strategies can significantly increase all participants' knowledge and for those with a biased worldview of low-risk perceptions this event drastically increased issues and concern identifications about such impacts. The results recommend that small group

deliberation focusing on resolving local issues may be an effective reduction tool on polarizing the decision-making effects.

Engagement by different stakeholders can be a challenging process. (Lewis, 2012) probed into the reconciliation of economic development along with flood risk mitigation on the Humber Estuary. In trying to harmonize flood risk mitigation with sustainable economic development, the British Environment agency has suffered hefty challenges in engaging with regional and local businesses within the governance process. Nevertheless, (Lewis, 2012) found out that importance of flood risk management for the business community is reported to be higher in the present and future than it was in the past. This increase can be attributed to the fact that the number of businesses who have experienced flooding episodes has increased.

Knowledgeability proves difficult to transfer between flooding events with an increase in number of concerns about pluvial flooding not percolating regarding coastal flooding from sea water. A more precariously worrying find was that the businesses which have received flood risk information from the British Environment Agency had lower knowledge of the importance of managing flood risks than those who had not, which highlights a discrepancy between lay and scientific knowledge. Without a good understanding of how businesses comprehend flood risk and how this affects participation within a governance process, the full cooperation of the private sector within the flood risk mitigation governance remains highly unlikely, therefore imperiling sustainable economic development on the Humber Estuary.

In a study about the perception of coastal protection by the business community, (Reddy et al., 2016) quantified and valued coastal protection and other ecosystem services (such as marshes) as a cost-reduction analyses of hurricane risk mitigation options for the businesses. They pointed out that businesses may be missing opportunities when not considering ecosystems services in their decision-making processes, as they do not have in hand a method to quantify and value how these ecosystems services may respond to increase in sea level rise and storm surges in the future. The authors show how a reduction in marsh area, will lead to increase the required levee height (12 percent) and cost (8 percent). During 2010, marshes

provided around \$117 million USD (€102 million) in coastal protection measures, supporting fisheries, more than 300 wildlife species and recreational facilities.

2.4.2. Vulnerability/ Risk Analysis

Indices have recently started to be used as a quantitative tool to measure business vulnerability to flooding. (Song et al., 2016) conducted a study to create a business vulnerability index (BVI) against sea level rise. Infrastructural factors were integrated with other factors based on existing literature results and business characteristics to create a BVI and determine impacted business factors, and how they will change with the current projections for sea level rise. GIS tools were used to merge business vulnerabilities and physical ones to analyze overall susceptibility and how it changes with sea level rise. Song's (2016) first key finding was that the highest deemed flood risk zones do not naturally intersect with the high-risk areas identified in the (BVI). The second finding revealed that businesses will be more vulnerable to flooding as sea level rise increases, as businesses operate within the context of other urban elements such as road networks and industrial areas, which also risk of getting flooded and thus cut off vital attraction to the area from transport users and workers. (Prime et al., 2015) also assessed the physical and economic impacts of sea level rise and low probability flooding events on coastal communities in Fleetwood, UK. An inundation depth scenario was presented as brick-course maps which enables a new way of reading and understanding flood maps.

Termination of business operations due to coastal hazard is already a reality. (Craig et al., 2019) assessed the climatic variability and shifting weather patterns that results in extreme weather events and natural disasters, and the risks that the phenomenon brings upon small businesses in the southeastern coastal regions of the United States, where extreme weather events such as flooding, thunderstorms and hurricanes have increased in frequency and severity. Around 40 to 60 percent of these small businesses ceased operations after they endured a natural disaster with the vast majority of the small business owners not having a disaster plan in place. The authors observed weather and sales data pattern for this small local business along Virginia Beach, Virginia, USA, and performed a SWOT analysis to help businesses identify their vulnerabilities and ways to address them to mitigate the effects of

coastal flooding. The graph in Figure 2.6 represents the daily sales against precipitation in Virginia Beach and one can easily notice that sales decrease during precipitation events. This study shows the potential to develop measures to assess vulnerability that are easily duplicated using readily available data, with these measures being easily explained to and understood by policymakers, local planners, and citizens.

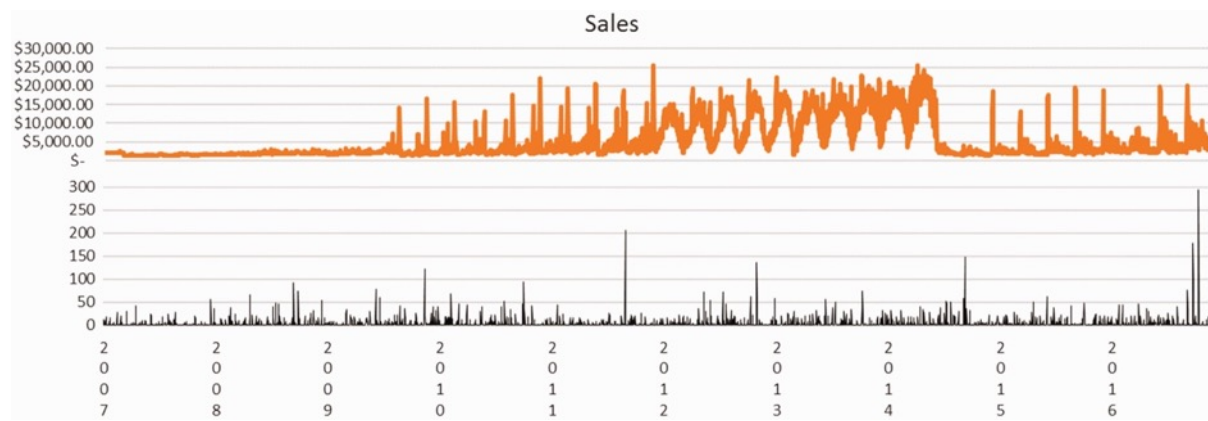


Figure 2.6 - Daily sales and precipitation in Virginia Beach between 1st January 2007 and 11th November 2016. (Source: Craig et al., 2019)

Stafford and Renaud (2019) also created a framework that identifies sea level rise vulnerability to local business and government in Coastal Virginia, USA. They fused together the measures they created with a physical vulnerability measure for them to classify those areas in Coastal Virginia where policymakers and planners need to focus more on examining the likely impacts of sea level rise on their local government and business community. The key finding of the local business community and government susceptibility to sea level rise is that in the event of an extreme storm, the area is predicted to endure a significant decline in its economy with a high percentage of businesses at risk of relocation after an extreme storm event. Stafford and Renaud (2019) study is important because their framework consists of identifying vulnerabilities pertaining to sea level rise to the local business community and government. This framework, if adopted, could assist the local Maltese business communities and governments to identify vulnerabilities within the town and could compare this study's findings with the local findings to assess the similarities and discrepancies.

The scope of indices, measures and data is ultimately to develop an assessment framework that can support businesses in natural disaster preparedness and post-recovery. Zhang et al., (2009) developed a framework for assessing business vulnerability to natural disasters and

outline five key objectives of such a framework. Firstly, it delineates the exact process of how natural disasters impact the business community. The key finding here was that natural disasters could impact the businesses from a supplier and customer perspective. From a supplier point of view, if a supplier is badly hit then the business would not be able to receive the supplies needed, while in terms of a customer perspective, businesses suffer a drop in sales. Secondly, it pinpoints the factors that decide the intensity of impacts the businesses suffer after such disaster. The key finding was that it depends on the intensity of the disaster, as intense natural disasters can cause a population relocation, loss of income, weakening market demand, hefty physical damages amongst others.

Thirdly, it pinpoints how and when businesses return to their pre-disaster levels in the disaster-stricken area. The key finding here was that the sector in which the business operates determines the timeframe to which they return to their pre-disaster levels. Small wholesale and retail businesses have a significantly a high susceptibility level, retail, and wholesale chains together with construction and manufacturing companies have a mediocre susceptibility level, while professional services companies, such as consultancy and law firms have low vulnerability. These levels indicate how fast a business can recover and get to pre-disaster levels, meaning that a low susceptibility level equals to faster recovery track while the high susceptibility level means a longer recovery track.

The fourth issue is by describing any measures that can be taken by individuals, firms, and community planners to minimize the impacts of such environmental disasters. The key finding here was that in the planning stage, emergency response plans and pre-disaster plans need to be included. These plans have been found to be highly efficacious in community recovery whilst also implementing mitigation measures for reconstruction. However, these plans are geared towards household recovery, therefore business recovery has been overlooked. The fifth and final point is that it identifies the need that public policy makers and future research must include effective methods that will minimize the business community's susceptibility to environmental disasters. The key finding for this final theme was that future research is needed to examine which hazard adjustments are ideal for business in general and which adjustments are tailored to a particular size or economic niche. Furthermore, an examination

must be carried out to investigate ways on how local and emergency planners can successfully output hazard warnings.

Stakeholders' engagement remains however crucial to gather first-hand information and help to create a detailed multidimensional analysis of flooding vulnerability. Masgrau and Palom (2012) analyzed the vulnerability of the businesses' community to flooding episodes in Girona (Spain) through a statistical and mapping method (cluster analysis) based on information gathered from around 568 questionnaires from the business community located in high-risk flooding areas. Based on business stakeholders' feedback, five different flood vulnerability profiles were created for the business establishments. These profiles give an impression of little adaptation risk and the possibility that the business community in this area would sooner or later experience large economic losses due to flooding. These vulnerability profiles could support government management policies and strategies to determine the level of risks for business owners and how to prioritize areas of flood susceptibility. Three decades of research by (Poulter et al., 2009) have shown on the other hand that the level of the risks involved is being understood more by stakeholders and that there are political advances in openness to policy changes.

With extreme storms projections expected to increase in frequency and severity, post-flooding recovery and economy support to small coastal businesses is increasingly being given scientific attention in literature, when assessing the lifespan of business vulnerability. Davlasheridze and Geylani (2017) studied local economic losses of small enterprises, which are more susceptible to flooding impacts due to lower capacities of economic recovery. The authors' assessed flooding impacts on businesses and the efficiency of small business administration (SBA) disaster loans for mitigation disaster effects. The authors found a significant short-term lack in adaptations to extreme weather events which highlight their extreme susceptibility to flooding. The results showed that subsidized disaster loans are crucial for small businesses employing 50 people or less. According to their estimates, for every dollar spent on disaster loans on each establishment, four small businesses will survive. Additionally, these effects have greater implications on a national scale as small businesses employ a significant number of people.

2.4.3. Other indirect and/or long-term effects of coastal flooding

Small and medium sized businesses tend to focus solely on the direct impacts of flooding whilst discarding the other related indirect or long-term effects, thus they would grossly underestimate the full cost of such events. Wedawatta et al., (2014) claimed that flooding can have a disastrous impact on small and medium sized business operation due to their lack of resources, making them susceptible to a wide range of indirect and direct effects. This study examined the range of impacts that small and medium businesses experienced in Cockermonth following the 2009 floods. Questionnaire findings revealed that businesses that were indirectly affected by the flooding episode experienced a wide range of long- and short-term effects but only short-term impacts were prioritized. A strong response was discovered between post flooding insurance costs and direct physical flood impacts, with a considerable rise in insurance excesses and property insurance costs after the flooding event.

2.4.4. Financial/Economic

In a study about the impacts of sea level rise and coastal flooding on the local businesses in Annapolis, (Stanford University, 2019) reported a decrease of approximately 3,000 customer visits due to high tidal flooding and the loss of revenue was estimated to be round \$86,000 to \$172,000 USD (€74,000 to €149,000). According to high tidal data of annual flooding days collected across 27 different locations in the US, the annual days increased exponentially from 2.1 days in the late 1950s to 11.8 days between 2006 and 2010. By 2035, around 170 coastal states are expected to experience around 26 annual high-tide flooding days.

In a similar study, (Clemon, 2008), assessed inland and coastal flooding impacts on small and medium businesses in relation to the insurance industry in the UK. This study shows that ninety percent of the small and medium enterprises (SMEs) were under-insured and that seventy percent of the businesses operating in high-risk areas were not even aware that flooding would affect them. Businesses had different opinions and perceptions on climate change and its consequences – eighty five percent were well informed on the subject and agreed that it is a global threat. However, forty six percent of the small to medium enterprises think that climate change was completely blown out of proportion; only twenty six percent acknowledged climate change as a major threat to their livelihood. The study was repeated

by an insurance company a year later and marginal changes in the responses were observed: a drop from eighty five percent to seventy seven percent for small business owners less troubled about climate change and an increase from twenty six percent to thirty percent for business owners seeing climate change as a major threat to their businesses. In most cases, the accommodation and catering sector will cease to operate following a flooding event.

On the basis on other data, (Clemo, 2008) concluded that due to the nature of small-scale businesses, owners continue to remain ill-equipped and with limited resources to deal with flooding. When businesses were asked what measures they have in place to protect themselves against flooding, (Clemo, 2008) found that around fifty nine percent answered that they were insured against business interruption or loss of earnings. Sixty two percent claimed that they have insured themselves against weather interruptions, whilst only thirty five percent of those interviewed are worried about the flooding threat. Around sixty five percent of all the businesses interviewed stated that they do not have any practical contingency plan. Twenty seven percent have reviewed their insurance policy and included cover against flooding and severe weather conditions while twenty four percent reviewed weather proofing. Interestingly, around twenty percent introduced flexible working hours, teleworking (working from home) or sought advice from the government on how to protect against this phenomenon.

Therefore, according to (Clemo, 2008) SMEs are at a greater risk of being completely put out of business by a major flooding incident. It is estimated that by the year 2080, the cost to the economy following SME's bankruptcy would be round 30 or 40 times what it is today if current climate change predictions are accurate and current adaptation and current development attitudes do not change. With today's prices, it is estimated that it will cost the UK economy around £42 billion (£49.4 billion) annually from business interruption. In future, more businesses are likely to be at risk of flooding and climate change especially if these trends of downsizing businesses and ill preparedness continues.

Clemo (2008) reported that the UK insurance industry has significant interest in such issues. Annually, in a non-exceptional year, insurance companies pay out around £500 million to £1 billion (£558 million to €1.2 billion) in weather-related claims. Currently, UK's insurance

companies are subsidizing flooding insurance due to the Association of British Insurer's Statement of Principles of Flood Insurance as a form of continuation of the preceded and eliminated Insurance Guarantee (1961). With current trends in the frequency and severity of flooding projections, this policy package will soon be unsustainable unless no corrective measures are implemented to tackle flooding and updating the policy parameters. With the lack of awareness and preparedness in the small and medium businesses about the consequences of climate change and flooding, the insurance industry is extremely nervous due to the huge sums of financial reimbursements being handed out following such events.

Real estate values are also projected to be impacted by flooding events related to sea level rise and storm surges. Yohe (1990) had calculated that financial costs for the US expected to range between \$38.5 - \$76.7 billion USD (€33.2 – €66.3 billion) up to 2050 and \$132.6 and \$362.4 billion USD (€114.5 – €313.1 billion) through 2100. In a more recent study, The (Union of Concerned Scientists, 2018) recalculated impacted real estate values in the United States and found out that the costs of coastal flooding will be more exorbitant. More than 300,000 of the current coastal homes and commercial properties are expected to be at risk of flooding within the next 30 years (Figure 2.7 and Figure 2.8). The value of those properties by 2045 is estimated to be around 136 billion USD (€117.5 billion). By the end of this century, around 2.4 million of today's residential properties and around 107,000 commercial entities would be at risk of flooding (Figure 2.9). It is estimated that these properties are worth around 1.07 trillion USD (€924.4 billion), which is roughly equivalent to Florida's entire GDP.



Figure 2.7 - An image showing flooded properties. (Source: Underwater Rising Seas, Chronic Floods, and the Implications for US Coastal Real Estate, 2018)

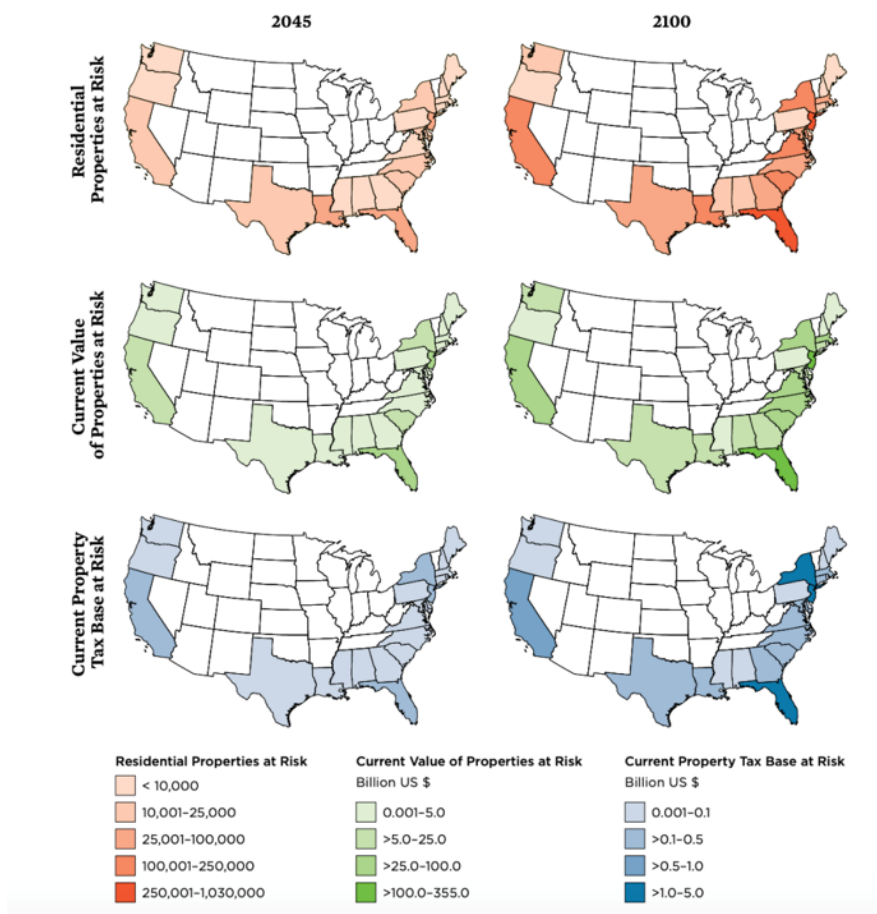


Figure 2.8 - This image shows a GIS map of the properties across the United States that are at risk. (Source: Underwater Rising Seas, Chronic Floods, and the Implications for US Coastal Real Estate, 2018)

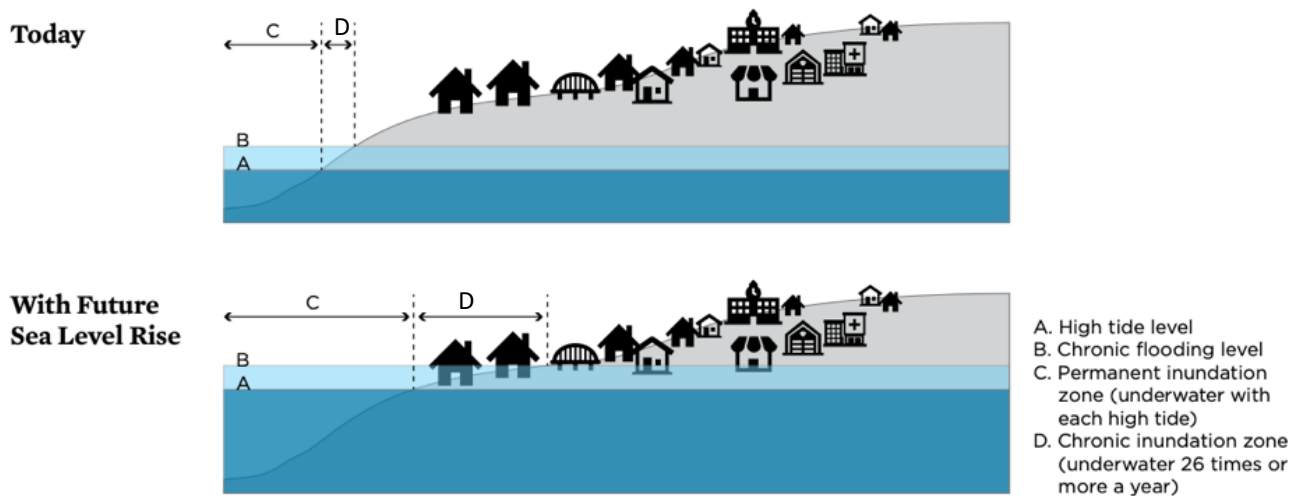


Figure 2.9 - This image shows the current sea level and future sea level along the locations of the properties. The top panel shows the current reach of high tide (C) and the current extended reach of extreme tides, which defines a current chronic inundation zone where flooding occurs at least 26 times per year (D). (Source: Underwater Rising Seas, Chronic Floods, and the Implications for US Coastal Real Estate, 2018).

Sierra (2019) assessed on a regional scale the impacts of sea level rise and storm surges throughout the 21st century in wave overtopping of ports breakwaters of 47 ports along the Catalan coast. Sierra (2019) findings showed that the number of ports affected by overtopping will increase with sea level rise along with its financial and economic impact and that financial savings from the most economic feasible adaptation measures would allow a minimum level of damages instead of the unfeasible zero damages option.

Insurance coverage against coastal flooding is a growing dimension in coastal management policies. Dávila et al., (2014) claims that insurance against natural hazards, such as flooding, are being integrated in coastal management policies for several reasons:

- i. Can offer support to accelerate social and economic recovery in the aftermath of a disaster;
- ii. Can assist in limiting coastal flooding impacts by imposing pricing or restrictions on coverage availability, to discourage any new development in susceptible hazard areas;
- iii. Can aid in reimbursing damages costs across the population both in the long and short term. It can also implement damages reduction policies that are related to mitigation measures for old and new buildings, by altering the depth-damages relationship whilst the long-term risk could affect overall damages, therefore discouraging any new or further building development in high-risk areas.

Dávila et al., (2014) explored insurance potential to promote resilient economies to address coastal flooding and erosion in Italy, Spain, France, and United Kingdom and discovered variable levels of insurance coverage following flooding events. Citizens in Italy felt that they were not adequately informed on flood risk and on the ability to protect themselves and their families with sand nourishment, recognized to be the most effective coastal defensive mechanism. In Spain it was noted that following an increase of coastal flooding events in recent years, more damages were reported, and citizens expect that future insurance costs will skyrocket, and additional exclusion clauses added to their policies. In the UK, it was discovered that insurance cover for flooding is included as a part of household or business insurance policy, although erosion is nowhere mentioned in these same policies. The UK business communities' insurance regarding flooding is to recover as soon as possible from flooding related setbacks.

In France, the Risk Prevention Group Ministry within the French government is directly responsible to addresses risk issues by providing information on prevention policies. Insurance companies are particularly interested in risk mapping to identify risk at a territorial level. In view of this, insurance companies collaborate with the Ministry for Risk Prevention to estimate the number of people living in susceptible areas. Another flood risk planner claimed that the balance of compensation after a flooding event is not publicly shared. Another manager claimed that people do somehow calculate the risks, however, they cannot fully protect themselves as they are not fully aware of the territory's vulnerability.

Prime et al., (2015) built scenarios of flooding impacts to amplify the levels of engagement within the coastal community in Fleetwood, UK. The study shows that under joint extreme scenarios called "surge wave river" (combined river flow and wave overtopping), the cost of flooding can significantly increase compared to just surge flooding scenarios, although flooding levels are expected to increase.

El Raey et al., (1999) assessed vulnerability and predicted socioeconomic losses across the Nile delta (Port Said and Alexandria) due to sea level rise. The results estimated that if no action is taken, around 30 percent of the city of Alexandria will be completely submerged and

lost. Around 2 million people will have to abandon their homes and it is predicted that around 195,000 jobs will be lost together with an estimated \$3.5 billion USD (€3 billion) of economic losses by the next century. In Port Said, the results indicate that beaches would be acutely affected; this will first affect coastal tourism and will eventually impact urban areas as well, with the least affected industry expected to be agriculture. A 0.5-meter rise in sea level is believed to cost around \$2 billion (€1.7 billion) in economic losses and \$4.4 billion USD (€3.8 billion) at 1.25 meters.

A study conducted by the (Intergovernmental Panel on Climate Change, 2012) assessed the role of insurance companies in disaster risk management and climate adaptation in developing countries. The economic and human expenses from natural disasters can rise exponentially by the long-term loss in disposable income, education, health, and other forms of capital resulting from the failure of communities to restore their sanitary condition, livelihoods, infrastructure, and housing availability in a timely manner. Financial mechanisms like Insurance, Disaster Risk Reduction (DRR) and other risk transfer instruments aim to minimize the financial losses incurred following natural hazards. Micro-insurance programs are being set up to enable affected households rebuild their properties and livelihoods to recover in the shortest possible time. These tools can also help in reducing vulnerability and promote development even before disasters strike, by providing firms and farmers in these susceptible regions the right environment in which they can engage in higher return, yet higher risk investments. Governments also participate in risk transfer. Investors are more likely to invest in countries whose government is seen and proven to have taken the necessary steps to minimize the risk of natural disasters on its own territory.

2.4.5. Tourism

Coastal zones are of utmost importance to the tourism industry and the need to protect such zones is imperative as they are vital to the country's economy and for the many coastal localities and regions. Sagoe-Addy and Appeaning Addo (2013) assessed the impacts of sea level rise on tourism facilities situated on Ghana's Accra Coast using the IPCC scenarios. Predicted models for 2020, 2060 and 2100 based on A2 (enhanced regional economic growth) and B2 (more environmentally focused) IPCC scenarios, show that 13 tourism facilities are

currently at risk of being flooded due to sea level rise and that 31 percent of all tourism facilities cannot physically endure sea level rise due to their proximity to the shorelines. Sanitation and salinization problems will further aggravate the negative effects on the tourism industry across the coast.

Studies by (Phillips and Jones, 2006) and (Usher et al., 2020) assessed beaches as key selling points to a country's marketing campaign and how erosion from flooding may impact the tourism industry. Stakeholder's consultation within a business resilience framework, led to the followings findings by (Usher et al., 2020):

- i. Most of the interviewees did not feel vulnerable due to the structural mitigation measures employed by the city;
- ii. The larger businesses invested more in strategic planning, recover planning and preparedness;
- iii. All businesses had dynamic ways of communication between customers and staff and with the help of memberships in local organizations, these businesses had access to resources;
- iv. Not every business prioritized staff training for these types of scenarios;
- v. All operators acknowledged the importance of staff training to effectively manage severe weather events.

2.4.6. Mitigation Management through Flood Management

The report by the UK (Committee on Climate Change, 2016) advocates the need for implementing adaptation and mitigation measures when working with business communities. It reiterates the importance of long-term strategies to focus on projected risks that communities and economic activities are expected to face in the future. The policy promotes measures to significantly reduce the negative impacts, disruptions, and costs those businesses will be facing, and working with infrastructure operators to improve and advance resilience locally by protecting important assets from flooding.

In (El Raey et al., 1999) options and cost adaptation measures are analyzed by stakeholders' consultations in a multi-criteria decision approach. Policies related to hard engineering

methods (hard engineering measures on some vulnerable areas) and no action policy (stopping the activities) achieved the lowest scores by stakeholders, whilst integrated coastal zone management (ICZM) and beach nourishment attained the highest scores. However, the integrated coastal zone management was considered a high-cost measure as it is expensive to implement. The best cost-effective option proposed was land-use change; however, it could also end up as a very high-cost measure. The study recommended that the integrated coastal zone management approach is to be adopted since it allows for a reasonable balance between cost effectiveness and overall costs.

Angus and Hansom (2021) explored the role of stakeholders' consultation in management approaches to achieve climate change resilience in a highly susceptible low-lying coastal zone complex in Uist, Scotland. Several climate change management approaches were reviewed with some originating from the community itself. These approaches were: high community awareness and participation translating to a higher success rate in resilience planning, coastal dunes for adequate protection, prioritizing and addressing issues, and a connection between society and the environment pertaining to climate change pressures. The approaches identified fused engineering and nature-based solutions by demonstrating how resilience can be achieved and improved in susceptible areas via continuous engagement with local stakeholders, backed by research adhering to these policies.

Adopting an inter-disciplinary approach to investigate the SME's operational and preparedness response to flooding is an important development in resilience research because despite their economic importance, a research gap in business flooding disruptions still exists. Coates et al., (2016) assessed the behavior of small businesses (SME's) to enhance flooding resilience in the UK. According to (Coates et al., 2016), SME's make up around 99.9 percent of businesses, 60 percent of the working force and 47 percent of the annual turnover in the UK. Business continuity management is perceived to be an organizational resilience. This research integrates multiple disciplines such as flooding modelling, agent-based modelling and simulation, economic modelling, behavioural science, and business continuity management. Coates et al., (2016) explains that these models could prove valuable to SME's to enhance their resilience to flooding.

Yusuf et al., (2018) study portrays a region-wide, multi-sectoral and community stakeholder engagement approach designed to focus on sea level rise and flooding which enabled an effective assessment to be used as a tool to capture community wide awareness and perceptions pertaining to sea level rise, flooding, and any other associated risk. Stakeholders of various backgrounds and industries were in talks in assessing the community's willingness to address sea level rise and flooding. Yusuf et al., (2018) key finding was that this event aided participants to individually broaden their understanding and perspective towards sea level rise and flooding. Those participants who were already exposed to the subject have already established their opinion that the region's willingness to take action was weak.

Assessing community disaster resilience is imperative to mitigate current and future risks. Almutairi et al., (2020) assessed coastal community resilience frameworks for disaster risk management. This study provides a review of coastal community resilience frameworks for disaster risk management, covering their content, structure, and assessment. Sixty-four critical resilience objectives were identified, with a focus on governance and institutions, the economy and society. Around 22 percent of the framework's participants do consider future risks; the remaining 78 percent were considered ill equipped to examine projected climate change risks. However, none of the frameworks consulted the full range of stakeholders to include expert bodies, the public and the government. A multidimensional hazard approach is required for a community resilience. However, during the development stage which includes applicability, acceptability, and effectiveness, 56 percent within this framework only account for one single hazard. Almutairi et al., (2020) recommendation was that interrelationships between multiple hazards should be acutely addressed in any future framework development.

Sung et al., (2018) study claimed that flood management can be complicated by climate change due to sea level rise, land to sea level differences, changes in economic activity and seasonal water variation. The results illustrated that those adaptive forms of flood control strategies tend to exceed non-adaptive measures in maintaining the community's model for the flood protection system. Adaptation measures that dynamically alter target flood protection level by closely surveilling flood damages and social memories of flood risk, can help the model community tackle various disruptions.

Few studies have assessed the effectiveness of stakeholder groups practicing sustainable adaptive measures and identifying opportunities and challenges of such management. A Creed et al., (2018) study stated that it is widely recognized that there is a dire need for engagement amongst responsible stakeholders to establish sustainable coastal zone management strategies on a global scale. Adaptive management has emerged as the preferred type of coastal zone management. The authors identified a few significant opportunities and issues throughout the entire decision-making process. The identified major issue was that people found it hard to accept adaptive management policies, especially for some aspects of those policies whose outcome was uncertain. However, it is noted that the advisory group responsible for consolidating the adaption of adaptive management were deemed to be valuable. Adaptive stakeholder coastal zone management has effectively reduced disputes through building knowledge, earning trust, and finally achieving acceptance.

A Mackinson and Middleton (2018) study assessed processes and behaviors from New Zealand's experience in stakeholders engagements in the fisheries research and management. Although fisheries management is outside the scope of this study, (Mackinson and Middleton, 2018) short pathways approach, consisting of fewer people and simplicity of the unilateral decision making process, addresses key steps in inclusive governance. Industry stakeholders become involved in management and research that is backed-up by a legislative framework, the structures that support it, the stakeholders themselves and an organization of their involvement.

2.5. Malta

The Maltese Islands occupy an area of 316 km²– Malta being the largest at 245 km² (The Government of Malta, 2021) and mainly consists of three islands: Malta, Gozo, and Comino. As of 2019, the Maltese population was estimated to be around 516,100 (National Statistics Office, 2021) and with a population density of around 1,457/ km². Briguglio, (2000) claims that the Maltese economy is heavily dependent on imports and exports which generate around \$10,000 USD (€8639) per capita; classifying Malta as an upper-middle income country. Malta's economic structure is as follows: 3 percent construction/quarrying, 3 percent

agriculture, 20 percent government, 24 percent manufacturing and 50 percent services. This results in a high dependence on the tourism and manufacturing sector.

2.5.1. Climate Change in Malta

According to (Malta Resources Authority, 2021), between 1923 and 2005 air temperature increased by 0.71°C/100 years which is aligned with the almost 0.8°C increase in global average pre-industrial times. Rainfall patterns for the Maltese Islands have a high spatial and temporal variability however, no significant shift in rainfall has been observed in winter and summer. Nonetheless, a decrease of 0.14mm/year during spring and an increase of 0.8mm/year during autumn in rainfall has been noticed. In addition, during winter the number of thunderstorm days has increased (+7 days over a 55-year time span).


2.5.2. Malta's Sea Level Rise




Malta's sea level measurements are recorded by the Physical Oceanography Unit and depict that despite alternating intermediate trends, sea levels decreased in the past 15 years (Malta Resources Authority, 2021). However, this scenario is only believed to be brief and warranted local sea level changes monitoring. Between 2002 and 2006, sea level rose by an annual average of 0.15-0.45cm. From a historical perspective, (Furlani et al., 2013) looked at sea level changes that occurred in Malta from the Holocene period (around 11,600 years ago). Sea levels rise due to the natural shifting of climatic systems is not a new event to the Maltese Islands. During the post glacial Holocene period, sea level rose by about 120 meters in the Maltese Islands. In using underwater archeological sites submerged by the Holocene inundation, the authors calculated that during the Roman Age (753 BC), sea level was measured at around -1.36 ± 0.1 meters and in the Middle Ages (5th – 15th century) sea level changed to -0.56 ± 0.2 meters. These readings are in accordance with earlier Mediterranean Sea projections.

2.5.3. Coastal Storm Events in Malta

Nowadays, the coastline of the Maltese Islands is becoming increasingly at risk to coastal flooding due to intense urbanization and the global threat of climate change. Gżira, Sliema, and St. Julian's are located on the central eastern part of Malta and are the main hub for businesses and tourism activities. Malta has been severely impacted by storm surge floods in recent decades and widely documented in the media (Table 2.1). Galdies and Mallia (2017) listed the expenses that some of these storms caused in Table 2.2 and one can easily see that these damages run into millions of euros and can be a financial strain on the country. In the future, extreme weather events are predicted to be more intensive and frequent resulting in a greater and repeated burdens on the country's economy and finances to repair the damages left their wake.

Table 2.1 - Examples of recent storm surge flood events experienced on the Maltese Islands

Weather Event	Description	Images
<p>The Malta Summit 2nd-3rd December 1989</p>	<p>At the end of the Cold War, United States President W. Bush and the Soviet General Secretary met up off the coast of Malta to declare the end of the cold war. Both the world's superpower leaders were on their naval cruisers, USS Belknap, and USSR Slava. Due to extreme weather events, both cruisers were forced to dock in Marsaxlokk's harbor. The storm lasted two days and saw one of the most symbolic dinners between the two superpowers cancelled and ultimately delayed the declaration of the cold war by two days. (New York Times, 1989; Times of Malta, 2009)</p>	 <p>Figure 2.10 - Flooded road during the Malta Summit (Source: Times of Malta (2009)).</p>

<p>Extreme Storm Event in November 2011</p>	<p>This extreme weather event had its wind speeds of around 33.4kmh (21mph) which almost doubled to 61.2kmh (38mph). During this event, heavy rainfall was observed in Comino, the Northwestern part of Malta and Gozo. In Baħrija a total of 123.6mm of rainfall was recorded and 107mm in Żebbuġ Gozo. During this event, damages were mostly felt in the agricultural industry. According to reports collected from farmers within the islands, total damages cost reached €1,831,292.85 (Galdies and Mallia, 2017).</p>	 <p>Figure 2.11 - Waves smashing along a breakwater during the 2011 Extreme Weather (Source: Gozo News, (2011))</p>
<p>Extreme Flooding Event in September 2013</p>	<p>The Mesoscale Convective System was set off by a cut off low in the Western Mediterranean Basin. This cut off led to intensive thunderstorms, precipitation, strong winds and waterspout formation. The strongest winds reached a speed of 89kmh (55mph). On September 2nd, a total of 48.6mm of precipitation was recorded by the Meteorological office in Luqa; equivalent to 121percent of the normal amount for September (40mm) (Galdies and Mallia, 2017).</p>	 <p>Figure 2.12 - Flood waves severely impacting on car use during the 2013 floods (Source: Mateo Malta, (2013))</p>
<p>Medicane Trixi October 2016</p>	<p>This medicane of October 2016 occurred above the southern Tyrrhenian Sea. This Mediterranean hurricane caused a shallow area with a core pressure of around 1015-1010 hPa. In the medicane's area, countries experienced widespread flooding and winds reaching speeds of around 120kmh (75mph) (Deutscher Wetterdienst Wetter und Klima aus einer Hand, 2016).</p>	 <p>Figure 2.13 - This shows rough sea waves caused by Hurricane Trixi breaking on the Grand Harbor's break (Source: Malta Today, (2016)).</p>




<p>Medicane Zorba, 28th September – 4th October 2018</p>	<p>A Mediterranean hurricane (Medicane) occurred with winds reaching around 70 to 90kph (43 to 56mph). The hurricane caused an extensive number of damages in the countries that it hit; like Malta, Greece, Sicily, Cyprus, and Turkey. Some countries also experienced flash floods between 50-152 millimeters. This hurricane caused extensive damages and severe disruptions in the Maltese Islands (Labropoulou and Miller, 2018).</p>	 <p>Figure 2.14 - Coastal flooding due to storm surge flooding in Marsaskala by hurricane Zorba (Source: Author, (2018))</p>
<p>Severe storm 22nd-24th February 2019</p>	<p>Within 4 months of hurricane Zorba, the Maltese Islands experienced a cyclone. The cyclone produced winds that reached up to 88kmh (55mph); with the highest recorded being of 101kmh (63mph). Temperatures fell to 1.7°C and around 47.6mm of rainfall fell in a day whilst some parts of the Islands were also covered in hail. This cyclone caused severe disruptions and heavy damages in the islands (Maltese Islands Weather, 2019).</p>	 <p>Figure 2.15 – Rough Sea waves along the Qui Si Sana (Sliema) promenade (Source: Bay News, (2019))</p>
<p>Extreme storm event in November 2019</p>	<p>In November 2019, the Maltese islands experienced another severe storm. During this storm winds reached upwards of 50kmh (31mph) and parts of Malta and Gozo were flooded. Għar Lapsi, Delimara and Wied iż-Żurrieq were amongst the areas worst hit. Virtu Ferry trips and the Gozo Channel ferry were suspended due to the rough seas (Times of Malta, 2019).</p>	 <p>Figure 2.16 - Coastal flooding in Marsaxlokk due to the latest extreme storm that hit the Maltese Islands in November 2019 (Source: The Malta Independent, (2019))</p>

Table 2.2 - This table represents the damages cost for extreme weather events in Malta and Gozo (Source: Galdies (2017))

Event	Reported Damages (€)	Estimated Wealth (€)	Normalized damages (€); based on Malta's GDP per capita	Percentage of year-specific GDP (Indexmundi, 2017)
29/11/2011	1,831,293	16,582 (2011)	110.43	0.02
2-3/09/2012	5,073,000	17,221 (2012)	294.58	0.05
15/01/2013	4,341,000	17,919 (2013)	242.25	0.05

2.5.4. Impacts of Projected Local Sea Level Rise

A study conducted by (Attard, 2015) looked at the impact of sea level rise and extreme weather events particularly on transportation in the Maltese Islands, by mapping the extent of potential damages to the islands' transportation system particularly those brought by sea level rise and extreme weather events (Figure 2.17). The results show that a considerable percentage of the islands infrastructure could endure significant damages. Given that most touristic zones across the Maltese Islands are low lying heavily developed coastal zones, Attard's (2015) findings offer a good indication on what to expect at the different rise in sea levels scenarios. It is important to note that this study's five localities are the hub for tourism and if sea level rise damages the infrastructure, the country could face severe economic problems due to its heavy reliance on tourism.

	2025	2050	2075	2100	Comments
Increase in Temperature (°C)	1.1	2.0	2.6	2.8	Regional Mean
Change in Precipitation (%)	-2.4	-4.4	-3.7	-1.8	Regional Mean
Sea Level Rise (cm)	7	14	23	30	Global Mean

Figure 2.17 – Variations between four different year scenarios for temperature, precipitation, and sea level. (Source: Attard (2015))

In an undergraduate thesis by (Attard, 2017) 3D visualizations of sea level rise in the Maltese Islands were presented. Four localities in Malta were chosen, namely Mellieħa, parts of Xemxija and Pwales, Paceville and Sliema. The following images are the 2D and 3D visualizations for Sliema and St Julian's as they are important localities for this research. The importance of these images is that first, they represent two of this study's localities and secondly, it displays the different sea levels at three specific scenarios. All economic activity in both localities occur in the first 5 meters above sea level which, as one can see from the figures below, this will result in the termination of any economic activity due to submergence

of establishments and infrastructure. In turn, the country would have lost one of its major economic contributors.



Figure 2.18 - 2D visualization of Sliema area displaying the three levels of inundation (Source: Attard (2017)).



Figure 2.19 – 3D visualization of The Strand Sliema displaying the three levels of inundation (Source: Attard (2017)).

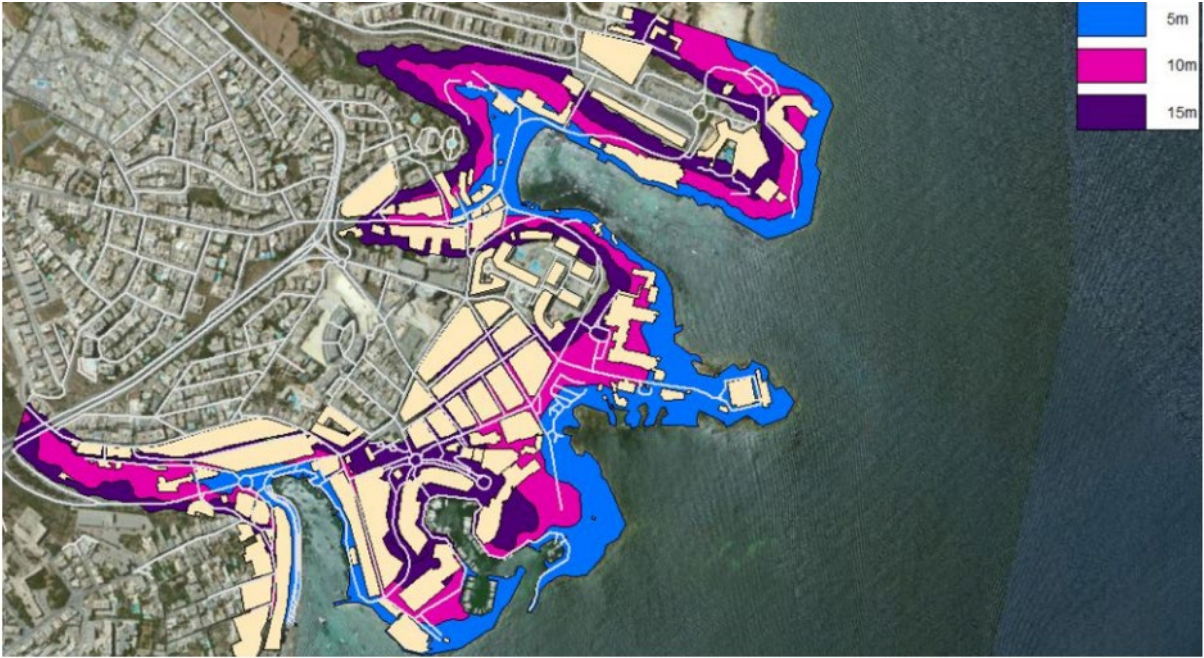


Figure 2.20 - 2D visualization of St Julian's area displaying the three levels of inundation (Source: Attard (2017)).

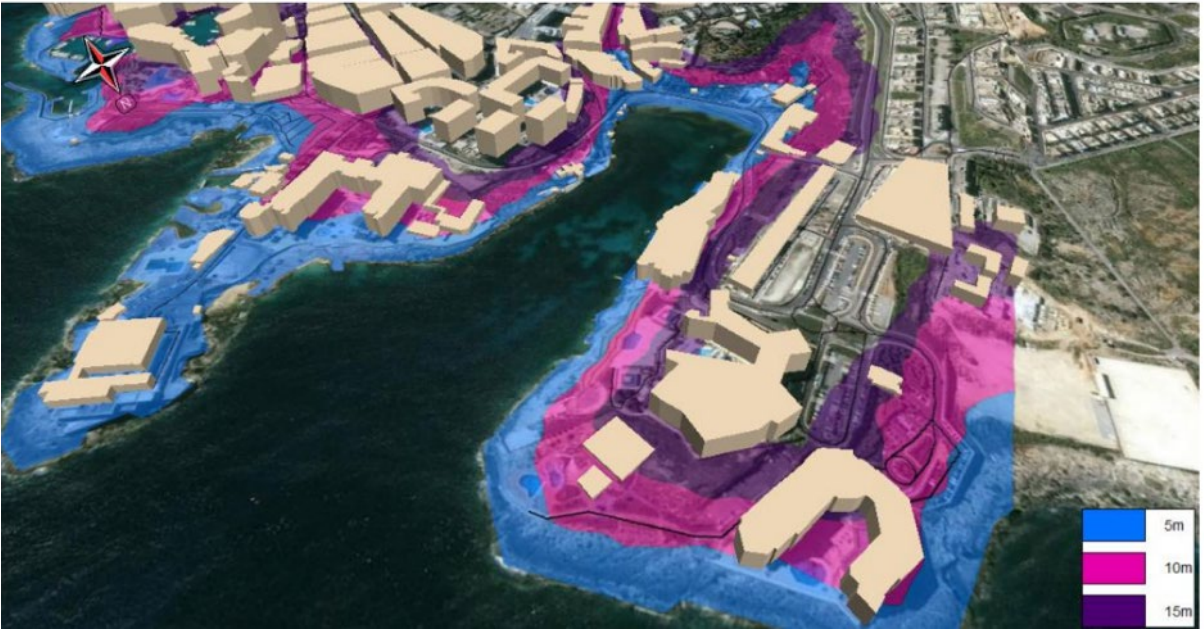


Figure 2.21 - 3D visualization of St George's Bay St Julian's displaying the three levels of inundation (Source: Attard (2017)).



Figure 2.22 - 3D visualization of Spinola Bay St Julian's displaying the three levels of inundation (Source: Attard (2017)).

Two key findings were identified from this research: one derived from the visualization aspect while the other from the questionnaire. The visualization aspect displayed that every bay would become submerged by less than 5 meters of sea level rise. In addition, any infrastructure (such as roads, buildings and so on), businesses, homes, public spaces and so on will also be submerged. As for the questionnaires, both 2D and 3D visualizations proved highly valuable in exhibiting the impacts of sea level rise at different levels to the public. After viewing the 3D visuals (as opposed to the 2D models), the initial thoughts of the respondents changed as 3D visuals are more realistic and understandable.

Formosa (2015) reviewed the processes that specifically target the spatio-temporal analysis of the current and future climate change scenarios, particularly to sea level rise impacts in the Maltese Islands. The key finding for the spatial analysis was that under six sea level rise scenarios (0.5 m, 1 m, 2 m, 5 m, 10 m, and 13 m), the buffer zone for the 0.5m scenario was 6.1 km² while for the 13m was 29.6 km² with the latter almost equivalent to 10percent of the total land area of the island. Formosa (2015) study has similar importance to (Attard, 2017) study.

In a media article by Mercieca (2017), he looked at what would be the effects of a 6m rise of sea level on the Maltese islands with flooding simulation imagery across several coastal towns in the Maltese Islands (Figure 2.23 - Figure 2.25). The simulated scenario was way beyond the

levels predicted by the international scientific community and mostly regarded as a piece of sensational news which worked its way with the public. This article in fact generated a considerable number of comments (298) with many replies downplaying or deriding the simulation as an exaggerated sensational plot. Such articles regretfully create an awareness and perception backlash amongst the community since a significant number of people end up not taking the issue seriously enough or completely denying that it could ever happen. This becomes a missed opportunity for the media to concretely address and discuss the issue of coastal threats, which remains real and highly probable in future. This article was included as it discusses the same areas studied in this research.



Figure 2.23 – A 6-meter rise in sea level in Gzira. (Source: Lovin Malta, (2017))



Figure 2.24 – A 6-meter rise in sea level in the Sliema Promenade. (Source: Lovin Malta, (2017))



Figure 2.25 - A 6-meter rise in sea level in St Julian's. (Source: Lovin Malta, (2017))

Thake (2016) conducted a study to investigate local perceptions on sea level rise in the Maltese Islands and to identify what sociodemographic factors are at play that are affecting the Maltese population in relation to knowledge, awareness, and ability to act against sea level rise. Thake (2016) findings showed that an individual's age, locality, gender, or work have had no meaningful effects on the level of perception, but education was a crucial factor in determining their level in knowledge, awareness, and ability to act. Divulging the factors that affected these variables should help in administering focus to future communication and

education of Maltese citizens in a way that stipulates an improvement in awareness, knowledge, and ability to act. Education could be the determining factor in some results pertaining to familiarity, knowledgeable, and management to effectively mitigate the effects of coastal flooding.

Though literature related to disaster risk reduction (DRR) strategies, risk mitigation and disasters impacts on the tourism industry are abundant, those related to the methodology of these strategies' implementation and their management by stakeholders with vested interests remain a gap in research. According to (Kennedy et al., 2020) one of these gaps is how small islands and their tourism are highly vulnerable to natural hazards, disasters and crises. They argue that it is vital to understand threat awareness and test the ability and knowledge of stakeholders to respond to unexpected and/or projected natural disasters to create and implement management plans, as recognized in the UNISDR goals by Hyogo and Sendai Frameworks.

With an increase in travellers to destinations with varying risks, the authors assessed the intersections of stakeholder's natural hazard awareness and vulnerability of small islands tourism destinations with Malta as a case-study. The results indicated that there is an increase in need for integrated stakeholder collaboration with drought, flooding and storms being the most prominent hazards to affect the Maltese Islands. The key outcome was that within the Islands, there is a dire need for training and the development of management strategies and their implementation that could benefit the country and its tourism sector to deal with natural hazards.

In another study by (Rizzo, 2019), it was found how coastal businesses rely on an accessible and efficient transport network to bring customers into the area. Hence, there is an impact cascading effect, in the case that coastal flooding hits coastal road networks and restricts access to the business areas. Rizzo (2019) assessed the vulnerability ranking of coastal roads in Malta using a multi-criteria analysis. The vulnerability indicators used for Rizzo's research was based on the IPCC vulnerability concept which play a critical role in the Multiple Criteria Decision-Making issue. The roads that were studied for this research were: Triq il-Bajja s-Sabiha in Birzebbuga, Triq ix-Xatt in Sliema, Triq Marina in Pieta', Triq il-Marfa in Mellieha,

Xatt il-Pwales in St Paul's Bay and Xatt ta' San Ġorġ in St Julian's. The results showed that out of those six roads, Triq ix-Xatt in Sliema, Xatt ta' San Ġorġ in St Julian's and Xatt il-Pwales in St Paul's Bay were deemed to be most at risk. This finding is interesting and important to this study as Triq ix- Xatt in Sliema and Xatt ta' San Ġorġ in St Julian's are part of the business community area in the chosen coastal towns for this study.

Another study by (Main et al., 2018) reviewed natural hazards on the Maltese Islands. International comparisons for disaster risk intermittently classify the Maltese Islands as being one of the least hazardous exposed country in the world. However, this ranking is misplaced as it failed to account for three crucial factors at play on the islands:

- i. The historic population increase and seasonal variation that the Maltese Islands experience;
- ii. Rankings are based on deficient research and partially completed historical catalogues of natural events;
- iii. Due to the small size of the Maltese Islands, these rankings do not account for the connotation of land restricted areas. These restricted areas can be immensely impacted by the slightest hazardous episode.

The authors mention storm waves as one of the impactful hazards on the coast. These three factors are relevant within the context of disaster risk produced by sea level rise and storm surge flooding on the coastal zones. The magnitude of effects on the economic and traditional factors brought about by storm surge floods were also examined by (Busuttil, 2011). She investigated the effects of storm surges on the urban environment and changes to the physical and economic structure for Spinola Bay, St Julian's. The main investigation entailed months of sea level rise measurements readings, interviews with the competent authorities, residents, and tourists. In addition, it also included an examination of present erosion in the vicinity of Spinola Bay together with a comparison of historical erosion. Busuttil's key findings were that the coast pre World War 2 till today experienced drastic urbanization and changes that significantly contributed to storm surge flooding. Interviewees agreed that the impacts of sea level rise and storm surge flooding in terms of frequency and intensity needs to be recorded. However according to (Busuttil, 2011) respondents, they said that the effect of

these two phenomena on the urban environment amidst the bay is minimal as these phenomena are seasonal therefore infrequent.

Busuttil (2011) recommended that precautions and engineering methods have to be applied and used sustainably to continuously safeguard the bay. Busuttil's study is extremely relevant to this study as Spinola Bay is investigated from different perspectives. This study could prove helpful to the local and central government in developing and implementing adaptation and mitigation measures in line with her findings. As for the business community, the results from this study could shed some light on how to mitigate coastal flooding within their establishments. In addition Busuttil also documented the issue of seasonality as a number of businesses reported seasonality for these phenomena.

Tourism in Malta generates around 20 percent of GDP, employs around 30 percent of the nation's labor force, and receives 25 percent of all foreign income. The tourism sector is the main driver of revenue for the catering and accommodation industry while communications, retail, banking, and the transport sectors are the second highest recipients of revenue from tourism. Malta's coastal areas are heavily used by the tourism, fishing, and ship repair industry. In a study by (Briguglio, 2000), one of the three areas considered to be highly important to the tourism sector, would be negatively impacted by sea level rise and by the increase in extreme weather events, such as storms and flooding especially air and sea transport (cruise liners) and other activities / events related to tourism. Due to the small size of Malta, even inland urbanization was impacted in a cascading manner from coastal flooding, especially those areas surrounding the harbours.

In an initial undergraduate study by (own author) Spiteri (2019), the impacts of coastal flooding (sea level rise and storm surge flooding) on coastal businesses from a management perspective were assessed through stakeholder's interviews in Marsaskala, Marsaxlokk, Birżebbuġa and Imsida local councils and business communities. The main key finding was that none of the businesses or local councils had any plans to combat such a phenomenon, even though both businesses and localities experienced recent coastal flooding, particularly from episodic storm events. Recent flooding events have pushed local councils to start

evaluating the vulnerability of their locality to coastal flooding and are in the process of drawing up plans to protect their towns from future sea level rise and storm derived flooding.

2.6. Conclusion

Mousavi et al., (2011 pg 575) stated that “global warming is expected to drastically increase hurricane flooding due to sea level rise and hurricane intensification with millions of people across the globe already exposed to coastal flooding from tropical cyclones”. Due to the lack of studies in this area, it is a must to conduct a deeper analysis of the effects of coastal flooding on coastal businesses. This is relevant for the local authorities, scientific community, and local businessmen to truly understand the impacts. Due to the limited number of studies in this research field, there are a significant number of topics that this dissertation cannot cover; hence the importance and need of more research. It is important for researchers conducting research in this area to encourage engagement in a triangulation of data collection for his/her study. This will involve the participation of government experts, local councils, and the business community to get a more accurate and detailed information from all three perspectives. In doing so, the research will provide information as to what the business community, local councils (i.e., a local government) and the central government are currently doing or what measures have already been implemented. This will be further supplemented by input from experts’ opinion in his/her area of expertise.

All the papers and studies discussed throughout this chapter justified the importance of research on the impacts of coastal flooding on coastal town businesses. Any major negative effect borne by coastal communities and their operating businesses will eventually have a ripple effect on the entire island especially from an economic perspective. One should point out that the three localities chosen for this study on Malta (Gżira, Sliema, and St Julian’s) are all critical to Malta’s economy as they house most of the tourism, financial, retail, entertainment, and real-estate sectors and as sectors these employ more than 40 percent of the total workforce. The other two localities Xlendi and Marsalforn are the main tourism hubs for Gozo and its economy. The next chapter will discuss the Methodology used in this literature review and is also accompanied by a detailed explanation of the methods used for data collection followed by the reasons these methods were chosen. In addition, a sample of the local council, experts, and business questionnaires will be provided.

3. Chapter 3: Methodology

3.1. Introduction

As explained in Chapter 1, “Introduction”, this dissertation is made up of a few objectives all designed to achieve a specific aim. These are as follows:

Aim

- i. To assess the impacts of sea level rise and storm surge flooding as appraised and perceived by the business community, local councils, and expert bodies.

Objectives

- i. Pave the way for current and future business owners’ decision-making process.
- ii. Pave the way for current and future policy makers and infrastructure architects to account for sea level rise and storm surge flooding when developing new policies and infrastructure.
- iii. Assist the government and the business community in effectively addressing and mitigating sea level rise and storm surge flooding.
- iv. Determine what is required in current local policies.

3.2. Literature Review Methodology

For the literature review, extensive background research was carried out from scientific journals, dissertations, papers, books and other studies from recognized government and non-government organizations and institutions related to this research. Climate change and its consequences have irreversible impacts on the entire world. Scientific sources that were consulted included:

- i. IPCC reports and journals like the AR 5 which is the latest climate change report published by the IPCC;
- ii. European reports and journals like the European Commission Climate Action and Ice2sea;
- iii. NOAA for the latest sea level measurements and studies;

- iv. The Fourth National Climate Assessment that was published by Climate Science Special Report in the United States;
- v. Scientific papers in high impact journals in the field of geography, oceanography, water, and earth sciences, and Dissertations dealing with relevant topics such as climate change, sea level rise, stakeholders' engagement.

For case study collection, sources such as HyDi (University of Malta online library), IPCC, dissertations, google scholar, books, springer link, research gate, science direct and Wiley online library and so on were used.

3.3. Site Justification

The reason why these five localities were specifically selected is because they share similar low-lying coastal landscapes and play a significant role in the Maltese economy due to their invaluable economic importance to the Maltese Islands. Gżira, Sliema, and St Julian's are the main hub for tourism, retail, real estate, marine, financial and tech industries. On Malta's sister island, Gozo, Xlendi and Marsalforn are the main towns that fuel Gozo's economy – mainly tourism. The sea level rise risk assessment used for this research between the businesses, infrastructure, residents and so on was based upon their proximity to the sea.



Figure 3.1- Satellite image showing the location of the three chosen sites in Malta (Source: Google Earth, 2021)

Figure 3.1 represents the locations of all five localities in Malta and Gozo. The Maltese localities were chosen due to their economic significance in terms of tourism, catering, retail, real-estate, and hi-tech companies. Centrally situated in the inner and outer harbor area on the Northeast of Malta, they host several five-star hotels, hundreds of catering establishments, small and large companies, and premium shopping malls consisting of world-renowned brands. Excluding tourism, these localities face a high demand from the local and foreign population alike, which in turn led to a property boom including high-rise towers and extensive building blocks both for residential and business purposes. According to the (National Statistics Office, 2019) in 2017, the Maltese Islands hosted approximately 2.1 million tourists of which 16 and 27 percent stayed in Sliema and St Julian's respectively, hence why these areas went through a period of over development which is still going on today and in more intensity. According to local councils, Gzira has a population demographic of around 12,000, Sliema has around 17,431 (National Statistics Office, 2019), and St Julian's around 15,000. All three localities are situated on the low-lying eastern coast of Malta and over the

last few decades, have suffered from intense episodes of coastal flooding during storms or heavy seas.

Back in 2018 according to the (Malta Tourism Authority, 2018) the Maltese Islands hosted approximately 2.6 million tourists of which 1.4 million, excluding cruise passengers, visited Gozo and Comino. Out of those 1.4 million, 72.7 percent and 66.6 percent visited Marsalforn and Xlendi respectively. In addition, out of that 72.7 percent, 12.5 percent stayed in Marsalforn while Xlendi accommodated 7 percent out of that 66.66 percent that visited the town, hence its popularity. Xlendi is highly popular with the Maltese, Gozitans and foreigners alike. During summer, this town sees an influx of thousands of tourists daily. Businesses in Xlendi thrive during summer, especially the hospitality and catering industries. There are several guesthouses, apartments, three and two-star hotels, catering establishments, car-rentals, and other tourism related businesses.

Xlendi is a major contributor to Munxar's and Gozo's economy with more than 85 percent of these businesses all concentrated in a small area within the bay. This low-lying area located at the end of a valley has a population of around 1,100 and has also experienced episodes of coastal flooding during heavy seas or storms. Just like Xlendi, Marsalforn is another popular destination for Maltese, locals and foreigners and enjoys a high number of tourists during summer. Marsalforn's economic activity is like Xlendi's, with a linear type of settlement along a quite low-lying coastal area, facing serious and frequent coastal flooding issues especially during winter with devastating effects. Its population is quite low with an estimated 900 people.



Figure 3.2 - Satellite image of Gżira (Source: Google Earth, (2021))



Figure 3.3 – Gżira businesses located at the water edge (Source: Author, (2021))

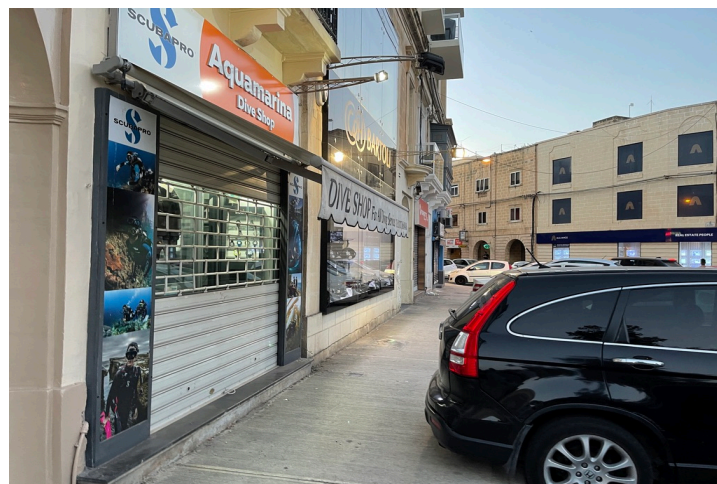


Figure 3.4 – A image illustrating Gżira's businesses (Source: Author, (2021))



Figure 3.5- Satellite image of Gzira (Source: Google Earth, (2021)) (Author, 2021))



Figure 3.6 – Businesses along the Sliema Promenade (Source: Author, 2021))

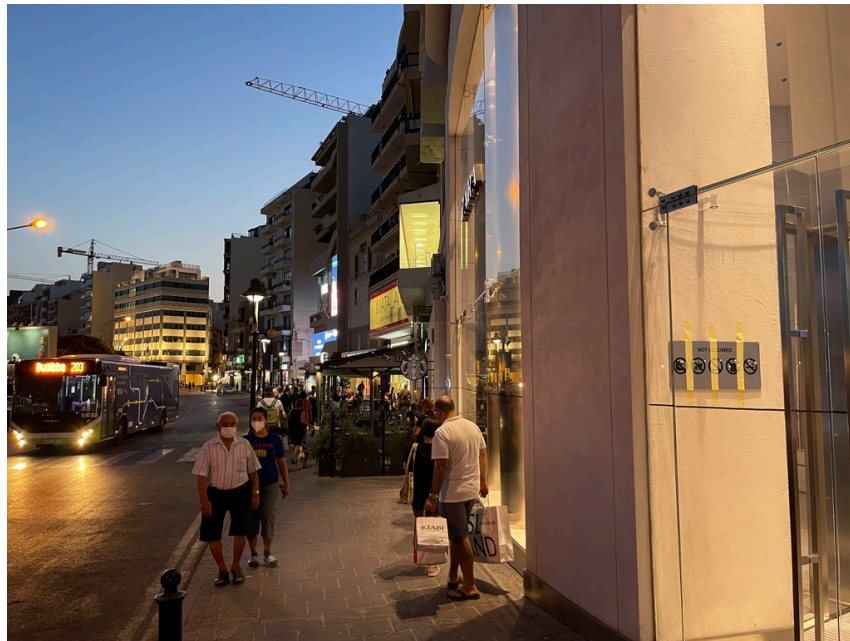


Figure 3.7 - Businesses along the Sliema Promenade (Source: Author, (2021))



Figure 3.8 – Satellite image of St Julian's Balluta to Spinola Bay (Source: Google Earth, (2021))



Figure 3.9 – Businesses operating on reclaimed land in Balluta (Source: Author, (2021)) Figure 3.10 – Business operating at sea level in Spinola Bay (Source: Author, (2021))



Figure 3.11 – Spinola Bay's business community operating close to shore (Source: (Author 2021))



Figure 3.12 - Satellite image of St Julian's St George's Bay (Source: Google Earth, (2021))



Figure 3.13 – Business establishment at the backshore of the bay (Source Author, (2021)) Figure 3.14 – Business establishment located in the bay (Source Author, (2021))



Figure 3.15 – Satellite image of Xlendi Bay (Source: Google Earth, (2021)) Figure 3.16 –Businesses located at the backshore of Xlendi Bay businesses (Source: Author, (2021))



Figure 3.17 – Continuation of businesses located at the backshore of Xlendi Bay businesses (Source: Author, (2021))



Figure 3.18 - Satellite image of Marsalforn (Source: Google Earth, (2021)) Figure 3.19 - An image of Marsalforn businesses (Source: Author, (2021))



Figure 3.20 – A continuation of Marsalforn businesses (Source: Author, (2021))

3.4. Mapping

3.4.1. Elevation Maps

A map for each locality was created to graphically show the business community’s elevation above sea level. The university’s own DSM (digital surface model) and DTM (digital terrain model) models were requested in raster format. Once the request was approved and the models were received, they were keyed into Quantum GIS (QGIS) to facilitate the creation of these maps. The following screenshots displays how the DTM model was imported.

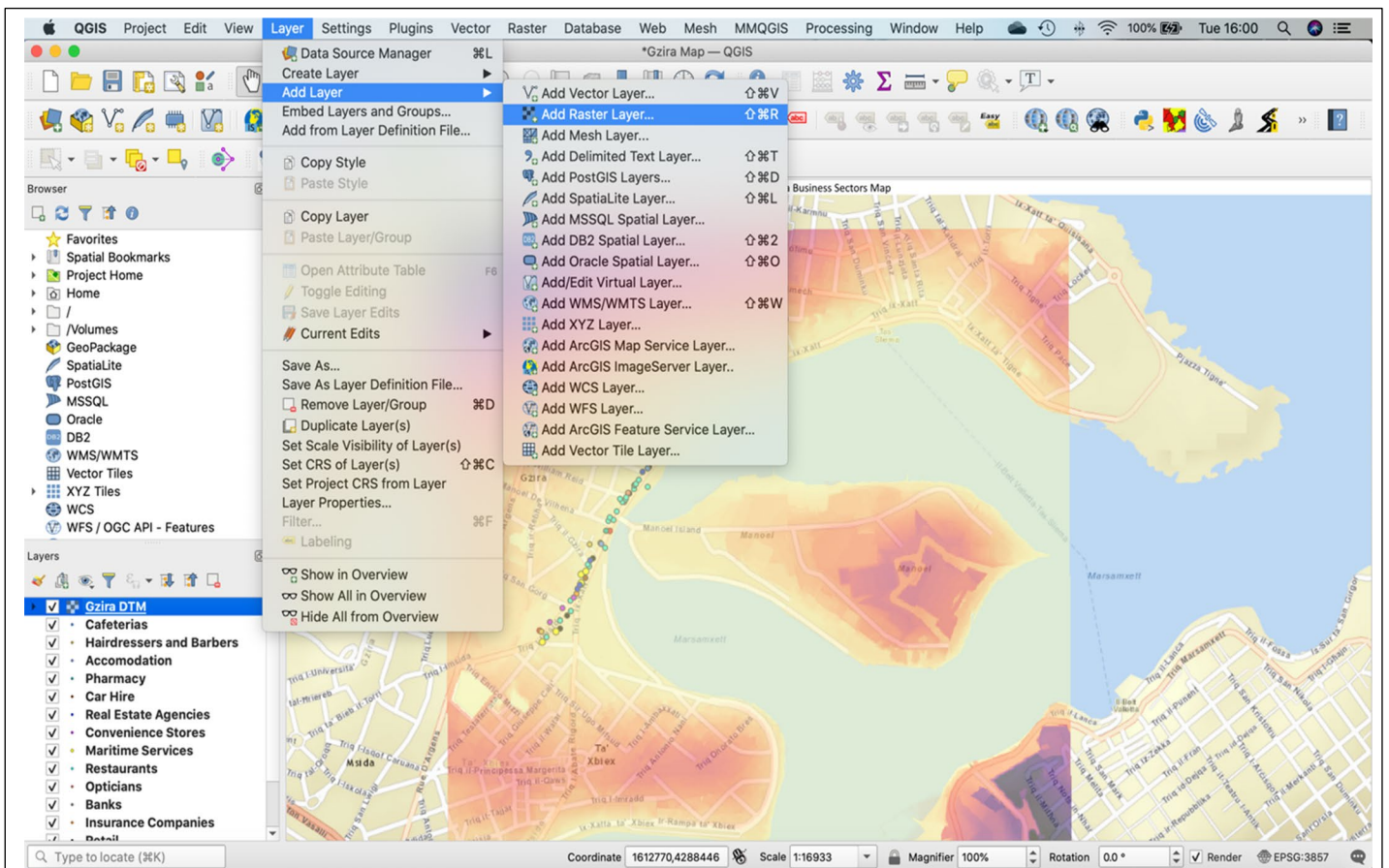


Figure 3.21- Importation DTM model into QGIS (Source: Author, (2021))

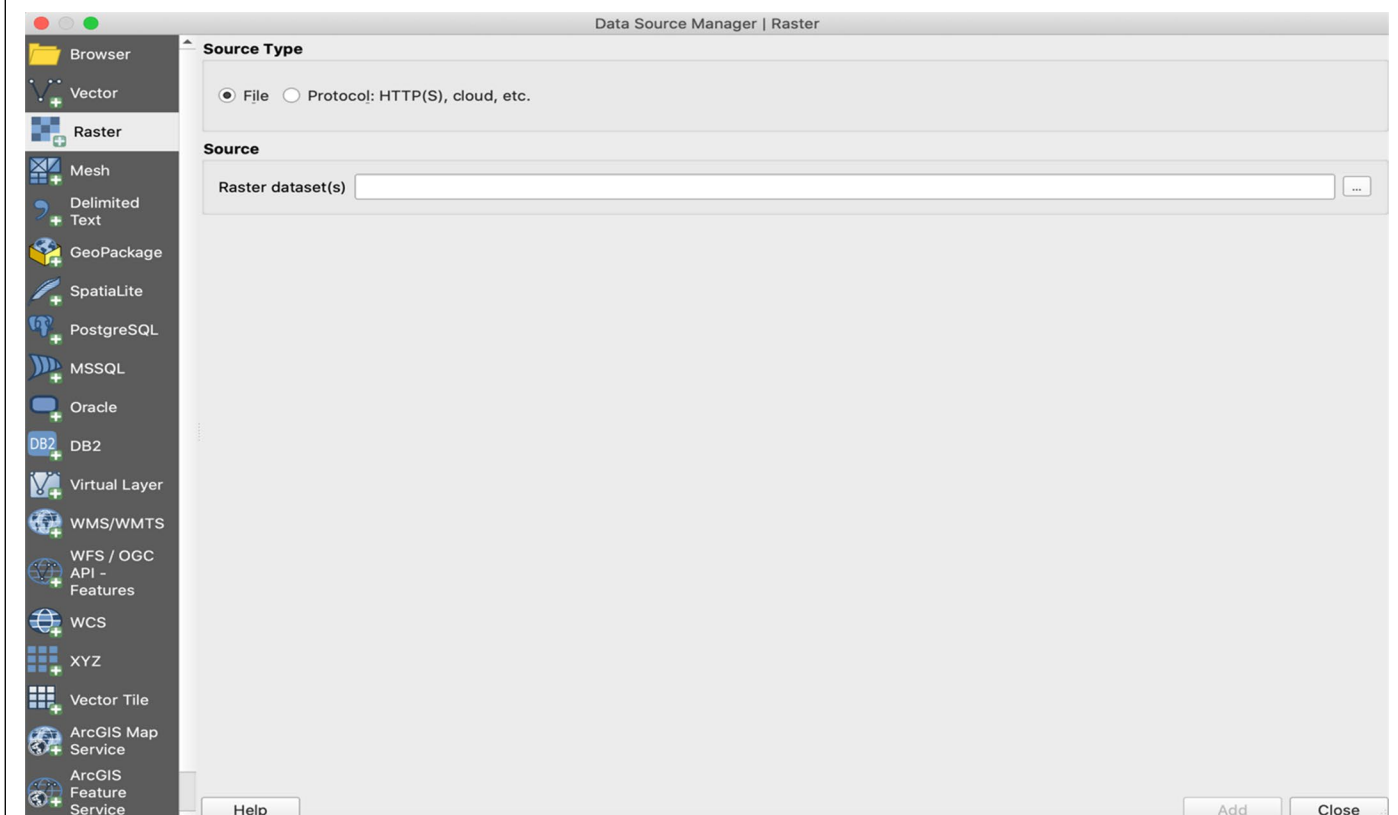


Figure 3.22 - Continuation of the importation (Source: Author, (2021))

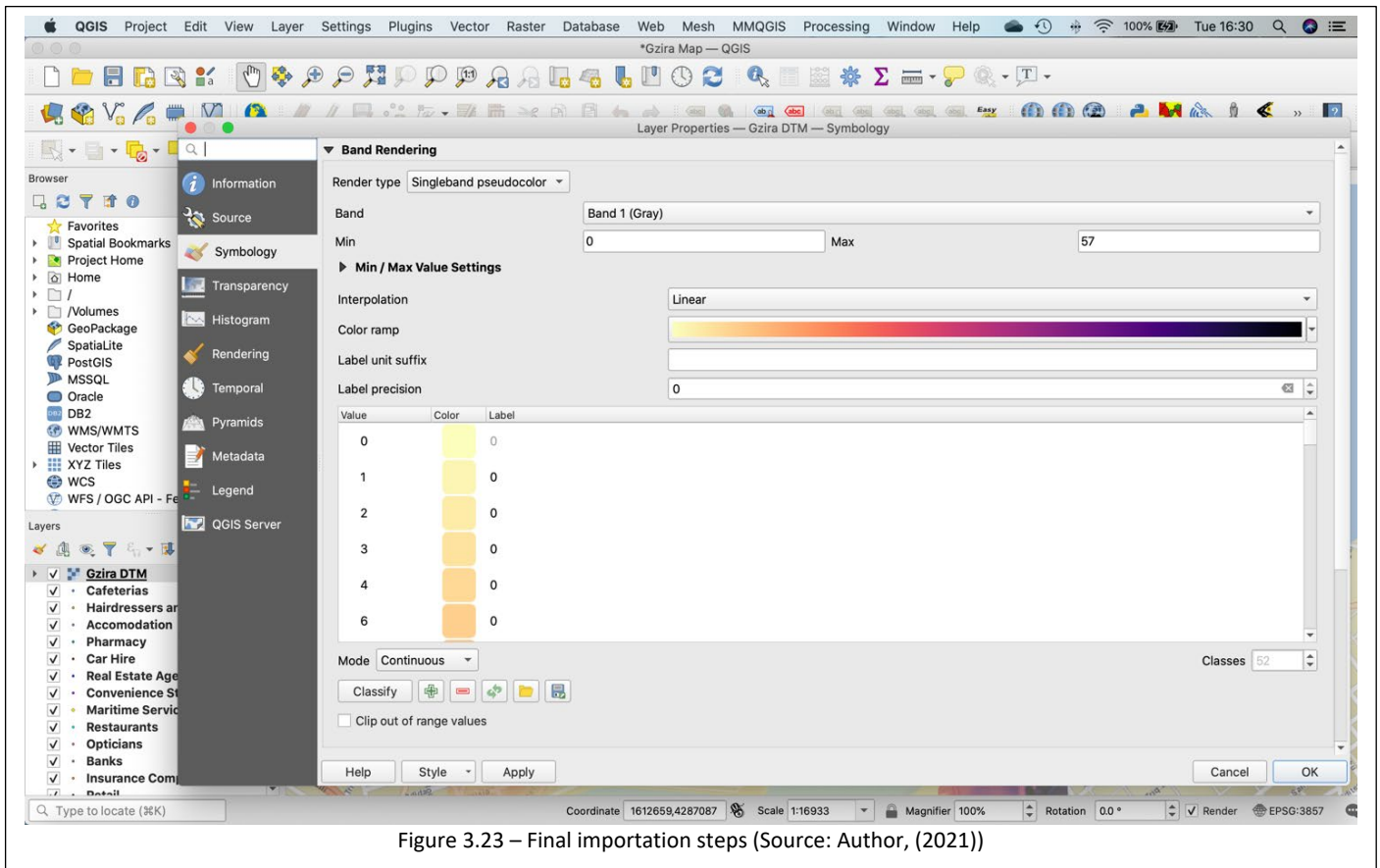


Figure 3.23 – Final importation steps (Source: Author, (2021))

3.4.2. Cloud Isle Height Profiles

For the creation of the height profiles, elevation data for all five localities was collected at specified intervals from a university open-source software called Cloud Isle which hosts the latest 2018 Lidar data (see section 2.1 in Appendix 2 for the screenshots). The reason why these height profiles were created was to see each area’s trendline in terms of elevation to determine the risk factor these businesses are facing.

3.4.3. Business Distribution Mapping using QGIS

QGIS was used to map out the business distribution in the five localities. QGIS is a free open-source geographic information system software that runs on Windows and Mac OS. This software supports viewing, editing, and analyzing of geospatial data. This task was carried out by going on site to Gzira, Sliema and St Julian’s collecting business coordinates via the embedded compass app on iPhone, followed by plotting the said coordinates onto QGIS. In light of the current COVID-19 pandemic, travel restrictions were put in place so travelling to Gozo for coordinates collection was not possible; instead, Google Maps was used as an alternative collection method. QGIS proved to be a key tool in this research as it transformed

the coordinates into a set of graphical business distribution maps representing each locality. By doing so, several useful information was extracted such as business clusters, business sectors, and business distribution in relation to the actual geographic distance to the sea.

For the creation of these maps presented in the following chapter, an Excel file was created for each business activity. Each file had three fields called ID (a unique numerical number given for each business), Easting and Northing fields holding the coordinates in their respective reading. This Excel file was then saved as a CSV file, uploaded into QGIS, and plotted. The images below show the steps taken to upload the CSV files into QGIS.

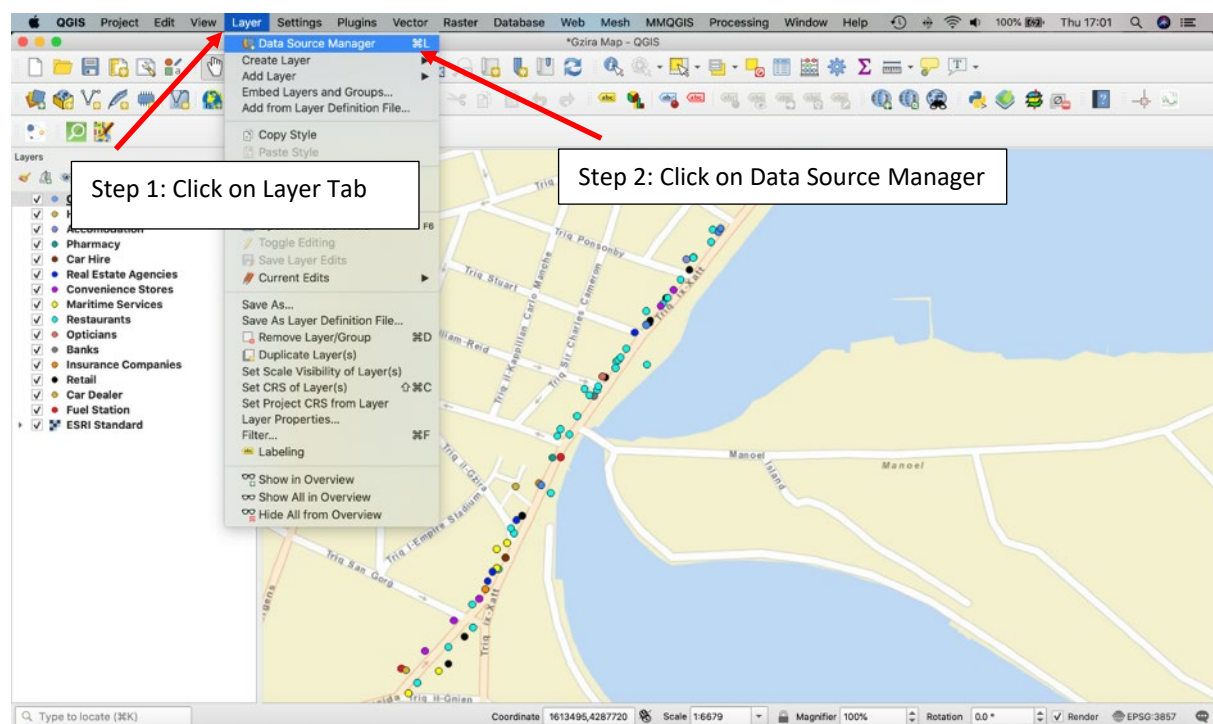


Figure 3.24 - The first part in the process with the red arrow indicating the steps (Source: Author, (2021)).

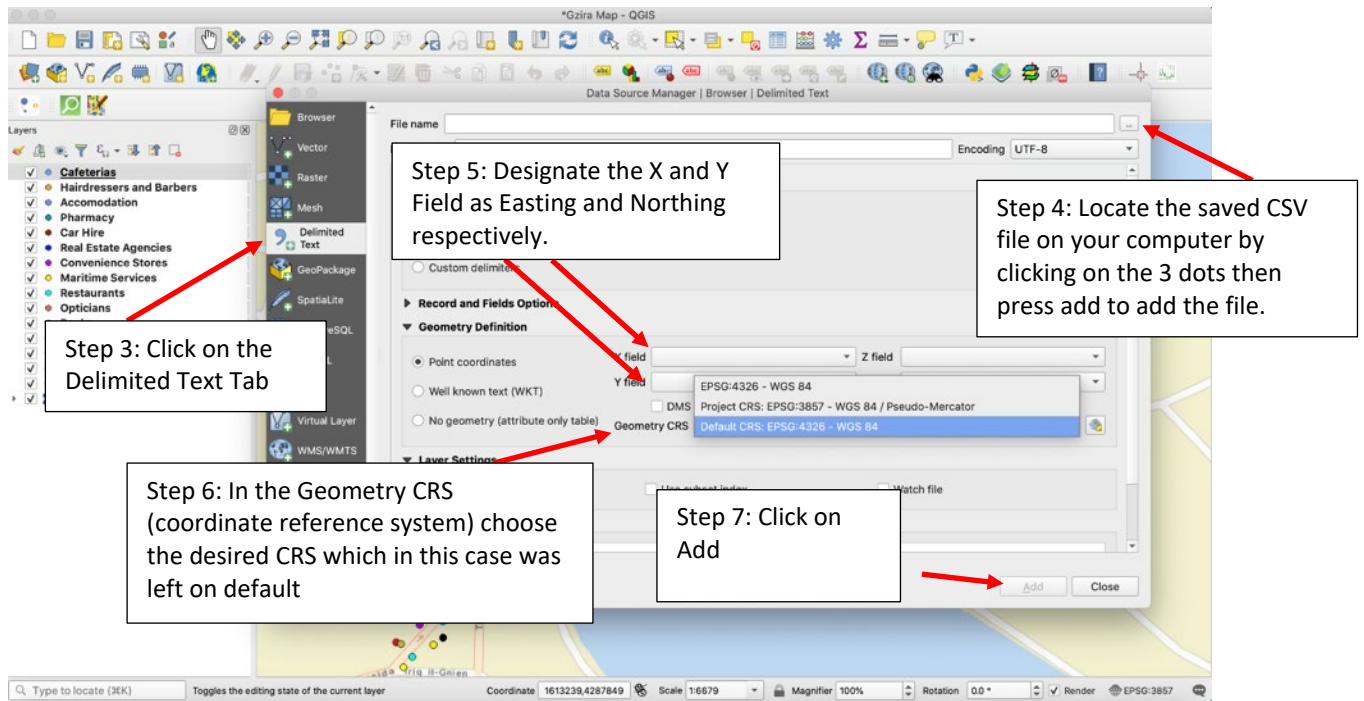


Figure 3.25 – The rest of the process red arrow indicating the steps (Source: Author, (2021)).

3.5. Quantitative and Qualitative Research Methods Justification

This research combined two types of research methods in data collection i.e., qualitative, and quantitative methods. The reason why both methods were chosen is due to their different outcomes as one provides in depth opinion of the three targeted audiences while the other provides statistical data.

3.5.1. Quantitative Research Method

In geography, one of the most common quantitative data collection method is a survey (i.e., interview or questionnaire). Secor (2010) contends that a quantitative style survey is a set of specifically designed questions administered to several participants which enables the researcher/s to collect data about a specific topic. A survey is quite specific, meaning that it is analysis based (i.e., statistical analysis). Sampling methods are very important when identifying participants in your target audience, because the quality of statistical analysis depends on the type of sampling method/s that the researcher/s must apply. There are various sampling methods but the two most common are:

- i. Random Sampling – the researcher/s picks participants at random from their target audience to participate in their survey;

- ii. Stratified Random Sample – the researcher/s still uses the random sample method, but the sample is applied to a specific geographical area/s or subgroup/s that are the target for the research.

As discussed by (Almeida et al., 2017) quantitative research methods have their own strengths and limitations (Table 3.1). The choice of these methods therefore should take into consideration whether the scope of the intended research can reap sufficient quality output from the strengths and offset the limitations with minimal effect on the quality of the research.

Table 3.1 – Selected strengths and weaknesses for quantitative research (Source: Almeida et al., (2017)).

Strengths	Weaknesses
Low development time	The structure is rigid
Cost effective	Data reliability is highly dependent on the quality of answers on the survey
Can easily reach high audiences	Does not apprehend emotions, behavior, and the respondents change of emotions.
Data is easily collected and analyzed using statistical analysis	
High representativeness	
Data can be biased by the researcher’s subjectivity	

3.5.2. Qualitative Research Method

According to (Almalki, 2016) qualitative research emphasizes on exploring and understanding individuals or groups exposed to social or human issues. This research method is described as gaining a perspective on issues by investigating in its own specific context. Qualitative methods emphasize on drawing the participants’ own opinions and experiences. Such methods are normally described as inductive with assumptions such as reality is a social construct, its variables are problematic to measure, data collection entails the participant’s perspective, and it is complex. Data collection techniques include several methods such as focus groups, interviews, expert interviews, open ended questions and so on with expert interviews and questionnaires being chosen for this research. Another type of qualitative data collection method is case studies, in which a group of individuals, single individuals, event and so on are extensively studied and thoroughly investigated to collect data via critical analysis.

Some data collection methods can be intertwined with both research methods, producing a mixed methods approach (Secor, 2010). Surveys can be designed to collect statistical information, but they can also collect qualitative information via open ended questions. Interviews will be conducted to the local business community operating in the chosen localities in conjunction with expert interviews from the local council and other relevant governmental entities related to this research.

Almeida et al., (2017) discussed the strengths and limitations of in-depth expert interviews in qualitative research (Table 3.2).

Table 3.2 - This table shows some of the strengths and weaknesses in of qualitative research (Source: Almeida et al., (2017)).

Strengths	Weaknesses
Few participants are needed to provide relevant and useful insights	The verification process to extract and compare information is heavily time consuming
Can be executed in informal environments	The development of such interviews is time consuming and could be significantly costly
Designed to get the highest possible detailed information on the subject at hand	Data cannot be generalized
	Participants should be carefully handpicked to avoid any bias

For this dissertation, expert interviews target governmental expert bodies like economics, businesses, infrastructure, climate change, tourism and so on, in conjunction with the local council’s mayor or vice mayor of the five localities. A wide variety of experts from different fields that address the research question of this dissertation were chosen to have a good understanding what other various governmental Ministries/entities are doing to address the issues of sea level rise and storm surge flooding in these localities. Even though most experts were identified depending on their role within their department and/or ministry, several other experts were introduced to the author during these expert interviews as they had to consult other experts, such as in the case of the Planning Authority, and the Ministry for The Environment, Climate Change and Planning. In terms of the local council, they were chosen to assess these two phenomena and how they are being addressed at local level with the questionnaire being addressed to the mayor or vice mayor of that council. Simultaneously, interviews will be conducted in person and on site with the business owners in each locality. The strengths mentioned in Table 3.1 and Table 3.2 justify why both methods are ideal for this research.

3.6. Questionnaires

3.6.1. Mixed Method Questionnaire

This part of the data collection was based on three types of questionnaires: one for the local council, one for the businesses and another for expert bodies. The local council and business questionnaires were structured to have mixed method questions using “Likert scales” and “Yes/No” based questions combined with several open-ended questions. The structure of both questionnaires allowed for rapid data collection for statistical analyses whilst also collecting crucial in-depth information from the open-ended questions in the questionnaire. The third and final questionnaire was the expert questionnaire where many of the questions were open ended as the scope of this questionnaire was to encourage experts to freely express their insights, share their experiences and professional opinions on the research topic.

3.6.2. Questionnaires Design and Research Compliance

All three questionnaires are constructed in such a way to accommodate the research question by asking a series of questions that are specifically addressed to the subject of interest. A good questionnaire is designed to ask simple and straight to the point questions for the questionnaire to yield useful information. As stated by (Clifford et al., 2010), the wording and design of the questionnaire could have a positive effect on the answers obtained. The questions can vary from open ended questions (opinion based), where interviewees voice their own opinions, to factual questions where interviewees are asked to give out information. When developing and writing good questions, the person behind the questionnaire must think about what information he/she is after but also on predicting on how interviewees will interpret the questions. The most critical aspect of developing a good questionnaire is to follow these three simple fundamental steps for the author to get accurate and detailed information on his topic:

- i. Design the questionnaire to be easily understood by all participants;
- ii. Use the simplest wording possible to minimize the risk of misinterpretation;
- iii. Define terms clearly.

Data collection was planned to be conducted during March and June/July 2020. However, between March and June 2020, the Maltese government enforced a lockdown on most business sectors to try and control the spread of the Covid-19 pandemic. Data collection was impossible to be carried out, so it was suspended until the lockdown was lifted and was eventually carried out between June and September 2020. It is important to point out that all questionnaires were designed to comply with research compliance guidelines and ethics setup by the University Research Ethics Committee (UREC). In fact, once designed they were sent to the ethics committee for their review and acceptance under the application number 4630_21032020.

3.6.3. Business Questionnaire

This questionnaire is expected to give an indication of how coastal flooding affects businesses in coastal towns. The collected data will define whether similarities or differences exist in the level of perceptions and experiences of business owners between the five selected localities. It should also be an eye opener for future government planning and stakeholders' investments. As already explained in Chapter 2, coastal flooding could completely halt or negatively affect current business activities in Malta and Gozo along with the country's economy and the tourism sector.

The aims for the business questionnaire are as follows:

- i. Analyze the business community level of awareness pertaining to climate change and its effects, with specific references to coastal flooding;
- ii. Collect their evaluation on how they think sea level rise and storm surge flooding will affect their business;
- iii. Ask about any contingency plans (if any) to tackle this phenomenon;
- iv. Gauge their thoughts on governance and management of coastal flooding.

This questionnaire was made up of 19 questions intended for the business community (Table 3.3). Each question has been included with a specific objective and justification to assess awareness and perception, coastal flooding indications, effects, planning, and finally actions.

Table 3.3 – Business questionnaire.

Question	Justification
Awareness and Perception	
1. How familiar are you with the issues of climate change and its implications?	Information is sought on how familiar the business owner is with the issues of climate change and its implications.
2. How informed are you about coastal flooding (in your locality)?	This question is designed to collect participant's knowledge on the subject.
3. What sector does your business fall under?	To investigate the various business sectors that participated this study.
4. Were you aware about the risk of sea level rise and possible coastal flooding when you opened your current business?	To investigate whether participants were aware of the risks of sea level rise and storm surge flooding when they setup shop.
Coastal Flooding Indications	
5. A. In recent years, have you experienced coastal flooding? B. If answered in the top three frequent categories, could you provide more details of your experience	To investigate whether in recent times, the participant's business establishment experienced any flooding. In part B of the question, if the participant answered in the top 3 categories, then the participant would be asked to provide more details about the event.
6. Have you ever envisaged that future sea level rise and coastal flooding could threaten your business?	The participant's thoughts are sought to see whether they ever thought about whether current sea level rise projections and storm surge flooding could one day threaten their business.
Effects	
7. A. Do you think that sea level rise and flooding will affect your business? B. If you selected the top three of the likelihood in Question 7a (i.e., Very Likely, Likely, Neutral) in what way do you think it will affect your business?	Information is sought on the participant's thoughts whether sea level rise and storm surge flooding would put them out of business or not. If the participant answered in the top 2 categories in question 7A, then the participant will be asked to elaborate by asking them in what way they think it affects their business.
8. A. If you knew the risks that coastal flooding (due to sea level rise and storm surges) could have on your business, would you still have chosen a location along the coast? B. Give reasons for your answer in Question 8a?	Researcher would like to know if the participant knew about such risks beforehand, would he/she still have chosen a location along the coast. In the second part of the question the participant is asked to provide reasons for their answer.
9. A. If such an event does happen in future do you think that your business can recover from such a setback? B. Can you give reasons for your answer in Question 9a?	The participant is asked whether he/she thinks they can recover in terms of finance if his/her business does get flooded. Irrelevant of the answer, the participant is asked to provide more details.
Plans	
10. A. Are there any contingency plans in case you go out of business due to sea level rise and coastal flooding? B. If you answered 'Yes' to Question 10a, can you provide more details of such contingency plans?	Information is sought on any contingency plans the business owners put in place. If the participant answers yes, he/she would be asked to provide more details on such a plan. If the participant answers no, he/she would be asked to provide more details of why no plan exist.

C. If you answered 'No' to Question 10a, can you provide reasons for not having such a contingency plan?	
11. A. Have you ever been asked by the competent authorities to attend to any talks/discussions on this subject? B. If you answered 'Yes' in Question 11a, who were these authorities and what was the agenda of the talks/discussions?	Information is sought on whether any government authority has ever held talks with the business community operating in the chosen localities on sea level rise and storm surge flooding. If answered yes, then the participant would be asked for more details as to which was the authority and the topic of such discussion/talk.
Actions	
12. In your opinion, what steps should be taken to mitigate the negative effects of coastal flooding?	The owner's opinion is sought regarding the steps that should be taken to mitigate the effects of sea level rise and coastal flooding.
13. What do you think the local council should do to protect businesses against coastal flooding due to sea level rise and storm surges?	The owner's opinion is sought on what he/she thinks the local council should do to protect his/her business.
14. What do you think governmental authorities should do to protect businesses against coastal flooding due to sea level rise and storm surges?	The owner's opinion is sought on what he/she thinks the government should do to protect his/her business.
15. A. Would it be possible to diversify your business operations, should current business operations not be possible anymore due to future impacts of coastal flooding? B. If you answered the top three categories of likelihood in Question 15a (i.e., Very likely, Likely, and neutral), what would the new business operation entail?	The owner is asked his/her opinion whether business diversification is feasible. If the owner responds in the top three categories, then the owner would be asked what the new diversification entails.
16. A. How likely would you consider relocating your business? B. If you answered very likely or likely to Question 16a, which new site would you consider?	The owner is asked whether he/she would consider relocating their business due to sea level rise and coastal flooding. If participant answered likely or very likely, then he/she would be asked to provide details on the new location.
17. Are there any other comments, recommendations, or experiences about coastal flooding that you would like to share in this study?	The participant is asked whether they have any other comments, experiences, or recommendations they would like to share about coastal flooding.

3.7. Local Council Questionnaire

The aims of the local council questionnaire were mainly the following:

- i. Analyze the local council's level of awareness on climate change and its effects, specifically the impacts of sea level rise and storm surge flooding;

- ii. Gather their feedback on their evaluation on how coastal flooding will affect their respective localities;
- iii. Understand what measures are being taken to mitigate the negative effects of coastal flooding in their respective locality;
- iv. Describe any plans or collaborative actions which the government may be implementing to tackle this issue, while also investigating the level of importance given to the threat of coastal flooding.

It is important to note this study used the same questionnaire of the author’s initial study however it was updated to align with the latest coastal flooding developments, to better suit this research.

3.7.1. Local Council Questionnaire Sample

This questionnaire was made up of 18 questions targeting the local council of each chosen locality (Table 3.4).

Table 3.4 – Local council questionnaire.

Question	Justification
Perception and Awareness	
i. Are you aware about climate change and its implications?	Information is sought about the council’s knowledge and perception on climate change and its implications.
ii. Have you ever envisaged that your town could be at risk of sea level rise?	This question asks the local council whether they ever thought that their town could be at risk of sea level rise.
iii. What are the number of households in your locality and what number of them are at risk of sea-level rise?	This question seeks data re the exact total number of households in the locality and the number of those households that are at risk of sea level rise.
iv. How many people live in this locality and what number of them are at risk to sea-level rise?	This question collects data re the exact population number of the locality and the number of that population that is at risk of sea level rise.
v. Do you think that sea level rise with its current projections (3.5mm/per year) is a threat to the town’s economy and local population? If yes, why?	The local council is asked whether they see current sea level rise projections as a threat to the town. If the council responded yes, then the council would be asked to provide some more details behind their reasoning.
vi. Have you identified sea level rise hotspots in your locality?	The council is asked if they have identified sea level rise hotspots in their locality.
Coastal Flooding Indications	
vii. Has this town ever experienced any signs of sea level rise (such as flooding and so on).?	The council is asked whether their town ever experienced any signs of sea level rise and/or storm surge flooding.

viii.	If yes, tick ✓ where appropriate	Question 8 is a follow up question of question 7. This question only applies if the council answers yes to question 7. Question 7 is a Likert scale question, where the council must choose between never, rarely, sometimes, frequently.
Threats, Impacts, and Disruptions		
ix.	If sea level rose or flooding occurred, were there any significant disruptions in your town? If yes, what were they?	The council is asked on disruptions caused if their locality experienced sea level rise or storm surge flooding. If the council answers yes, then the council would be asked to provide more details on these disruptions.
x.	What affects do you think sea level rise will have on this town (such as property value, transport, infrastructure and so on)?	The idea behind this question is to see the council's thoughts on the effects of sea level rise and coastal flooding onto the town.
xi.	Do you have any infrastructures that are/will be at risk due to sea level rise? If yes, what are they?	The council is asked on the locality's infrastructure to see if any infrastructure is vulnerable to sea level rise and storm surge flooding. The second part of this question is if the council answered yes, then the council would be asked to provide more details on what these infrastructures are.
Plans		
xii.	In recent years, have you ever implemented any measures to help mitigate the effects of sea level rise on your town? If yes, what were the measures and their financial cost?	This question seeks information related to any measures that the council took or is taking to mitigate the effects of sea level rise and storm surge flooding in their locality. The second part of this question is asking the council to provide in depth detail of what measures did the council implemented and an approximate financial cost of those measures.
xiii.	Has any government entity informed your council on this phenomenon?	The council is asked whether any government entities informed them on sea level rise and coastal flooding.
xiv.	Are there any contingency plans for such an eventuality?	The council is asked whether they have any contingency plans in place for sea level rise.
xv.	Has the council organized any meetings with the town's residents and the business community? If yes, what was discussed in these meetings?	Information is sought on whether the councils have conducted any meetings regarding sea level rise and coastal flooding with their town's residents and business community. If the council organized such meeting/s then the council would be asked to provide any details about what was discussed in the meetings if possible.
xvi.	Are there any FREE SPACES in your locality that can be used for social development in case current social amenities e.g., schools, police station, medical clinics and so on are no longer accessible due to sea-level rise?	The council is asked if there are available spaces within their town to relocate social amenities in case the current amenities would be no longer usable due to sea level rise and coastal flooding.
xvii.	Do you have any future plans to protect your town against sea level rise? If yes, what are they?	The council is asked about future plans. The reason for this is that even if sea level rise isn't presently an immediate threat to the town, it is highly likely to be in the future. So, the council is asked whether any

	<p>management plans have been drawn up or are going to developed in the future.</p> <p>The second part of this question is that if the council replied yes, then the council would be asked to provide more details on these plans. (if they can disclose them).</p>
Damages	
<p>xviii. During the last severe storm that hit the Maltese Islands, did the coastal business community suffer any damages?</p> <p>If yes, what was the damage and what support (if any) did they get from government authorities such as the local council?</p>	<p>Due to the nature of this research, it is pertinent to ask the local councils if the business community situated along the coast within their town suffered any damages in the last severe storm that struck the Maltese islands.</p> <p>If the council replied yes in the first part of this question, then the council would be asked to explain what support they got, if any, from government authorities.</p>

3.8. Expert Interviews

For expert interviews, a wide spectrum of fields that are directly or indirectly related with this research have been chosen. Once the selected experts were identified, a structured approached questionnaire was specifically created and designed around each expert’s area of expertise. Twelve experts were identified from the following government authorities:

1. Malta Tourism Authority – the chosen localities for this research are deemed to be the main touristic hubs for Malta and Gozo, so an interview with a tourism expert had to be carried out to acquire insights and professional opinions on the impacts of coastal flooding on these towns from a tourism perspective.
2. Ministry for Transport, Infrastructure and Capital Projects – in any locality, infrastructure plays a crucial part in the well-being of the local population. The purpose of this interview was to see whether Infrastructure Malta addresses flooding impacts in its operations and policies across the islands.
3. Environmental Resource Authority (ERA) – this entity oversees the environment of the Maltese Islands. From this entity the researcher sought any information related to climate change management, plans, studies and so on.
4. Ministry for the Economy – due to the economic aspect of this research, it was pertinent that an expert interview was carried out with an economist and get his/her views and opinion on the economic costs of climate change on Malta when sea level

rises and coastal areas within the chosen localities (Sliema, St Julian's, Gzira and so on) become partially or fully submerged.

5. Malta Chambers of Commerce – this is the entity that deals with the business community in the Maltese Islands. This entity should provide the necessary information on how businesses found in coastal towns are or may face economic difficulties when episodes of coastal flooding occur.
6. Malta Resource Authority – this authority is responsible for regulating water, mineral resources, and energy with an aim to promote renewable energy and efficiency. The authority also has the responsibility for climate change and oil exploration. In 2015, the Regulator for Energy and Water Service Act shifted the authority's responsibilities to drilling and abstraction metering and mineral resource regulation for oil. As for climate change, the responsibilities shifted to reporting and operating the emission trading scheme.
7. Malta Chamber of Small and Medium Enterprises – this non-government organization is legally recognized as representing owners of small and medium sized enterprises including retailers, importers, service providers, wholesalers, and manufacturers rights on a global scale.
8. Civil Protection Department (CPD) – the civil protection department is legally obliged to respond to any emergency within Malta's territory and likewise for prevention (where possible) and to be always prepared to respond/prevent to any event in a timely manner. In the case of coastal flooding, the CPD will only be involved if lives are in peril as their direct responsibility is firefighting, fire prevention and preparation.
9. Ministry for the Environment, Sustainable Development and Climate Change – crucial for this study as it is directly responsible for climate change, sustainable development, and the environment.
10. Planning Authority – entrusted with safeguarding Malta's environment and with finding the right balance between any urban/industrial development and the environment. The authority aims to improve the quality of life in general through transparent and sound planning policies without hindering projects that could be beneficial to the country.
11. Transport Malta - the authority's mission is to promote and develop the transport sector in Malta by means of proper regulation, promotion, and development.

12. Transport Malta Ports and Yachting Directorate - Transport Malta, through its Ports and Yachting Directorate, is responsible for regulating maritime leisure activities in the territorial and internal waters of the Maltese Islands. The directorate is also involved in the development and implementation of better organization of popular bays in Malta and Gozo.

3.8.1. The Malta Tourism Authority Expert Interview Sample

All expert in depth interviews were conducted anonymously (i.e. not recorded) and designed in such a way to be as open-ended and in-depth as possible to gain the maximum knowledge and information from the expert. The Malta Tourism Authority expert questionnaire is made up of 7 questions addressed to the expert. Table 3.5 consists of a sample of questionnaire. To see all the other experts' samples, refer to Appendix 2.

Table 3.5 – Malta Tourism Authority Expert Interview.

Question	Justification
<p>1. Is the Malta Tourism Authority aware of climate change and its implications, especially in relation to impacts of sea level rise and coastal flooding on the Maltese Islands?</p> <p>If yes, how do you think climate change (and especially sea level rise and coastal flooding) will affect Malta's tourism industry?</p>	<p>The expert is asked if the Malta tourism authority is aware of climate change and its implications in relation to the impacts of sea level rise and coastal flooding.</p> <p>If the authority is aware of such impacts, then the expert would be asked on his/her thoughts on how those impacts will affect the tourism industry.</p>
<p>2. Has the authority ever conducted studies on how climate change would impact Malta's tourism industry?</p> <p>If yes, what did such studies entail and what were the key results?</p> <p>If no, why have there not been any studies on this issue?</p>	<p>The expert is asked if the authority ever conducted any studies to assess how climate change would impact Malta's tourism industry. If the authority did conduct such studies, then the expert would be asked to provide some details on what those studies entailed and their key findings. On the other hand, if no studies have been conducted, then the expert would be asked to provide reason/s why those studies have not been conducted.</p>
<p>3. Are there any studies that detail the contribution of coastal businesses (related to the tourism industry) to Malta's economic revenue?</p> <p>If yes, can you give more details about these type of studies (accessibility, figure and so on) for the sole purpose of this research?</p>	<p>The expert is asked regarding any studies that have been conducted by the authority on the contribution to Malta's economy from coastal businesses related to tourism. If such studies exist, then the expert is asked to provide further details.</p>
<p>4. Given the importance of the tourism industry to Malta and that most of the</p>	<p>Considering the importance of tourism to Malta's economy and that most of the tourism related</p>

<p>tourism activities are found along the Maltese coastline (which is threatened by sea level rise and coastal flooding), has the authority ever carried out an impact assessment as to the loss of any business activity, accommodation spaces, job losses, revenue and other type of tourism related facilities?</p> <p>If yes, what did these types of studies reveal and what is the estimated revenue loss? Any other key results worth sharing?</p> <p>If no, do you envisage the authority undertaking these types of studies in future?</p> <p>If yes, how?</p> <p>If no, why?</p>	<p>activities are found along the coast, the expert is asked whether the authority has ever conducted any recent studies or impact assessments that analysed the loss of business activity, jobs and revenues and any other factors related to tourism.</p> <p>According to what the expert answers in the first part of this question, the expert is asked what the studies revealed, the estimated revenue loss and other key findings. If no, then the expert is asked if the authority is planning to conduct these types of studies in the future. If the last question is answered positively, then the expert is asked how these studies are going to be conducted. If answered no, then the expert is asked for reasons why not.</p>
<p>5. What is the authority's position about applications for new development for touristic and business purposes situated very close to the shoreline?</p>	<p>The expert is asked on the authority's position on new development for touristic purposes which are situated along the coastline.</p>
<p>6. In 2016, it was revealed that 9 out of 12 victims of drownings were foreigners. Is Malta being considered as a high-risk destination by foreign tour operators in terms of coastal safety?</p> <p>Give a reason for your answer.</p>	<p>The expert's opinion is engaged on whether he/she thinks that the Maltese Islands are being considered as a high-risk island by foreign tour operators and to back up his response with relevant data.</p>
<p>7. Do you think that the authority should align its future policies and marketing to reflect climate change impacts on coastal tourism, especially in relation to sea level rise and coastal flooding?</p> <p>If yes, why?</p> <p>If no, why?</p>	<p>The expert's opinion is engaged on whether he/she thinks the tourism authority should align its future marketing strategies to reflect climate change. Irrespective of the answer, the expert will be asked to provide reasons for his answer.</p>

3.9. Questionnaires Distribution

For sampling purposes, 50 percent of the businesses in each locality were interviewed to achieve a good confidence level. A sample size calculator was used to calculate the sample size for each locality. The size for each locality was heavily influenced by the number of business establishments in that respective locality. The total number in all five localities stood at 356. Calculator.net (2004) was then used to determine what would be an acceptable

business sample based on the full number (356). With a 50 percent sample size, the interviewed sample came down to 186 businesses at 95 percent confidence level and a 5 percent margin of error (see Figure 3.26). The number of questionnaires to be distributed in each locality was calculated from the 186 sample which are as follows:

- i. Gżira: 40 questionnaires
- ii. Sliema: 50 questionnaires
- iii. St Julian’s: 78 questionnaires (due to Covid-19 restrictions the maximum possible number of questionnaires collected were 50)
- iv. Xlendi: 7 questionnaires
- v. Marsalforn: 13 questionnaires

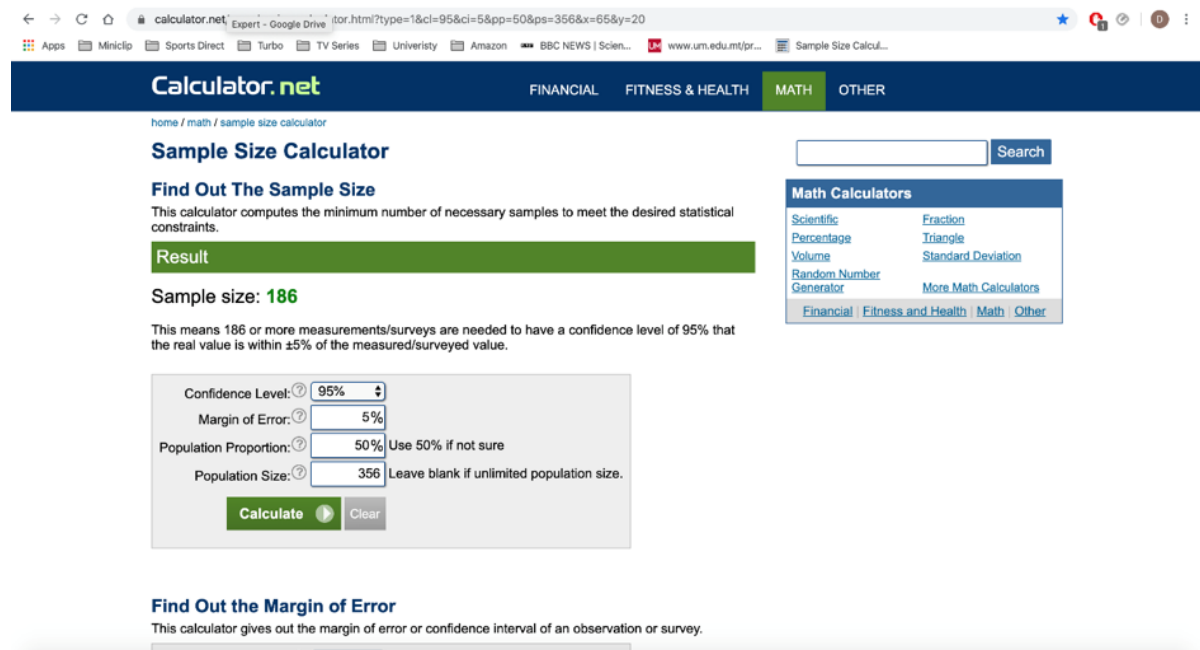


Figure 3.26 – This is a screenshot of how the sample size was calculated (Source: Author, 2021).

As for the local council and experts’ interviews, the author planned to conduct the interview in person, however, due to the Covid-19 global pandemic, being physically present was not possible so the interview had to be sent and received in a questionnaire format via google forms.

3.10. Data Analysis Methodology

3.10.1. Transcripts Coding

The qualitative data collected from the interview was analysed with transcript coding (Clifford et al., 2010) which is a way of analyzing and sorting out data to pattern the themes within the collected answers. Coding is heavily used by researchers to analyze qualitative data to observe any emerging themes and better frame the discussion of the findings within the literature. Coding enables researchers to identify new issues and may also help to isolate any trends and categories in the data and develop new research questions.

NVivo, a qualitative data analysis software was used for the expert's thematic analysis. Each interview was imported into the software followed by the creation of themes and sub-themes categories followed by each identified theme dragged into its corresponding category. A sub code is a specific sub theme that was identified in a particular theme. For instance, in disruptions, an important point identified by experts was that the business community does suffer disruptions, because their outside seating area would be unavailable due to the adjacent road flooding. So, the main code here was disruptions but outside seating was the main reason for this disruption justifying the subcode. NVivo enabled the possibility to identify any similarities and differences in the answers provided by experts.

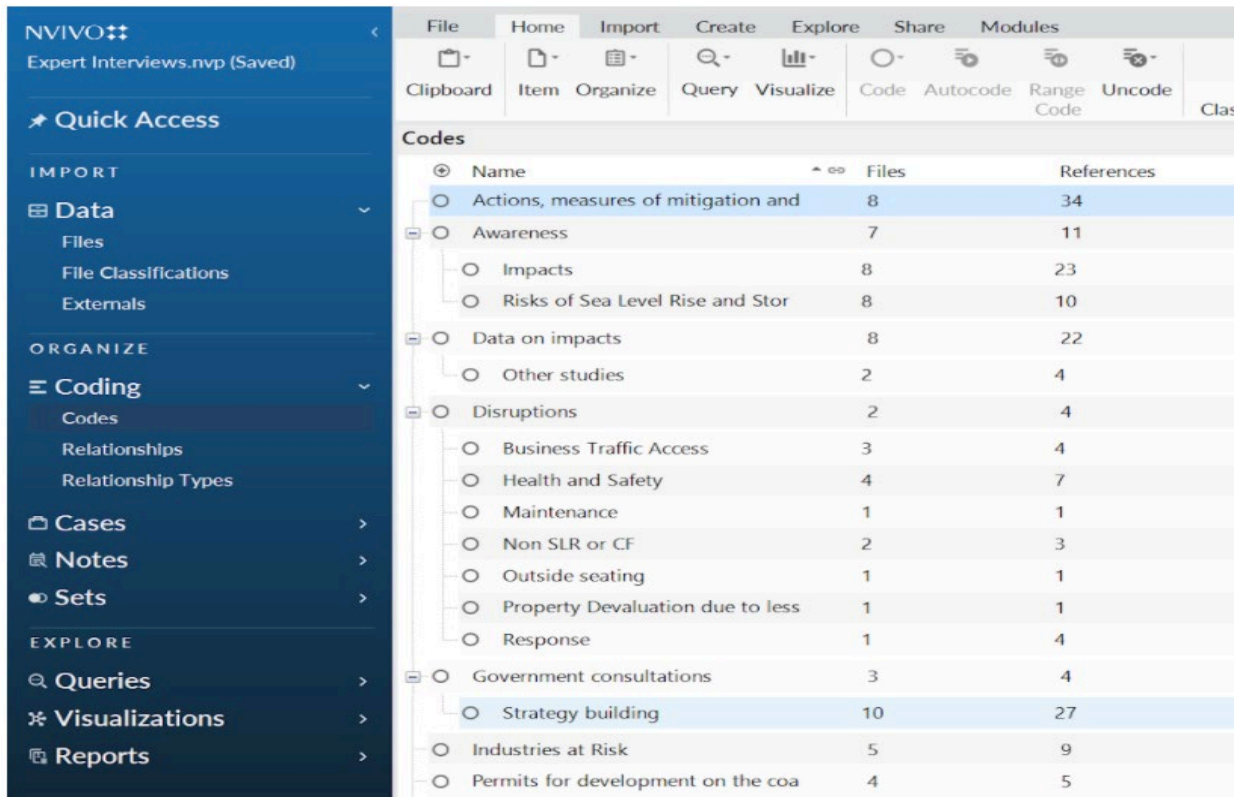


Figure 3.27 – NVivo Codes and Subcodes Screenshot

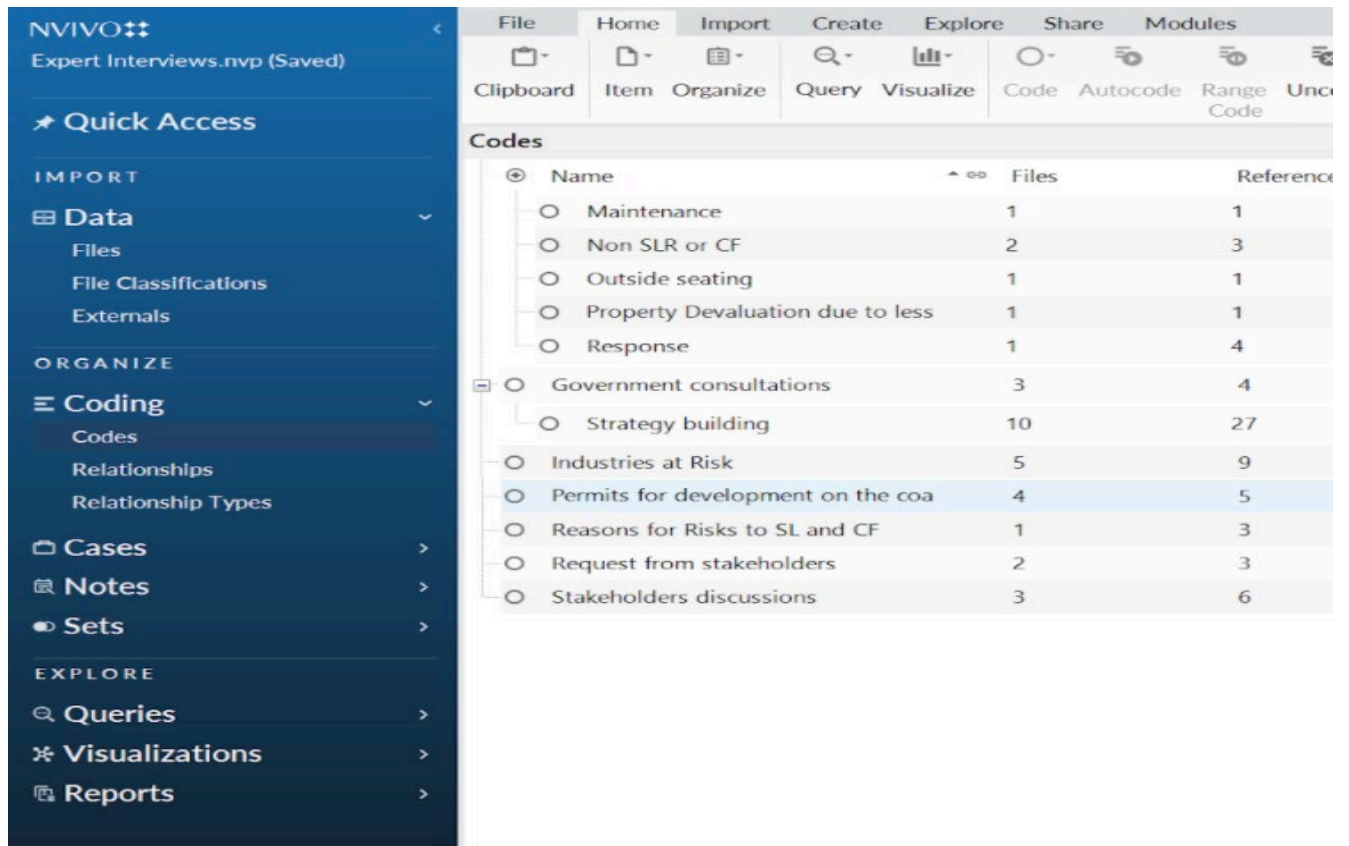


Figure 3.28 – A continuation of NVivo Codes and Subcodes

NVivo enabled the author to present a cluster analysis which is an exploratory technique that visualizes patterns by grouping sources that are coded similarly by nodes. In this case the

similarities and differences in codes between the experts will be examined. A horizontal Dendrogram was used to present the cluster analysis. Within this diagram (see Figure 4.1 and Figure 4.2) similar codes were clustered together on the same branch while different codes were placed further apart.

3.10.2. Statistical Analysis

i. Businesses

The two statistical software that were used for this research were Microsoft Excel and IBM SPSS. Data that was presented in graphical format was achieved via MS Excel, due to its ease of use and its user-friendly interface. On the other hand, statistical test such as Kruskal Wallis were conducted via IBM SPSS. The one-way analysis of variance, Kruskal Wallis H-Test, was used to analyze Likert scale-based questions of the businesses' questionnaires. The KWH test is a non-parametric test, and it is used to compare two or more independent samples of different or equal sizes. The reason why this test was chosen was to test whether any differences or similarities exist between the replies of owners according to their business category and locality. Before carrying out each Kruskal Wallis H-Test, the Kolmogorov-Smirnov normality test was carried to justify the use of a non-parametric analysis of variance. In statistics it is important to develop two hypotheses, 'alternative hypothesis (H1)' and 'null hypothesis (H0)'. The difference between these two is that the alternative hypothesis states that there is a statistical relationship between the two studied variables while the null hypothesis claims that there is no statistical relationship between the two studied variables. The two variables consist of an independent and dependent variable, which in this case, the independent variable is the business sector category while the dependent variable is the answers to each question. For example, Q1 asks about the level of familiarity about climate change issues. The alternative hypothesis states there are differences in the level of familiarity about climate change issues between the categories of the business sector, while the null hypothesis states that their differences in the level of familiarity between the different business categories are not statistically significant

The hypothesis was accepted or rejected depending on the significant factor value (p-value). If the p-value was equal or less than 0.05, then the alternative hypothesis is accepted (H1)

and the null hypothesis (H0) was rejected; if the p-value was higher than 0.05 then the difference is not statistical significance and therefore the null hypothesis (H0) was accepted and the alternative hypothesis (H1) was rejected.

ii. Local Councils and Experts

Since the majority of the local council questionnaires were mostly of a “yes” or “no” nature, it was feasible to create a color matrix on MS Word. This was done by creating a table consisting of each question and its associated responses with blue assigned to “yes” and those colored in white assigned to “no”. Meanwhile for the expert’s analysis, since most of the questionnaire was of an open-ended nature, the analysis was conducted via the use of NVivo.

3.11. Methodology for Data Presentation

3.11.1. Descriptive

This section consists of three parts: the first part describes the results of the experts’ questionnaire, the second part examined local council’s results, and the final part illustrates the businesses’ results. The expert’s descriptive analysis was presented in the form of a report, the local council in a color code matrix and some short report style writing in each qualitative question. For the business descriptive analysis, first the mapping results and height profiles were presented to visually see and discuss the businesses in each locality’s threat level in relation to distance and elevation from the sea. Followed by three inventories describing business damages and disruptions, another consisting of any reasons provided by the owners to back up their answers, while the final one lists the preventive/adaptation measures inventory. In each quantitative question, graphs (one for each locality) and tables (if required) were presented to identify any similarities and differences between the five localities in terms of percentages.

According to (Tetzner, 2021), academic writing can have its potential substantially enhanced with strategic and well designed and aesthetically pleasing use of tables and figures. This enables the reader to understand the presented complex information easily and visually. The most effective way to go about this is to clearly number the tables and figures with a caption that outlines what that figure or table is meant to display. Right beneath it, a detailed

explanation was given to explain what the table or figure is portraying in terms of data and this was also confirmed by (Pamplona, 2021). Both authors (Tetzner, 2021) and (Pamplona, 2021) justified the reason for the pattern presented in chapter 4, albeit the author of this research also found this pattern to be prudent for the reader to fully understand the data analysis of each question and locality.

3.11.2. Inferential Statistics

Two tables were created, one exhibiting the question along with its own alternative hypothesis (H1) and null hypothesis (H0) and the second table exhibiting color coded p-values of each question in locality. “Blue” was assigned to the p-values smaller than 0.05 while “white” was assigned to those p-values larger than 0.05 moving on the analysis of each question per locality. Five SPSS screenshots each representing a locality were presented, followed by a short explanation whether a negative or positive statistical relationship between the two variables is identified. This process will be repeated for all locality-based questions. The final section discussed the data as one large dataset meaning that all data was compiled together as one followed by a Kruskal Wallis Test for each question. The result was then presented via a screenshot and an explanation of what the test result meant.

3.12. Conclusion

This chapter covered the entire methodology for this research in terms of literature review, studies collection, data collection, and analysis for the different data collected. It also included a description why the localities were chosen along with their location with the Maltese Islands. In addition, a detailed explanation was provided on the tools that were used for this research and why they were chosen, such as NVivo, SPSS, Excel, and QGIS. The different methods employed for this research allowed different data structures to be collected and compared to provide a good representative stakeholder’s assessment of coastal flooding. The next chapter (Chapter 4) presents the findings of the data collection. The reason why such a wide variety of research techniques were used in this study is because the nature of the collected data is varied and required a variety of research techniques to be analyzed. In addition, the author wanted to learn and gain new experience in other techniques that he has never used before.

4. Chapter 4: Presentation of Results and Descriptive Analysis

4.1. Introduction

This chapter addresses the descriptive data analysis for all three data sets (experts, local council, and business communities). The structured expert interviews are presented via a report style writing analysis where the questions were categorized with a theme in NVivo and all those questions that fall under that theme were discussed in a paragraph/s style. Moving onto the local council, a color matrix and graphs were used for the quantitative while a report style writing analysis was used for the qualitative data. As for the business community, for each question, a text box was created consisting of five graphs one for each locality within that question. This section contains 22 tables, 2 bar graphs, 5 scatter graphs, 12 maps displaying a variety of information and 52 pie charts. This visual data was included so that the chapter would have the right mixture of text, tables, and pictures so that readers will find it easier to read and follow.

4.2. Presentation of Results: Expert Interviews

4.2.1. The Malta Chamber of Commerce, Enterprise, and Industry (MCCEI)

For the full transcript of this expert interview, refer to Appendix 4 Table 4.1.

i. Role of MCCEI

The Malta Chamber of Commerce, Enterprise and Industry is the independent voice of the private sector in Malta. Its principal mission is to actively represent companies from all economic sectors and ensure that entrepreneurs enjoy the best competitive environment and regulatory conditions possible for the conduct of business.

ii. Risks of coastal flooding

MCCEI answered that they are aware of the risks of sea level rise and storm surge flooding on the business sector. According to them, all the industries will be affected by sea level rise and storm surge flooding due to the geographic nature of being a group of small islands and having most coastal localities classified as low-lying areas. MCCEI identified the retail and real estate industries as the two industries that will be severely impacted. MCCEI's view is because both

industries have a strong presence in all low-lying coastal areas on the islands. For the real estate industry, this phenomenon was retained to be more impactful as properties that are highly susceptible to coastal flooding will have structural damages and their market value will be severely reduced.

iii. Impacts of coastal flooding on commercial activities

MCCEI's assessment of Malta's impacts of coastal flooding was that it will moderately impact its commercial activity but provided no reasons to substantiate such claims. MCCEI identified several disruptions that the Maltese business coastal community may be expected to endure. To begin with, health and safety issues were mentioned as coastal flooding can result in injuries to both employees and clients; however, the expert claimed that health and safety measures must be in accordance with the Health and Safety Measures Act as devised by the authorities. The second identified disruption is maintenance, where businesses would need to carry out the required maintenance before opening again, and this could prove to be costly. Another disruption mentioned was reduced business traffic, where due to coastal flooding, the business community would experience a reduction in business traffic, either because flooding limits their operational capability or because customers would avoid the area completely due to floodwaters. Cleanliness issues were also discussed, given that coastal businesses would have sanitation problems due to the filth deposited along the coast during and after each flooding event. Businesses would need to thoroughly clean their establishment to eliminate the danger of bacteria and clear up any hazardous objects in their paths. The final disruption mentioned is specific to the real estate sector which is discussed in Section ii. Properties will experience a significant drop in their values if they flood multiple times during the year.

iv. Projected data related to impacts

To date, MCCEI has no data indicating the expected loss of revenue, jobs, and coastal business establishments, but it was agreed that this data needs to be modelled out. On a national scale, MCCEI currently has no data that quantify the losses brought about by coastal flooding on the Maltese economy and its labour force.

v. Engagement with potentially vulnerable stakeholders

MCCEI answered that the Chamber did indeed discuss the threats pertaining to sea level rise and storm surge flooding with coastal business communities. MCCEI explained that being aware of the realities of climate change, it took a proactive approach with the stakeholders and has in the past organized information talks with the coastal business community and potential stakeholders on the effects they are expected to face from sea level rise and storm surge flooding. MCCEI has never been approached by any of its members requesting information or advice on the impacts of sea level rise and storm surge flooding and what mitigation measures are appropriate.

vi. Consultations with government authorities and strategy building

The Chamber was invited by the Climate Action Board (government-appointed board formed to discuss climate change impacts) to participate in talks on the impacts of sea level rise and storm surge flooding on the coastal business community. The outcome of these talks did not lead to any specific strategies being formulated. The following is quoted directly from Chapter 543 of the Laws of Malta “The main aim of setting up the Climate Action Board (CAB) under the 2015 Climate Action Act (Chapter 543) of the Laws of Malta was to: mainstream climate action, monitor the implementation of International and EU obligations re GHG emissions and to facilitate preparedness to ensure adaptation to the impacts of climate change”. MCCEI believes that they should have a role in building a national strategy to address flooding impacts from sea level rise and storm surges on coastal business communities. It reiterates that the country needs a sound economic vision built around the concept of sustainability and actions against climate change. This is crucial for businesses and to support the stability of sea levels. The chamber has published a document called “Chamber Economic Visions- Smart Sustainable Island”. The main aim of this document is to ensure that the country’s budget for 2021 focuses on a concept of a smart sustainable island that strives to bolster economic growth while enhancing quality of life of the public. This critical, historic budget is required to focus on and ascertain on the recovery of the country’s economy, entice reinvestment, and stimulate reinvention. The chamber’s recommendation is for implementation of effective growth-enhancing measures to aid the country’s goals for sustainability and the mental and

physical wellness of its population. The Chamber of Commerce believes that COVID-19 could aid us in achieving these objectives.

4.2.2. The Chamber of Small and Medium Enterprises (SMEs)

For the full transcript of this expert interview, refer to Appendix 4 Table 4.1.

i. Role of SMEs

The Malta Chamber of Small and Medium Enterprises represents employers' interests especially within the small and micro enterprises. The Malta Chamber of Small and Medium Enterprises also seeks to safeguard a level playing field and operational freedom for businesses.

ii. Risks of coastal flooding

The Chamber of SMEs answered that they are not aware of the risks of sea level rise and storm surge flooding on the business sector; thus, no industries have ever been identified that will be impacted from such a phenomenon.

iii. Impacts of coastal flooding on commercial activities

Despite not being aware of the risks of coastal flooding, the Chamber is highly aware that Malta's coastal commercial activity is classified as "very high risk", as most coastal localities are classified as low lying. The Chamber expects coastal business communities to experience the following: accessibility issues, outside seating issues and walking trade. During flooding events, roads are usually flooded and inaccessible which makes accessibility to the business establishment nearly impossible. The second business disruption is outside seating capacity, which is specific to the catering industry, and which will have to be closed as a health and safety precaution; forcing the catering establishment to work at reduced operational capacity. The final disturbance identified by the Chamber of SMEs was walking trade as coastal flooding will temporarily reduce trade in the surrounding areas.

iv. Projected data related to impacts

To date, SMEs has no data indicating the expected losses to revenue, jobs and coastal business establishments brought about by coastal flooding. Similarly, SMEs have no data that shows the expected losses to the Maltese economy and its labor force. The Chamber claimed to have limited resources available at their disposal, therefore they are forced to prioritize their workload on more pressing issues which affect the wider business community. However, they do acknowledge that this issue is of high importance and strongly encourage more research on it.

v. Engagement with potentially vulnerable stakeholders

The SMEs answered that to date they have not discussed the threats pertaining to coastal flooding with coastal business communities. This is because, according to the Chamber, this topic was never on their agenda over the past years. Since the Chamber specializes in small and medium businesses which are more susceptible to coastal flooding impacts, they admit that this topic warrants a higher priority in future. The Chamber has never been approached by any of its members requesting information or advice about issues of coastal flooding and what mitigation measures are considered appropriate.

vi. Consultations with government authorities and strategy building

The Chamber was never invited by any government authorities to participate in talks on the impacts of coastal flooding on coastal business communities. The Chamber believes that they should have a role in building a national strategy to address this issue and to enter discussions and consultations with its members so that they will ultimately come up with proposals that will effectively address their concerns. Furthermore, they can prioritize these issues and, if beyond their expertise or resources, they would present them to the government or authorities in the hope that such issues will be rectified.

4.2.3. Civil Protection Department (CPD)

For the full transcript of this expert interview, refer to Appendix 4 Table 4.2.

i. Role of CPD

The CPD is legally obliged to respond to any emergency within Malta's territory. The same applies to prevention and preparedness. However, the CPD pointed out that for issues related to coastal flooding, the CPD can only react during an emergency created by threat. Due to their role pertaining to coastal flooding if this phenomenon starts occurring more frequently throughout the years, the CPD will not be heavily involved.

ii. Coastal flooding high risk areas

As already stated, the CPD is not involved in any discussions related to coastal flooding but as for the risk of tsunamis, the CPD classifies all northern and eastern beaches as high risk.

iii. Coastal flooding measures

The CPD confirms that they have implemented measures in coastal localities by designing a tsunami plan for Malta which would be executed if such a phenomenon occurs. The CPD is also working on locality-based tsunami plans, and these will be eventually sent to each locality. As for training, the CPD is involved in response only and since coastal flooding is a slow onset disaster, Malta will have time to react events such as coastal flooding. Nonetheless the CPD has acquired some machinery to be able to tackle such emergencies and should the need arise, during national emergencies, it can also call on third-party contractors who have the necessary machinery and operators. The necessary legislation has also been drawn up and approved.

iv. Calls

The CPD does not receive emergency calls from coastal areas during flooding events, but they do receive calls from households found close to valleys which have been flooded. However, they have received calls from establishments, including hotels that are located by the coastline. In most instances, the CPD can only reinforce doors and apertures and pump out water if firefighters are able to access the structure from a safe entrance. It is important to note that the CPD has not implemented any physical measures in coastal towns to reduce the number of calls they receive. They believe that any infrastructure built should be designed in

such a way to mitigate the effects of flash flooding; in fact, newly built coastal infrastructure is designed to tolerate flash flooding.

v. Research area

The CPD's professional experience of coastal flooding in the five research areas is that these areas are exposed to flash floods which were more disruptive than coastal flooding. Flash flooding consists of fast-moving water, but the area will not remain flooded for a long period of time. Nonetheless, the real risk is that fast-moving water is a hazard and has been known to injure and kill people, regardless of being in a vehicle or on foot. As for mitigation measures in these areas, the CPD believes that any infrastructure or alterations required should consider flash flooding. As to how the CPD effectively tackles flooding events, it was noted that the CPD will only intervene and respond to those calls where lives are at stake. During these events, the high number of requests and calls received from all over Malta and Gozo in a very short period makes it very difficult for the CPD to assist everyone due to their limited resources. The CPD has noted a significant decline in interventions since the introduction of the flood relief project across the Maltese Islands and are analyzing trends emerging from this project.

vi. Liaising

During intervention, the CPD liaises with, and directs other entities such as Transport Malta, Police and if need be, the armed forces.

vii. Future CPD strategies

As an intervening authority related to risks and hazards, future sea level rise and storm surge projections are proving to be difficult for the CPD to effectively form future strategies. Business owners that are affected by storm surges tend to implement their own measures to mitigate the effects without requiring any further assistance. Same goes for government-built infrastructure, as such infrastructures are designed and built to withstand such events. Older infrastructure can be upgraded to withstand current and future storm events. The tricky part for the CPD is that storms vary in intensity, duration, strength, and direction, therefore it is

extremely unlikely that any strategy is storm proof. On the other hand, the CPD has already been given the required tools to cater for storm surges.

4.2.4. Ministry for the Economy

When the ministry reviewed the questionnaire, they replied that the Ministry for the Economy, Investment and Small Businesses does not collect data on the economic impacts brought by coastal flooding. For this reason, the expert representing this government ministry declined from participating in the interview.

4.2.5. Environment and Resources Authority (ERA)

For the full transcript of this expert interview, refer to Appendix 4 Table 4.3.

i. ERA's Role

The authority's role is mostly linked with issues relating to environmental protection as outlined by the Environment Protection Act (EPA, Cap. 549) of the Laws of Malta. Climate change is not directly addressed by ERA but is indirectly addressed through the implementation of the Act and its related policies.

ii. Climate change and sea level rise risks

Most of the agency's work is related with the adaptation and mitigation measures, including issues with site management, environmental aspects linked with biodiversity management, desertification, nature protection, waste, water, and air quality monitoring as well as other areas tied to permits and compliance. ERA's function complements the work carried out by other governmental entities in relation to climate change and sea level rise.

iii. Infrastructure/localities identification

ERA was asked if the authority identified any road networks and public structures that are at risk of sea level rise and storm surge flooding. Their response was in the affirmative and such areas have been identified, like the marshlands within the Natura 2000 sites. The authority classified coastal erosion as a major issue as it leads to the removal of embankments and

results in sea water instead of freshwater flooding. Actions have been planned for sites such as, Il-Ballut I/o Marsaxlokk through the MT-EU Life co-funding. Other actions are linked with coastal erosion on which ERA has carried out a study and related desertification processes and modelling. Climate change may exacerbate such erosion and desertification issues due to more sporadic and violent storms. However, ERA has not identified those localities that will most likely be affected by sea level rise and storm surge flooding. This is because climate change issues are coordinated through other governmental entities, and it is not within ERA's remit. Notwithstanding this, ERA aids in relation to selected thematic areas within ERA's legal responsibilities and commitments.

iv. Recent Studies

When ERA was asked if the authority has conducted any recent studies on the impacts of sea level rise and storm surge flooding on coastal town businesses across the Maltese Islands, they responded that they have not, as climate change is not ERA's main responsibility.

v. ERA assessment/protection

ERA does not have an assessment and ERA strongly promotes green and blue infrastructure to protect coastal towns across the Maltese Islands.

vi. Future strategies and regulations

Since Malta failed to reach the targets as set out by the 2020 EU climate change, ERA's future direction to reduce carbon dioxide (CO²) footprint is being addressed through different strategies being drafted and adopted in line with existing legal requirements and commitments. ERA's actions are driven by the various implementation processes linked to site management and thematic areas and other relevant policies and strategies as to be in accordance with Article 51 of the EPA. The latter are driven by the current gap analysis and reviews established through the State of the Environment Report process and the review of the implementation of national targets – such as the ongoing review of the National Biodiversity and Action Plan 2012-2020 (NBSAP). Also, it is important to note that new policies are being drawn up. As to future regulations on coastal development in highly susceptible

low-lying areas, ERA does foresee the need for such regulations. When asked what type of regulations, ERA claimed that there is already a legal and policy regime addressing selected issues linked with environmental protection under the EPA. Other aspects linked with land use, are also addressed via the Development Planning Act (DPA, Cap. 552), which is administered by the Planning Authority. As to 'regulations', ERA is undergoing a better regulation process, which implies updated legislation and new policies which address different aspects within our legal portfolio. In terms of legislation, these are often updated based on experience in implementation; scientific and administrative progress; ongoing monitoring and review and discussions in relevant national and international fora as applicable. Moreover, ERA is responsible for monitoring the state of the environment in Malta in regular cycles. Such a report identifies the status of various aspects, including climate change, and is used to redirect policy to address emerging issues and gaps. Indeed, ERA is currently revising various policies in line with the results of the latest assessment.

4.2.6. Ministry for the Environment, Sustainable Development and Climate Change

For the full transcript of this expert interview, refer to Appendix 4 Table 4.3.

i. Ministry Environment, Sustainable Development and Climate Change role

As a member of the Paris Agreement, Malta is also one of the countries responsible for the implementation of the global goal on adaptation i.e., enhancing adaptive capacity, strengthening resilience, and reducing vulnerability to climate change in the context of the temperature goal of the Agreement. The role of the Ministry as the policy maker, is to identify those sectors of society and the natural environment which are susceptible to climate change impacts and, as stated in the Climate Action Act (CH 543), draw up and implement policies and measures that significantly strengthen national adaptation efforts.

ii. Climate change and sea level rise risks

The Ministry has the role of elaborating and implementing the national Climate Change Adaptation Strategy. Currently, the Ministry is in the process of updating the 2012 Adaptation Strategy for the Maltese Islands, identifying areas of action which call for strengthened resilience and increase preparedness for climate change impacts. It is also within the

Ministry's remit to improve its understanding on the degree of vulnerability to which society, our economic sectors and our natural environment are exposed, being it from sea level rise or other threats related to climate change. This would enable better targeted and prioritized actions where most needed. To this effect, Malta is also planning to conduct a comprehensive review of the latest Vulnerability Risk Assessment.

iii. Infrastructure/localities identification

The Ministry for Environment, Climate Change and Development Planning Policy has identified those roads or structures that are at risk of sea-level rise and/or coastal flooding, not surprisingly so, noting that our urban development extends close to our shores. In view of this, several policies and measures are included in the current and upcoming Adaptation Strategy to increasingly address such impacts. Examples which have been identified include reviewing the Storm Water Master Plan; and ensuring better long-term planning on existing and planned new coastal infrastructure, considering projections for the next 50-100 years of significant sea level rise. Within the Malta Adaptation Strategy, several actions have been identified to preserve valleys and roads from floods and to provide an early warning system in this regard. Implementation of such measures fall under the remit of a separate Ministry, responsible for infrastructure and capital projects. As for localities, the ministry claimed that they have identified those localities that will most likely be affected by sea level rise and storm surge flooding by referring to studies carried out locally by research institutions. Several high-risk areas including Msida, Gżira, Mellieħa, and Marsaxlokk are susceptible to sea level rise and flooding and are highly dependent on the extent of sea level at the time.

iv. Recent Studies

To date, such studies were conducted by global and local research institutions, focusing on the EU, both regionally (particularly that focused on the Mediterranean basin) and on a national scale. However, as part of the comprehensive review of the Vulnerability Risk Assessment which is planned for the 2021-2022, climate change impacts will be modeled on the Maltese Islands.

v. Assessment/protection

The ministry bases its assessment on research conducted globally, particularly the EU, and other high-level studies in the Mediterranean basin and on a national scale. In the current Adaptation strategy, measures are in place to protect the coastline, roads and infrastructure from sea level rise and floods. Noting that all Ministries have climate change responsibilities, the implementation of such measures rests with the relevant authorities. The Ministry collaborates and monitors the status of these measures to ensure that their implementation is successful and timely.

vi. Future strategies and regulations

With the lowest emission per capita, Malta has achieved further emission reductions in terms of its total greenhouse gas emissions after overhauling its energy generation sector, shifting from heavy fuel oil to natural gas. Recently, Malta has committed to the EU-wide climate neutrality target by 2050. The compilation of its long-term strategy towards decarbonization shall enable us to identify the mitigation potential of the various contributing sectors and the actions required to address such goals, noting the resultant socio-economic impacts. Considering that our economic structure is not carbon intensive, and that heavy industry is very limited, mitigation action will target the energy and transport sectors amongst others. The ministry is currently in the process of updating the Adaptation Strategy, which will inform policy makers and other authorities, which are the “implement vehicles”, on how regulations should be better strengthened to increase our resilience to climate change impacts. As such, we are not able to confirm whether development planning regulations on coastal development will be revised.

4.2.7. Ministry for Transport, Infrastructure and Capital Projects (Expert 1)

For the full transcript of this expert interview, refer to Appendix 4 Table 4.4.

i. Role

The Public Works Department has several Directorates and Units with specialized functions with the Marine and Storm Water Unit (MSWU) being responsible for marine works, coastal protection works, and storm water management.

ii. Infrastructure/ localities identification

The ministry did identify those road networks and public structures that are susceptible to sea level rise and storm surge flooding. The identified localities were all low-lying coastal towns such as: Marsaskala, Sliema, Birżebbuġa, Marsaxlokk and St Paul's Bay together with most pocket/ sandy beaches across the Maltese Islands.

iii. Priorities

Priorities depend on the impacts on the local community or wider areas, whereby specific projects may be instigated by the aftermath of large storm events. At present, there is no comprehensive assessment of the risks associated with coastal flooding and its impacts on coastal communities and businesses. Thus, the Department does not have a structured list of priorities. Actions and works are carried out depending on the budget allocated on an annual basis and this varies from one year to the next. The National Risk Assessment can provide guidance and direction for the CPD in extreme events, and this may be used for more strategic actions. This may be addressed in good part by studies and plans for coastal erosion risk assessment which is undertaken holistically and will also include wider coastal vulnerability assessments. Works are very limited, and the results are not being made publicly available. Information on national coastal vulnerability assessment is currently unavailable although the PA did conduct a preliminary study and some research has been carried out on the North-Eastern coastal section in Gozo. For security purposes, information extracted from the National Risk Assessment is held by the CPD and is only published in outline form. In its annual budget, the ministry does not allocate funds for further studies on the impacts of such a phenomenon on coastal infrastructure. The funds coming from the budget allocated to the Department, especially to the Marine and Storm Water Unit department, are used to finance other operations as well and are not solely dedicated to risk management for this phenomenon. However, the Department does submit proposals for studies whenever there is an opportunity of EU funding.

iv. Sea level rise and storm surge flooding consideration

Before embarking on any new projects relating to coastal infrastructural development, the ministry does plan for sea level rise and the prospect of more frequent and violent storms in their planning and feasibility studies by incorporating the necessary requirements to cater for such scenarios.

v. Measures

Recently, Malta has seen an upgrade to its coastal infrastructure. When the expert was asked if there were any measures that may have been put in place to protect these new upgrades/investments from sea-level rise or coastal flooding, the expert confirmed that these measures have been implemented but did not specify what was implemented as he/she did not have the information at hand. These measures will also protect infrastructures that are in danger of being partly submerged and likewise, to protect coastal towns that have a high incidence of flooding.

vi. Required resources

According to the expert's opinion, adequate resources are required for rigorous and regular research including a steady monitoring program. Funds are also required to draw up a holistic coastal risk assessment, evaluating the impacts coming not only from this phenomenon but also from other hazards/processes that are exacerbated by climate change, and which ultimately affect the coast. Well-trained professional and technical HR is also required, with adequate training for research, planning and monitoring. Significant funds will then also be required to implement project interventions that will provide the identified mitigation measures even if these proposed measures might prove costly.

vii. Coastal Infrastructure Future Planning

There are plans to upgrade current coastal infrastructure in the future to align with current and future sea level rise and storm surge flooding projections. One would have to look at the coastal infrastructures on a case-by-case basis and carry out further research to find out what were the ultimate aims of the initial planning and design (if at all).

4.2.8. Ministry for Transport, Infrastructure and Capital Projects (Expert 2)

For the full transcript of this expert interview, refer to Appendix 4 Table 4.4.

i. Role

The Public Works Department is currently building up its capacity to be able to monitor and implement projects aimed to address issues of coastal erosion and flooding.

ii. Infrastructure/localities identification

According to the second expert, road networks and public structures have yet to be identified as the priorities will be defined once a Shoreline Management Plan is prepared. Once the plan is available, a public consultation will be carried out and studies will then proceed.

iii. Priorities

To date the ministry does not have any priorities as they will be defined once this Shoreline Management Plan has been finalised.

iv. Sea level rise and storm surge flooding consideration

The Ministry does take into consideration sea level rise and the prospect of more frequent and violent storms before embarking on any new coastal infrastructure. With the help of foreign consultants and using complex mathematical models, they try to assess the effects of sea level rise and storm surge flooding on these projects.

v. Measures

Recently, Malta has seen an upgrade to its coastal infrastructure. When the expert was asked if there were any measures that may have been put in place to protect these new upgrades/investments from sea-level rise or coastal flooding, the expert promptly replied “no” and no further explanation was forthcoming. Likewise, no measures have been implemented to protect other existing coastal infrastructures and investments that are deemed to being partly submerged. Also, the expert stated that no plans exist for those localities that have a high incidence of floods.

vi. Required resources

In its annual budget, the Ministry does not allocate additional funds to cover studies on the impacts of such a phenomenon on coastal infrastructure. However, an assessment could be drawn up in relation to the emerging risks for such infrastructure and then set priorities accordingly to their threat level; especially in those areas that are crucial to the Maltese economy (like the areas within this study). In addition, the expert claimed that more professionals and technical personnel are required, as well as specialised training to analyse the collected data, modelling of different scenarios, environmental design, and civil engineering works.

4.2.9. Malta Resource Authority (MRA)

For the full transcript of this expert interview, refer to Appendix 4 Table 4.3.

i. MRA role

The MRA is designated as the greenhouse gas Inventory Agency, meaning that it records the number of greenhouse gases pollutants the country releases annually, including air and maritime services pollution.

ii. Climate change and sea level rise risks

The expert reported that climate change and any of its consequences fall out of MRA's remit however they did do a preliminary report about floods, but to be clear, the expert did not provide any details to answer this question.

iii. Infrastructure/ localities identification

This task falls out of the MRA's remit.

iv. Recent Studies

This task falls out of the MRA's remit.

v. Assessment/ protection

The MRA's current level of assessment and knowledge on the vulnerability of sea level rise and storm surge flooding on the Maltese Islands is based only on high individual knowledge, (meaning there are bodies within MRA who are highly knowledgeable on this matter) as MRA only deals with taking stock of greenhouse gases.

vi. Future strategies and regulations

Malta has met its EU's climate change 2020 targets to reduce the carbon dioxide's footprint via the flexible mechanism (aka emissions trading) which is designed to lower the costs of achieving a country's own target emission. This mechanism enables countries to reduce or remove their output of carbon dioxide. The MRA does not foresee any future regulations pertaining to coastal development in low lying area that are highly susceptible to sea level rise and storm surge flooding however, it is acknowledged that adaptation measures will need to take place without any need for regulations.

4.2.10. Planning Authority (PA)

For the full transcript of this expert interview, refer to Appendix 4 Table 4.3.

i. PA role

The Planning Authority's work is guided by the strategic policy framework of the Strategic Plan for Environment and Development (SPED 2015) which identified climate change as a key challenge for the Maltese islands and presents the policy framework for the Coastal Zone and Marine Area. The PA's work is also guided by other national documents specifically addressing climate change and related issues. As the focal point for the Integrated Coastal Zone Management (ICZM) Protocol within the Mediterranean, the Authority is working to improve Malta's capacity to address various aspects of coastal zone management, where in this case, article 23 of the Protocol addresses such risks.

ii. Climate change and sea level rise risks

The Development Planning Act of 2016 states that spatial planning policy is hierarchical. Therefore, any policy changes that are carried out are assessed to determine whether coastal issues such as climate change and sea level rise may need to be addressed. The level of work that the PA can carry out depends on the data and information that is available at national level by the relevant authorities responsible for developing the national climate change policy. In the absence of such information, effort is made to incorporate precautionary measures in policy changes. For the functions related to evaluation of development proposals, these are tackled on a case-by-case situation and in many instances such matters are addressed through EIAs and detailed studies whose TORs are prepared by ERA.

iii. Infrastructure/localities identification

The PA did not identify any road networks and public structures that are susceptible to sea-level rise and storm surge flooding. Likewise, the PA did not identify those localities that will most likely be affected by sea-level rise and coastal flooding. This is because a task of this magnitude requires a national effort and involves different entities pitching in both at government and research level. In the absence of clear data on the national vulnerability and future trends to climate change, any one-off exercise that is carried out will only be indicative.

iv. Recent Studies

The Planning Authority did conduct recent studies assessing the impacts of sea level rise and storm surge flooding across all coastal towns throughout the Maltese Islands. This study was conducted as an internal administrative exercise, thus, its findings are not publicly available. However, the scope behind this study was to raise awareness on the importance of coastal vulnerability given the current sea level rise and extreme weather events projections within the authority.

v. Assessment/protection

The PA based its current assessment level on the existing published knowledge (National reporting to UNFCCC). As for protection, the PA has led the process since 1992 to shift away

from hard engineering to soft engineering solutions. However, not every case can be resolved by using soft engineering technology and the PA is trying to keep abreast with technology and expects that, in time, practitioners (engineers/architects) are trained and will be able to deliver new options more linked to nature-based solutions.

vi. Future strategies and regulations

As to the 2020 targets, the PA was not responsible for this task, hence, they could not answer the question and cannot comment on future strategies to reduce the overall carbon footprint of the Maltese Islands. When it comes to future regulations on low lying coastal development, the PA does not see any future regulations due to the absence of any clear evidence of sea level rise and storm surge flooding impacts in the Maltese Islands.

4.2.11. Malta Tourism Authority (MTA)

For the full transcript of this expert interview, refer to Appendix 4 Table 4.4.

i. MTA climate change awareness

The MTA is very aware of climate change and its implications on a global and national level, particularly that of sea level rise and flooding which pose a serious threat to the Malta's tourism industry. On a yearly basis, thousands of tourists visit Malta (especially during summer) for the country's beaches. If weather impacts the beaches in such a way that sand and bathing areas are reduced or degraded, it will have a direct effect on tourism.

ii. Studies

The MTA has never conducted any studies on how climate change would impact Malta's tourism industry as the authority is not responsible to deal directly with environmental issues – they retain that these fall under the remit of other governmental entities. Studies do not exist that detail the contribution of tourism related coastal businesses to Malta's economic revenue. The authority reported that touristic coastal businesses are various, and each business does its own contribution to various sources. These include, but not only, hotels, restaurants, dive centers, concessions, event organizers, souvenir shops, property

negotiators, water sports, and much more. However, the MTA could not provide details pertaining to figures and accessibility.

iii. Impact/Risk Assessment

The authority has never carried out any impact assessment as to quantify the losses if any business activity, accommodation spaces, job losses, revenue and other type of tourism related facilities are lost. This is because the MTA does not conduct environmental studies; instead, the MTA relies on other entities that are focused on environmental issues. As for risk assessments, although during 2016, it was revealed that 9 out of 12 drowning victims were foreigners, the MTA claimed that Malta is not classified as high risk. Life savers and first aiders are deployed on most popular beaches, and they manage to save scores of lives every summer. Their priority is prevention rather than cure.

iv. Development Position

The MTA evaluates every proposal for the development of tourism related business activity, which is adjacent to the shoreline on its own, and submits its own recommendations to MEPA according to the impacts/benefits that the development has to offer.

v. Future marketing and policies

The MTA does not believe that, as an authority, they should not align its future policies and marketing to reflect climate change impacts on coastal tourism. The reason for this is marketing, as it can attract high quality and environmental tourists in a positive manner, and it is insignificant to market issues whose impacts on the islands are not clear enough.

4.2.12. Transport Malta (TM)

For the full transcript of this expert interview, refer to Appendix 4 Table 4.5.

i. Transport Malta Role

The authority is aware of such problems and of its future consequences and is making sure that whenever possible, new projects are designed to cater for future sea level rise.

ii. Infrastructure/ localities identification

TM did identify road networks, public structure and areas that are at risk of sea level rise and storm surge flooding such as: Marsaskala, Sliema, and Birżebbuġa which have already experienced issues with sea level rise when parts of these localities end up submerged/ flooded during this phenomenon.

iii. Projections

The authority does consider sea level rise and storm surge flooding projections when designing new roads, especially those roads situated along the water's edge.

iv. Management Strategies

Interestingly, to date the authority has not implemented any management strategies on its coastal roads to reduce traffic congestions when flooding occurs. However, the expert claims that his/her department are not responsible for the formulation of such management strategies; nonetheless to the expert's knowledge no strategies have been implemented. In addition, the authority does provide consultations to the competent stakeholders on the likely impacts of sea level rise and violent storms which may lead to more flooding days and areas in relation to any new upcoming coastal infrastructural development. This assessment is done via a mathematical study, the results of which determine whether further assessments may be requested or else the project is approved.

v. Measures

TM have implemented measures to protect Malta's newly upgraded coastal roads from sea level rise and storm surge flooding. Although the expert claimed that he/she is responsible for the actual coastal infrastructure and not roads, he/she did not know what measures have been implemented and how they were implemented. However, whenever possible, structures are constructed at higher elevations to cater for the phenomenon. One must keep in mind that these low-lying areas are heavily populated with buildings very close to the water's edge.

vi. Plans and resources

The authority has plans to protect coastal infrastructure from being partly or completely submerged. Currently, TM is looking into the original flood valves at Sliema Ferries, but in the long run other areas will also need to be tackled. Additionally, the authority would need additional resources to carry out a holistic study to see how such problems can be solved. In the future, we should be looking at studying various coastal areas and come up with solutions on how best to mitigate such problems. This will have to be done in collaboration with other entities and units.

4.2.13. Transport Malta Ports and Yachting Directorate

For the full transcript of this expert interview, refer to Appendix 4 Table 4.6.

i. Transport Malta Ports and Yachting Directorate Role

This department's role within TM is to monitor sea level to ensure navigation safety for small boats and ships.

ii. Current coastal infrastructure

The department of Ports and Yachting Directorate claimed that current coastal infrastructure is not equipped to withstand the impacts of sea level rise and storm surge flooding. This is because according to their records, past sea level rise recorded very slow rates in our areas: 1.6mm per year resulting in 1.6cm per 10 years and 16cm per 100 years.

iii. Maritime services impacts

The only foreseen impact on the Maltese Islands' maritime services is the Malta Freeport operations due to the air draft required to operate its cranes. However, the expert claims that the Freeport's impact will not harm the Maltese economy.

iv. Mitigation Measures

The Ports and Yachting Directorate did not consider implementing any mitigation measures to protect coastal infrastructure and towns from sea level rise and storm surge flooding. As a Directorate, they are only responsible for safety of Navigation and the operation of vessels in Maltese territorial waters. Currently, there is not a significant rise in sea level that can be considered as alarming (unlike other countries in the Atlantic). Flooding experienced by other low-lying coastal areas such as Msida, Sliema, Marsaxlokk and any other area is not the responsibility of Ports and Yachting Directorate.

v. Research areas

Sea level rise and storm surge flooding is not considered when constructing new berthing facilities especially when seaborne transport (ferries) developed on the Maltese Islands. The expert does not believe that new berthing sites should be equipped to withstand sea level rise and storm surge flooding and even the Directorate does not think that sea level rise will affect seaborne transport within this research's coastal sites. However, they do predict that seaborne transport may be affected if there are significant storm surge floods taking place which could lead to the eventual suspension of local cruise and ferry operations in the ports.

vi. Resources

Since to date, sea level rise is not a priority to the Ports and Yachting Directorate, they do not need any additional resources. However, if the rate changes significantly, then there may be the need of additional funds to raise the quay levels.

vii. Future Projections

From their records, current sea level rise is not significant, and they expect this negligible rate to persist in the future and that it will not become a coastal threat. However, port operations may be disrupted during storm surges, but the expert believes that there are yet no strategies for this.

Table 4.1 and Table 4.2 list the coded themes and sub-themes that have been classified from the analysis of the experts' feedback. The following is a list of the main sectors and the experts interviewed within each sector:

- Business – Chamber of Commerce, and Chamber of Small and Medium Enterprises.
- Environment – Environment and Resources Authority, Ministry of Environment, Climate Change and Development Planning Policy, Malta Resources Authority, and Planning Authority.
- Transport and Infrastructure - Ministry for Transport, Infrastructure and Capital Projects, Transport Malta, and Transport Malta Ports and Yachting Directorate.
- Tourism - Malta Tourism Authority
- First Responders - Civil Protection Department

Table 4.1 and Table 4.2 indicate all the those interviewed against the codes and subcodes identified in NVivo. Both tables clearly indicate that every authority has its own responsibility pertaining to coastal flooding as not every code and subcode was identified in each interview. However, one key observation is that most responsibilities tend to overlap between authorities/entities. This suggests that there is some form of inter cooperation between the identified entities irrespective of what their responsibilities are. For example, when looking at the Chamber of Small and Medium Enterprises and the Civil Protection Department, despite being two completely different entities, a few codes were identified in both interviews. Having said that, there are still some codes and subcodes that were identified only within a specific small cluster of experts, such as stakeholders' discussions were only identified in The Chamber of Commerce, The Chamber of Small and Medium Enterprises, and Transport Malta which makes this code restricted to three experts out of eleven. The most concerning discovery from both tables was identified within the Planning Authority expert where the authority was identified in just two codes and subcodes respectively, which is alarming, as when compared to the other government authorities it looks like the PA is the least involved. Having said that, the Malta Resources Authority's responsibility is unique and overlaps with other entities' responsibilities hence why it is not found in any of the codes and subcodes tables.

Table 4.1 – Codes identified with NVivo

Codes	Actions, mitigation measures and legislation	Awareness	Data on impacts	Disruptions	Government Consultations	Industries at risk	Permits for development on the coast	Reasons for risk of SLR and CF	Request from stakeholders	Stakeholders' discussions
The Malta Chamber of Commerce, Enterprise, and Industry (MCCEI)		✓	✓	✓	✓	✓		✓	✓	✓
Chamber of Small and Medium Enterprises	✓	✓	✓			✓			✓	✓
Civil Protection Department	✓		✓	✓	✓	✓				
Environment and Resources Authority	✓	✓				✓	✓			
Ministry of Environment, Climate Change and Development Planning Policy	✓	✓	✓			✓	✓			
Ministry for Transport, Infrastructure and Capital Projects	✓		✓							

Malta Resources Authority										
Planning Authority	✓		✓							
Malta Tourism Authority		✓	✓			✓	✓			
Transport Malta	✓	✓						✓		✓
Transport Malta Ports and Yachting Directorate	✓	✓	✓			✓				

Table 4.2 – Subcodes identified with NVivo

Codes	Awareness		Data on impacts	Disruptions						Government Consultations	
	Impacts	Risks of sea level and storm surge flooding		Other studies	Business traffic access	Health and safety	Maintenance	Non SLR or CF	Outside seating	Property devaluation	Response
The Malta Chamber of Commerce, Enterprise, and Industry (MCCEI)		✓		✓	✓	✓			✓		✓
Chamber of Small and Medium Enterprises		✓		✓	✓			✓			✓
Civil Protection Department	✓	✓			✓		✓			✓	✓

Environment and Resources Authority	✓											✓
Ministry of Environment, Climate Change and Development Planning Policy	✓	✓						✓				✓
Ministry for Transport, Infrastructure, and Capital Projects	✓	✓	✓									✓
Malta Resources Authority												
Planning Authority	✓											✓
Malta Tourism Authority	✓		✓		✓							✓
Transport Malta	✓	✓		✓								✓
Transport Malta Ports and Yachting Directorate	✓											✓

Figure 4.1 and Figure 4.2 represent the Dendrogram explained in section 3.10.1. NVivo grouped the identified codes and subcodes to display the similarities within the codes. From Figure 4.1, a few groups can be identified; the first group has codes between “Non SLR of CF to Stakeholder discussion” while group two includes the rest of the codes (i.e. “Reasons for Risks to SL and CF to Strategy building). To analyze the dendrogram one must look at the height variation joining the clusters in each group meaning the closer and shorter the link the similar the categories are while the longer links show differences between the categories.

In group 1, the request from stakeholders and stakeholders’ discussions categories are quite similar as the link that joins both categories is the shortest while significant difference can be identified between outside seating and request from stakeholders’ category due to the longer link between both categories. Likewise, the same process is used to carry out the analysis for group 2. As one can note, the second group consists of most of the codes within the analysis and this is because most of the expert interviews’ responses fell under the classification of these codes, which makes sense, as most of the experts’ codes and subcodes seen in Table 4.1 and Table 4.2 do overlap. Pertaining to the color codes, the colors represent from which expert/s interview the categories were identified.

As for Figure 4.2, which represents the expert entities, the clear evident outlier was the Malta Resources Authority which is understandable and expected as almost all responses were “this falls outside of MRA’s remit”. However, some interesting discoveries were made that various experts from various departments, entities, and ministries each with a varied set of legal obligations from their counterparts were ranked by NVivo as similar, while a few others stood alone. For instance, The Environment Resources Authority’s and Transport Malta’s responses, despite being two completely different authorities with different responsibilities, were ranked to be similar by NVivo. Likewise, The Transport and Yachting Directorate and The Ministry for the Environment, Climate Change, and Development Policy were classified as similar. An unsurprising outcome was that NVivo classified similar entities such as The Malta Chamber of Commerce, Enterprise, and Industry and The Malta Chamber of Small and Medium Enterprises.

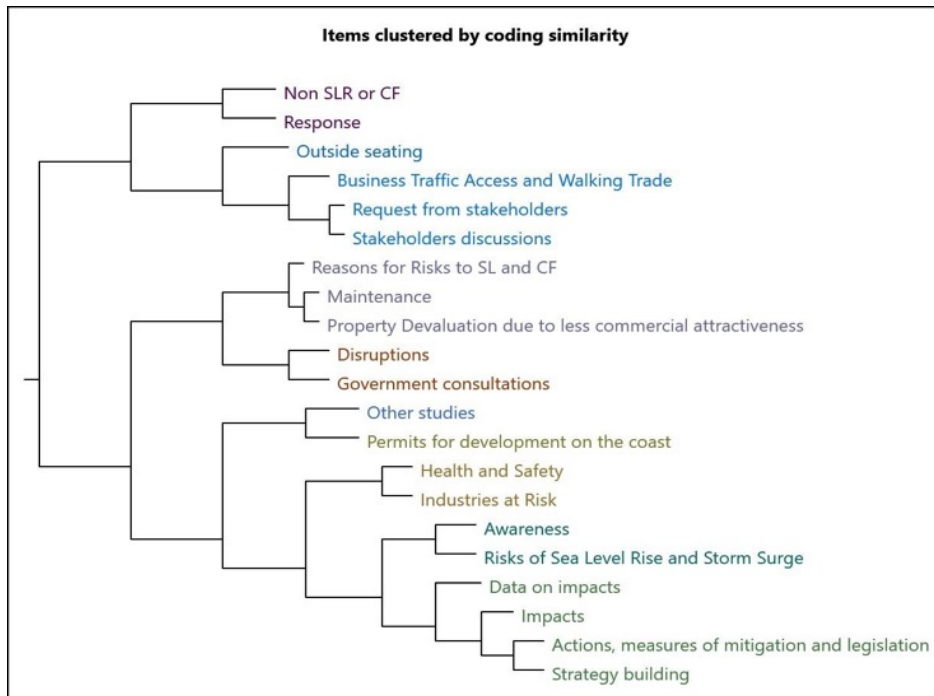


Figure 4.1 – Codes and subcodes horizontal dendrogram extracted from NVivo

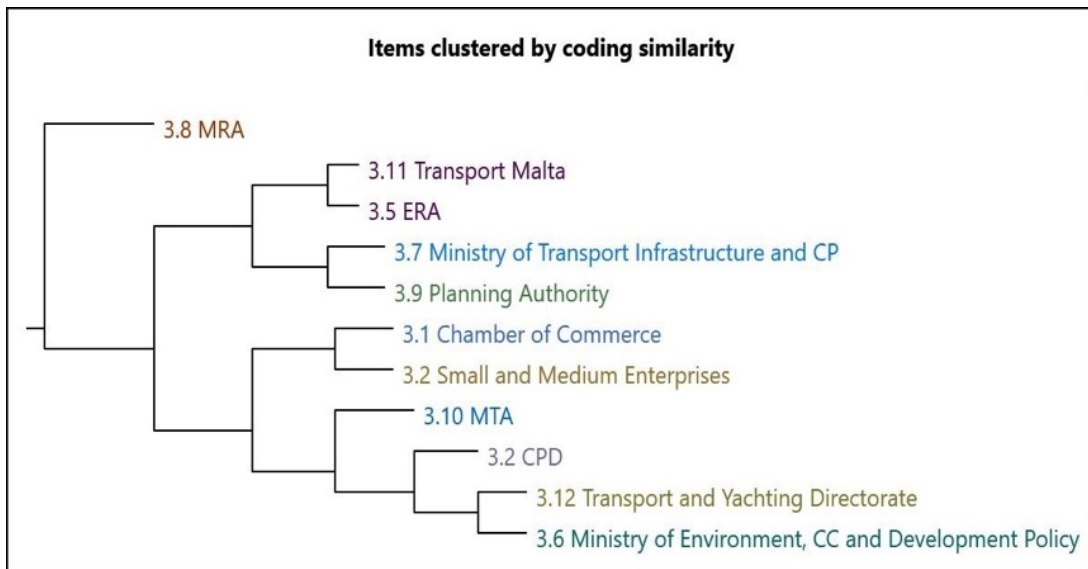


Figure 4.2 – Expert interviews horizontal dendrogram extracted from NVivo

4.3. Key Findings

4.3.1. Awareness

The Malta Chamber of Commerce, Enterprise, and Industry (MCCEI) classifies sea level rise and storm surge flooding at medium risk to Malta's commercial activity. Meanwhile The Chamber of SMEs is not aware of sea level rise and storm surge flooding and climate change derived risks. The MTA is aware of climate change and its implications and believes that if climate change impacts our beaches in a way that sand and bathing areas are degraded or reduced, this phenomenon will have a direct effect on tourism. The MRA's only role pertaining to climate change is to serve as the GHG Inventory Agency.

4.3.2. Business Disruptions

The MCCEI predicts business disruptions that pertain to health and safety, reduction in business traffic, cleanliness, and reduction in prime value of real estate. The expected business disruptions are walking trade, accessibility issues, and outside seating issues.

4.3.3. Stakeholder Discussions/Government Consultations

The MCCEI did organize discussions with potential stakeholders discussing the threats which may impact the coastal business community from sea level rise and storm surge flooding. The Chamber of SMEs never organized any seminars/talks with potential stakeholders, discussing the threats which may impact the coastal business community from sea level rise and storm surge flooding. To date, this was not on the Chamber's agenda. The Chamber of SMEs can enter consultations and discussions with its members to assess their concerns and propose ways and mitigation measures on how these concerns can be mitigated. Also, the Chamber can effectively prioritize issues and present them to the government for further action. Local research institutions conducted research to help the ministry identify those localities that are at risk of sea level rise and storm surge flooding with the following localities considered as hotspots: Msida, Gżira, Mellieħa, and Marsaxlokk.

4.3.4. Data on Impacts

The MCCE does not have any data showing the expected losses to revenue, jobs, labor force and coastal business establishments as such data still needs to be modelled. The Ministry for the Economy, Investment and Small Businesses does not collect economic data related to sea level rise and storm surge flooding consequently to climate change. The ERA has not conducted any studies on the impacts of sea level rise and storm surge flooding on coastal towns across the Maltese Islands as it is not within ERA's remit. The MTA has not conducted any studies as the authority does not deal with specific environmental issues.

4.3.5. Coastal Development

The TM is usually involved when new coastal infrastructural developments are proposed. It will highlight the likely impacts of sea level rise and violent storms on these new developments. The MTA assesses every development proposal on its own and submits recommendations to MEPA, highlighting both the impacts and benefits from such a project.

4.3.6. Planning, Management, and Regulations

The Ministry for the Environment, Sustainable Development and Climate Change does foresee future regulations pertaining to coastal development in low-lying areas that are highly susceptible to sea level rise and storm surge flooding. Currently, the ministry is in the process of updating the Adaptation Strategy which will inform policy makers and other authorities which are implementing vehicles on how regulations should be better strengthened to increase our resilience to climate change impacts. The Ministry for Transport, Infrastructure and Capital Projects' priorities depend on the impacts on the local community or wider areas, whereby specific projects may be instigated by the aftermath of large storm events. At present, there is no comprehensive assessment of the risks associated with coastal flooding and its impact on coastal communities and businesses. Thus, the Department does not have a structured list of priorities. Actions and works are carried out depending on the budget allocated on an annual basis, and this varies from one year to the next. The PA does not foresee any regulations in the future pertaining to coastal development in low lying areas

that are highly susceptible to sea level rise and storm surge flooding as the authority does not have any clear evidence to base any regulations on.

The MTA does not think it should align its future policies and marketing strategies to reflect climate change impacts on coastal tourism, especially in relation to sea level rise and storm surge flooding. The reason is that marketing has the possibility to attract high quality and environmental tourists in a positive manner and not by highlighting issues whose impacts are not clear. TM does have plans to protect coastal infrastructure and other investments which are deemed to be at risk of being partly or fully submerged. Currently the authority is looking into repairing the original flood valves at Sliema Ferries. In the long run, other areas will need to be addressed too. In the case of tsunamis, the CPD classifies all Northern and Eastern beaches as high risks. The CPD also has a tsunami plan for Malta, and they reported that each locality will start receiving its own tsunami plan.

4.3.7. Transport

The ERA, The Ministry for Transport, Infrastructure and Capital Projects, The Ministry for the Environment, Sustainable Development and Climate Change, and TM identified road networks and public structures that are at risk of sea level rise and storm surge flooding.

4.3.8. Adaptation/ Mitigation Measures

The CPD did not implement any preventive measures to reduce the number of calls related to coastal flooding. The Ministry for the Environment, Sustainable Development and Climate Change reported that in the current Adaptation Strategy, measures are implemented to protect the coastline, roads and infrastructures from sea level rise and storm surge flooding including flash floods. The implementation of such measures does not fall under this ministry. Despite drowning related deaths these incidents have nothing to do with this research, however its risk assessment is quite valuable, as Malta's beaches and bays are heavily marketed and are highly susceptible to sea level rise. Given that in 2016, it was revealed that 9 out of 12 drowning victims were foreigners, the MTA believes that foreign tour operators do not classify Malta as high risk as the MTA deployed lifeguards and first aiders on Malta's

and Gozo's most popular beaches to safeguard lives as these people employ a prevention better than cure approach.

TM reported that newly constructed and future roads are designed to cater for sea level rise. Whenever possible, roads or infrastructures are constructed at higher levels, although most low-lying areas are heavily populated with buildings sitting very close to the water's edge. TM reported that during the recent coastal road upgrades, the authority implemented measures to protect these investments from sea level rise and storm surge flooding. The Ports and Yachting Directorate did not consider any mitigation measures to protect coastal infrastructure and towns from sea level rise and storm surge flooding as its not part of the Directorate's area of responsibility. The Directorate's responsibility is to ensure safety of navigation and operation of vessels in Maltese territorial waters.

4.4. Presentation of Results: Local Councils

4.4.1. Introduction

As explained in Chapter 1, the role of the local government is an important one in flood risk management because local councils are always the recipients of first-hand experiences and issues arising from the locality and its community and have detailed understanding of the operations being implemented by the central government and how these may impact the locality. This section provides a descriptive analysis of the local councils' questionnaire results. The closed questions are analyzed in a multi-comparison way between the five localities. The answers collected from the 14 closed questions of the local council questionnaire exhibit a certain degree of response variability (see Table 4.3). Only 3 out of 14 questions (Q1, Q7, and Q9A) show a total agreement between the five localities. In this variability, no distinct pattern was observed between the Maltese and Gozitan localities. The presence of this response variability confirms the importance of undertaking stakeholder's consultations at locality level because despite the small scale of the Maltese Islands, disparities of opinions between one local government entity and another may exist (see Table 4.3) whereas the open-ended questions are discussed and compared in more detail with graph outputs.

4.4.2. Data and Analysis

The answers collected from the structured local council questionnaire exhibit a certain degree of response variability (See Table 4.3). Only 3 out of 14 questions (Q1, Q7, and Q9A) show a total agreement between the five localities. In this variability no distinct pattern was observed between the Maltese and Gozitan localities. The presence of this response variability confirms the importance of undertaking stakeholder's consultations at locality level because despite the small scale of the Maltese Islands, disparities of opinions between one local government entity and another may exist.

Table 4.3 – Local council matrix table for quantitative analysis.

Question No.	Question Description	Malta Case Studies			Gozo Case Studies	
		Gżira	Sliema	St Julian's	Marsalforn	Xlendi
1	Are you aware about climate change and its implications?	Yes	Yes	Yes	Yes	Yes
2	Have you ever envisaged that your town could be at risk of sea level rise?	Yes	Yes	Yes	Yes	No
5A	Do you think that sea level rise with its current projections (3.5mm/per) is a threat to the town's economy and local population?	Yes	No	Yes	No	No
6	Have you identified sea level rise hotspots in your locality?	Yes	Yes	Yes	Yes	No
7	Has this town ever experienced any signs of sea level rise (such as flooding and so on)?	Yes	Yes	Yes	Yes	Yes
9A	If sea level rose or flooding occurred, where there any significant disruptions in your town?	Yes	Yes	Yes	Yes	Yes
11A	Do you have any infrastructures that are/will be at risk due to sea level rise?	No	Yes	No	Yes	Yes
12A	In recent years, have you ever implemented any measures to help	Yes	Yes	No	Yes	No

	mitigate the effects of sea level rise on your town?					
13	Has any government entity informed your council on this phenomenon?	No	No	No	Yes	No
14	Are there any contingency plans for such an eventuality?	No	Yes	Yes	Yes	No
15A	Has the council organized any meetings with the town's residents and the business community?	Yes	No	Yes	No	Yes
16	Are there any FREE SPACES in your locality that can be used for social development in case current social amenities e.g. schools, police station, medical clinics and so on are no longer accessible due to sea-level rise?	No	Yes	No	Yes	Yes
17A	Do you have any future plans to protect your town against sea level rise?	Yes	No	Yes	No	Yes
18A	During the last severe storm that hit the Maltese Islands, did the coastal business community suffer any damages?	No	Yes	Yes	Yes	Yes

At first glance, it seems that Xlendi’s responses are contradictory to those of the other four localities. This could possibly be because Xlendi is a small suburb under the Munxar council. Despite Munxar being a coastal town, its coastline topography consists of cliffs, therefore this issue was likely to be overlooked or given low priority. However, as these two phenomena worsened Xlendi was being recurrently devastated in the aftermath of every storm, the council was caught by surprise. All the councils are aware about climate change and its implications on a global, national and local level (Q1) and apart from Xlendi, they all agree that coastal flooding by sea level rise and storm surges are a risk to their locality (Q2) (Table 4.3).

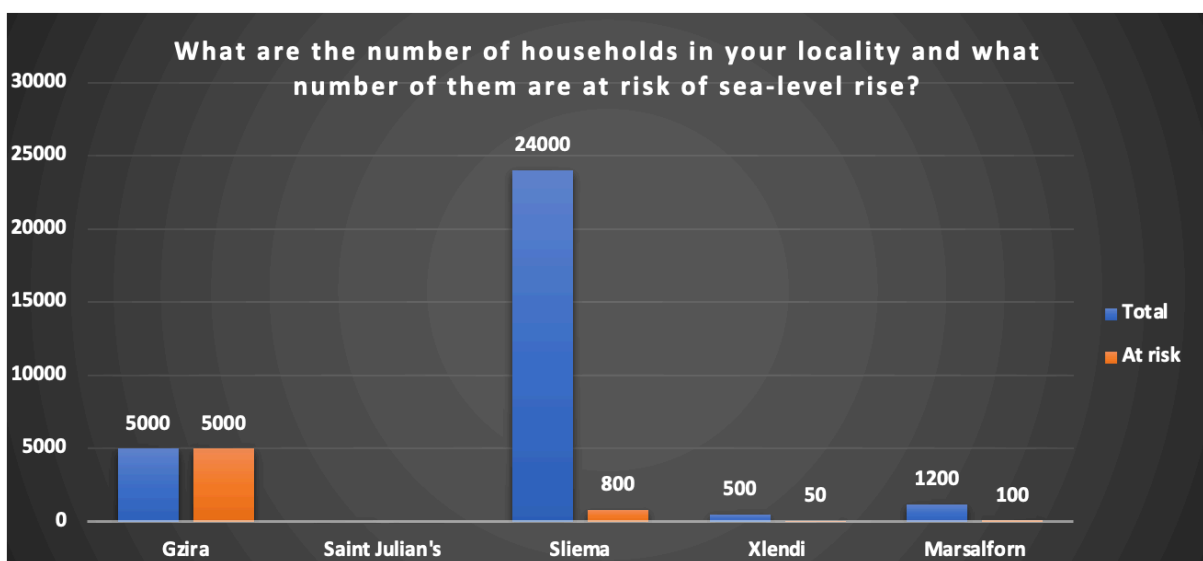


Figure 4.3 - Total number of households and at-risk households in each locality.

In Q3, Gzira’s local council reported that they designated all its households as susceptible to sea level rise and frequent flooding which would leave a devastating effect on real estate and property whose market value will plummet (Figure 4.3). Out of 24,000 households in Sliema, just 800 are designated to be at risk (3.33 percent). Out of 500 households in Xlendi, only 50 (10 percent) of them are classified to be at risk. Marsalforn reported that out of 1200 households, 100 (8.33 percent) are at risk to sea level rise. As for St Julian’s, data was unavailable as the local council did not have the latest figures available, as the latest census which conducted in 2011, is now outdated by a decade, so it is unclear what the current scenario for St Julian’s is.



Figure 4.4 - Total population and at-risk population of each locality.

In Q4, Gżira and Xlendi reported that all its residents are at risk of sea level rise (Figure 4.4). St Julian's council did not have the latest figures in hand, but according to latest NSO statistics, the total population stood at 14,939. As for the risk factor, the council pointed out one street, 'Borg Oliver Street' but figures for this street were also unavailable (latest census is outdated as it was conducted in 2011). Sliema had conflicting reports as according to the NSO, the population stood at 24,412 in 2020. However, the council's mayor or vice mayor reported a population of around 40,000 with 3,000 were reported by the local council to be at risk of sea level rise, as they live close to the front. Marsalforn's council reported that the area hosts 900 residents with just a few being at risk to sea level rise. The council did not provide exact figures, so it is unclear what these "few" numbers represent.

In Q5 (Table 4.3), local councils were asked whether a 3.5mm of annual sea level rise poses a threat to the town's local population and economy. Gżira and St Julian's councils believe that this rate (especially in the future) is a threat to the town's population and economy since both towns are low lying. The remaining three localities Sliema, Xlendi, and Marsalforn do not think that such small increments will pose a threat to the town in any way. In addition, Gżira and St Julian's councils were asked to provide reasons on how they think a 3.5mm of annual sea level rise will affect their towns. Both councils confirmed that coastal flooding will be a major issue. Currently, when coastal flooding occurs (mostly due to surge events in high tide) these towns experience significant disruptions especially where transport is concerned. When major roads

flood, they become inaccessible or extremely dangerous to drive through, public transport and private cars seek alternative routes and this in turn creates massive traffic jams and congestions. In some cases, vehicles end up driving in one-way streets causing accidents, which further aggravates the problem. During flooding events, damages are caused to the infrastructure, residential and commercial property creating several disruptions in the locality both to the residents and to the business sector. Some of these incurred damages were reported to be expensive to repair.

In Q6, the councils were asked if they have ever identified sea level rise hotspots within their locality. Xlendi's council was the only council that did not identify such hotspots. This is quite surprising especially when accounting for the magnitude of coastal flooding Xlendi experiences during storms due to its location at the bottom of the valley. However, all five local councils stated that they have seen signs of sea level rise and storm surge flooding (Q7).

Q8 is a follow-up question of Q7 in which the councils were asked how often their locality experiences coastal flooding from sea level rise (Figure 4.5). St Julian's council stated their locality experiences sea level rise quite frequently throughout the year. Gżira and Marsalforn councils stated that sometimes their locality does experience sea level rise. Sliema's council claimed that sea level rise alone rarely happens while interestingly, Xlendi claimed that their town has never experienced any sea level rise.

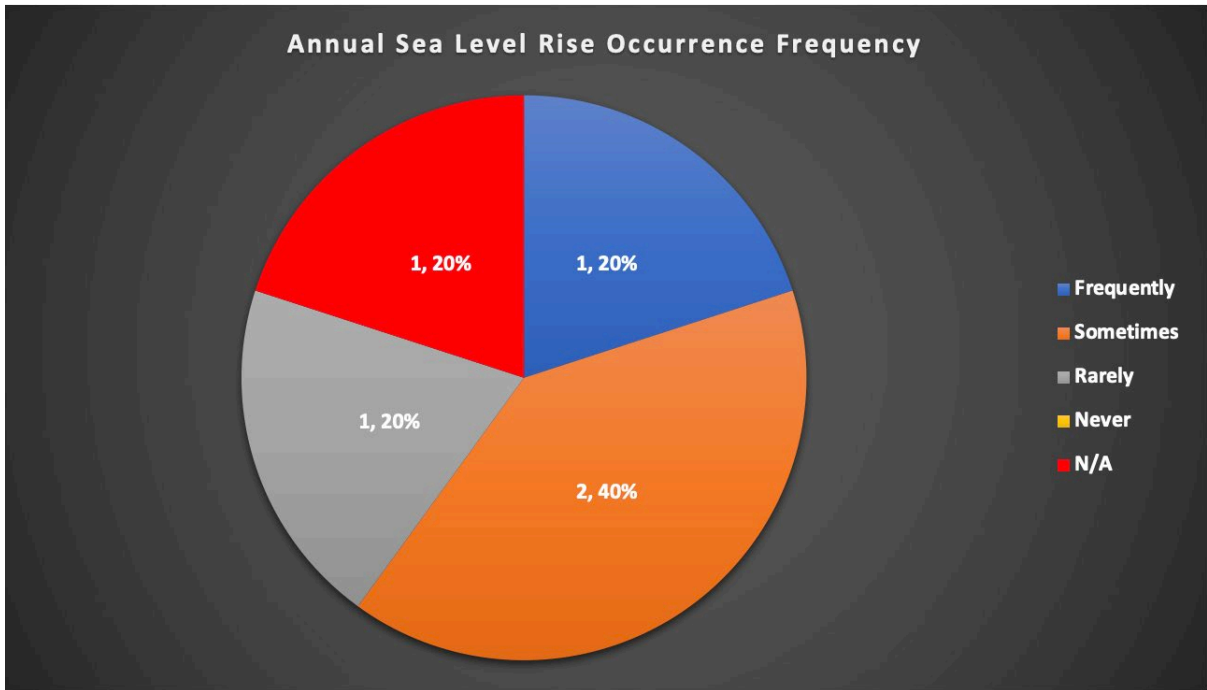


Figure 4.5 – Sea level rise occurrence frequency.

This question is a follow-up question of question 7 where the councils were asked to provide “frequency” - how often their locality experiences sea level rise and storm surge flooding. Figure 4.6 exhibits the frequency of sea level rise within the localities. St Julian’s council stated their locality experiences sea level rise quite frequently throughout the year. Gżira and Marsalforn councils stated that sometimes their locality does experience sea level rise. Sliema’s council claimed that sea level rise alone rarely happens while interestingly, Xlendi claimed that their town has never experienced any sea level rise.

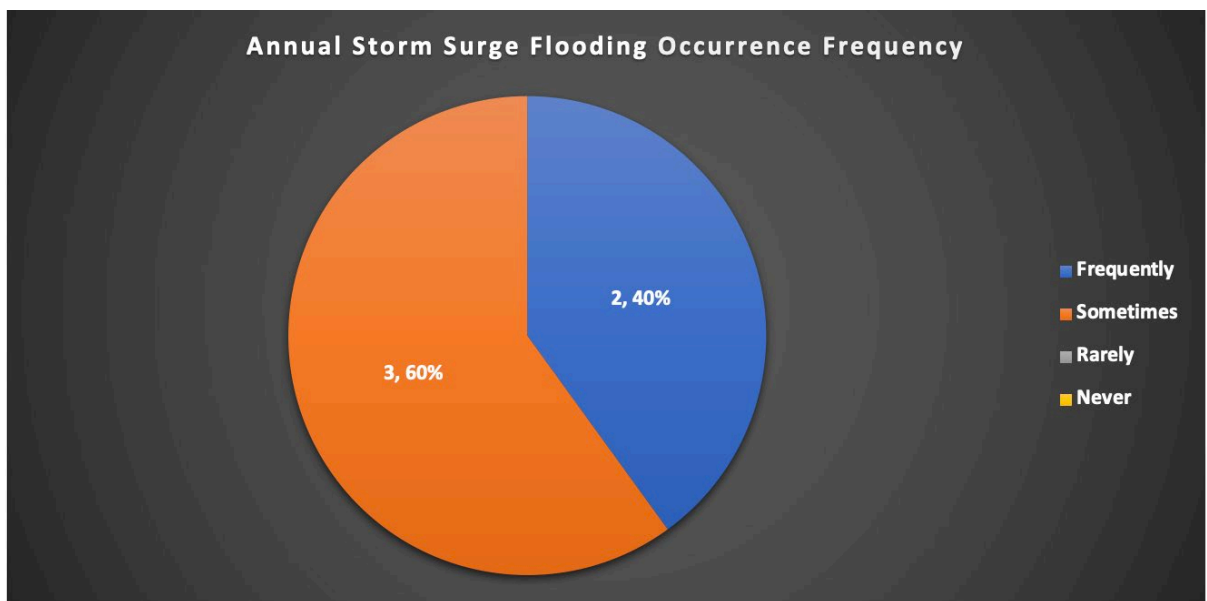


Figure 4.6 - Localities storm surge flooding frequency

In Q9, local councils were asked whether there were any significant disruptions in their respective towns if sea level rose or storm surge flooding occurred. All councils agreed there were significant disruptions in their towns with Table 4.4 below lists each locality's own disruptions.

Table 4.4 – Question 9B local council disruptions.

Disruptions	Councils
Flooding	All
Traffic Disruptions	Gżira, Sliema, St Julian's, and Xlendi
Damages	Sliema, St Julian's, and Xlendi
Life Disruptions	Gżira, and Sliema
Accessibility	Gżira, Sliema, and Xlendi
Business Disruptions	Gżira, and Marsalforn.

The first and most obvious disruption was flooding which was common in all five localities. Traffic congestion was reported by Gżira, Sliema, St Julian's and Xlendi. This is due to road flooding within the locality, which causes heavy traffic congestions as public and private commuters seek alternative routes. Damages were reported by Sliema, St Julian's, and Xlendi. According to the local councils, after a major flooding, their towns sustain significant damages to public infrastructure, business establishments and residential properties. Damages to public infrastructure include road surfaces (in some instances flooding removed asphalt), sizable potholes, trees chopped off and land upon roads (impeding traffic flow), benches and pavements along promenades and drainage infrastructural damages.

Accessibility and life disruptions are interlinked as one impacts on another in a cascading manner. Gżira and Sliema reported life disruptions to its residents as well as to the Maltese and foreign population that visit these localities. When flooding occurs, people would not be able to walk along the promenade and would not be able to wait for public transport as bus stops become inaccessible. In Gżira and Xlendi, it was reported that accessibility to residential houses and commercial businesses is a challenge as water blocks the entrances and residents/shoppers' risk of being swept away by the current. The final disruption was reported by Gżira and Marsalforn where both councils reported that businesses would have their operations impeded and in the case of Marsalforn, restaurants just close for the duration of the event.

In Q10, the councils were asked what effects they think their town will experience due to sea level rise. Gżira's and Xlendi's councils claimed that everything that occurs within the town will be affected as both localities are designated as low-lying areas. St Julian's stated that the major impact of sea level rise would be public infrastructure, commercial establishments, and private property damages. Sliema's council reported that they envisage public infrastructural damages such as water mains, electric cables, pavements, roads, and drainage systems followed by a drastic drop in property prices due to frequent flooding. For Marsalforn's council, their main concern is real estate, where they believe that there will be a sharp downward trend in property values as few would buy/rent property in their town.

In Q11, local councils were asked if they have any infrastructure at risk from sea level rise. Interestingly, Gżira and St Julian's reported that they have no infrastructure at risk, while Sliema, Marsalforn, and Xlendi reported that they have. Again, Gżira and St Julian's both reported that they suffer from sea level rise and storm surge flooding, but they also acknowledged that currently, no infrastructure is at risk. Sliema reported that street furniture such as benches, bins, bollards, street lighting posts and other standing pillars are all at risk. Marsalforn reported road and street lighting furniture like Sliema along with damages to the pier. Xlendi also reported road and street lighting furniture but also added boat yards and public toilets. From an environmental perspective, the council reported that sea level rise will cause significant damages to the trees and underlying soil resulting in their death due to saline intrusion.

In Q12, local councils were asked if they have recently implemented any measures to help mitigate the effects of sea level rise on their town. St Julian's and Xlendi claimed that no measures exist, while Gżira, Sliema, and Marsalforn claimed that such measures do exist. The second part of this question asked the council what measures have been put in place and an estimate of their financial cost. Gżira's council, reported that these measures are still at a planning stage, therefore they cannot quantify exact costs as it is part of a larger governmental project called the "Gżira Gardens". The council is aiming to achieve sea level rise and storm surge flooding mitigation once the project is concluded. As for Sliema, the council conducted scientific studies on sea level rise and storm surge flooding impacts within the town. Pertaining to any other major project, the council is not responsible and is shifting

responsibility to central government due to its lack of available resources. As for Marsalforn, the council was very active in upgrading current infrastructure to mitigate coastal flooding. The council upgraded its current roads to withstand sea level rise and storm surge flooding and is hoping that this measure will mitigate flooding. In addition, they also redesigned streetlight fittings to withstand flooding, so that they do not sustain any damages. The cost of both these measures was approximately €150,000.

In Q13, the local councils were assessed whether any government entity informed them on sea level rise and storm surge flooding. Marsalforn is the only council who claimed that they were informed while the rest of the localities claimed to have never been contacted. Q14 assessed the council's preparedness for such an eventuality by asking if any contingency plans exist. Gżira and Xlendi reported that they don't while Sliema, St Julian's, and Marsalforn reported that such plans are already in place, but no further details could be given on these plans.

In Q15, the local councils were asked whether they organized any meetings with the locality's business community and residents to discuss sea level rise and storm surge flooding. Sliema and Marsalforn reported that such meetings have never taken place while Gżira, St Julian's and Xlendi reported that they have. Gżira organized a public consultation to discuss and hear any suggestions with regards to the Gżira Gardens project. The public was encouraged to voice their opinions and suggest any improvements to the current plan. St Julian's council organized a meeting to discuss, listen to opinions, concerns, and improvements on its community projects that the council proposed to the central government to mitigate sea level rise and storm surge flooding. The proposed project was the construction of wave buffers in the middle of the bay as this measure is expected to significantly contribute to lessen wave strength during storms. In turn, this will reduce damages to land infrastructure, business, and sporting establishments that are currently being decimated during every severe storm. Xlendi's council also engaged with its community during meetings held pertaining the day to day running of the council, current issues and future projects were discussed. This enhances cooperation between the council and its community as the latter could voice their concerns about current issues, enabling the local council to update its current risk assessment. It also serves for a public consultation on any future projects the council has in the pipeline.

Q16 provides a land use availability assessment within the locality. Since all the localities are designated as low-lying coastal towns, each council was asked whether they have available land that they could use for social development in case current social amenities such as schools, police station, medical clinics, churches and so on will no longer be usable due to sea level rise. Sliema, Xlendi, and Marsalforn reported that land is available, while Gżira, and St Julian's reported that there is not. For both these localities, sea level rise and storm surge flooding could pose a credible threat as if such infrastructure listed within the question above are no longer usable, major concerns are raised that the locality would be missing critical infrastructure.

In Q17, local councils were assessed on whether they have any plans to protect their town from future sea level rise. Gżira, St Julian's and Xlendi claimed that plans have been drawn up, while Sliema and Marsalforn did not. Gżira, St Julian's and Xlendi were asked to provide more details of what these plans involve. According to Gżira's council, their plan is to completely redesign the whole promenade to withstand current and future sea level rise projections along with plans for rainwater to be redirected so that the promenade will not flood.

St Julian's reported that they will request and put pressure on the central government to implement their wave buffer proposal. Xlendi has a plan to assess the effects of building dams in the valley as a reduction measure to reduce flooding volume at the end of the bay. The council is advised to account for sea level rise in their planning, as dams constructed along the valley, despite having strong potential, are only limited to rainwater flooding. Sliema also explained why no plans exist; the council does not have the required expertise or financial backup to draw up and implement any short or long-term plans and the means to maintain them. The council is completely reliant on the central government for the necessary expertise and financial support. The financial constraints do not even enable the council to employ full time professional researchers to study the effects of sea level rise and storm surge flooding on the locality. According to the council, for such a study to be conducted, it needs to be on a voluntary basis, which leaves them with no options but to be entirely reliant on the central government.

The final question, Q18, asked the councils whether their business community suffered and reported any damages. The only council that reported no claims from their business community was Gżira whilst its neighbouring locality, Sliema, did report damages. This could be for a few reasons such as not reporting the damages to the local council and that the waves reaching Gżira, which is situated in less exposed part of Marsaxmett Harbour would have been relatively less impactful. The follow up question was to examine what damages were sustained and what support was provided. According to St Julian's, Sliema, and Marsalforn, their business community did not receive any support from the council as the council lacks the necessary resources to provide the required aid to their business community. As for Xlendi's council, their business community reported that they sustained infrastructural damages. The council did not report if they provided businesses with any support.

4.4.3. Key Findings

Sliema, Marsalforn, and Xlendi's councils do not think that with current sea level rise projections of around 3.5mm per year, sea level rise is a threat to the town's economy and local population, while Gżira and St Julian's do think it is a threat. All councils except Xlendi identified sea level rise hotspots within their locality. Gżira and St Julian's reported that they do not have any infrastructure that are or will be at risk to sea level rise while the remaining councils reported that they do. Gżira, Sliema, and Marsalforn reported that in recent years the council did implement mitigation measures to reduce the effects of sea level rise within their town while St Julian's and Xlendi reported that no such measures have been implemented. When the councils were asked if any government entity informed their council about this phenomenon, all councils except Marsalforn reported that to date, they have not been informed. Gżira, St Julian's, and Xlendi's councils reported that they organized meetings with their town's business community and residents discussing the effects of sea level rise on the town while Sliema and Marsalforn reported that to date, no such meetings took place. Gżira, St Julian's, and Xlendi's councils reported that they do have plans to protect their town against sea level rise while Sliema and Marsalforn reported that no such plans exist.

4.5. Presentation of Results: Coastal Businesses

4.5.1. Introduction

This section presents the two set of results of coastal businesses' assessment (i) the elevation and height profile for locality itself along with its own height profile graph including a trendline to assess where the area is increasing or decreasing in elevation. In addition, the spatial distribution of coastal businesses according to their height above sea level in the form of elevation maps which are located around 1-3m above sea level and (ii) the results of the interviews with business owners.

4.5.2. Spatial Distribution of Coastal Businesses: Location and Elevation

i. Gżira

Gżira's coastline hosts a large spread of coastal businesses from different sectors, mostly concentrated within the elevation range of between 0-36 meters (Figure 4.9). The business distribution is quite linear following the Gżira waterfront area and therefore, all the businesses are exposed to fairly the same marine risk conditions related to sea level rise and storm surge flooding. Since height above sea level and their orientation is uniform, then, exposure from specific waves approaching from a specific bearing can only be varied by other elements such as the presence of Manoel Island. All the businesses in the image below are in the lighter color bracket of a 0-1m above sea level elevation; thus, these businesses are designated as high risk to coastal flooding due to the fact they are operating in a low-lying area to a maximum of 50 meters away from the sea.



Figure 4.7 - Gzira's Height Profile (Source: Author, (2021)).

Figure 4.7 blue line indicates the cluster of businesses operating along the coastline in a linear exposed pattern. The green dots represent elevation above sea level at specified intervals.

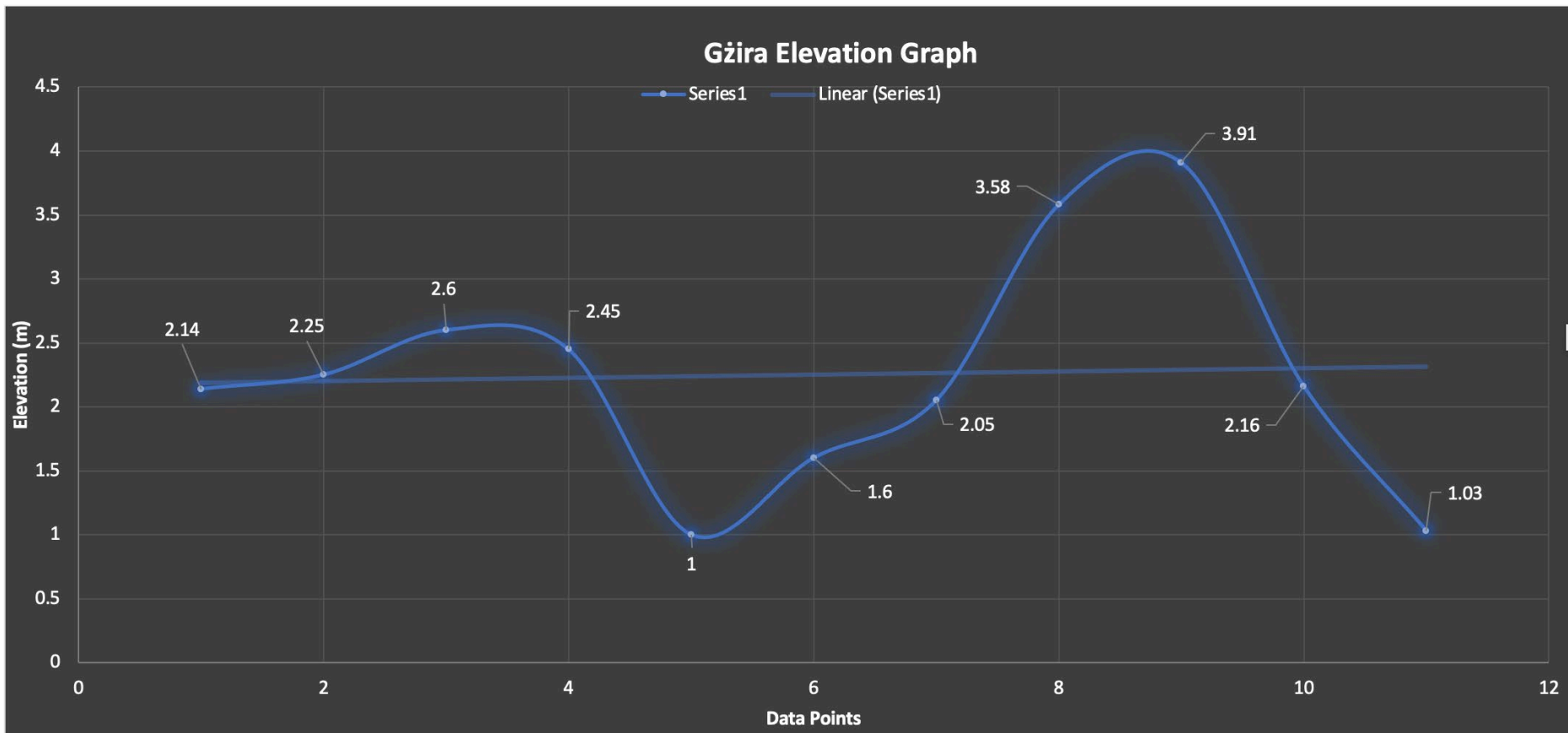


Figure 4.8 - Gżira height profile graph (Source: Author, (2021)).

Figure 4.8 represents Gżira's elevation height profile shown in Figure 4.7, which according to the trendline, is slightly increasing in height, despite major elevation fluctuations. As one can see, the highest elevation point recorded on the profile was at 3.91m whilst the lowest was at 1m.

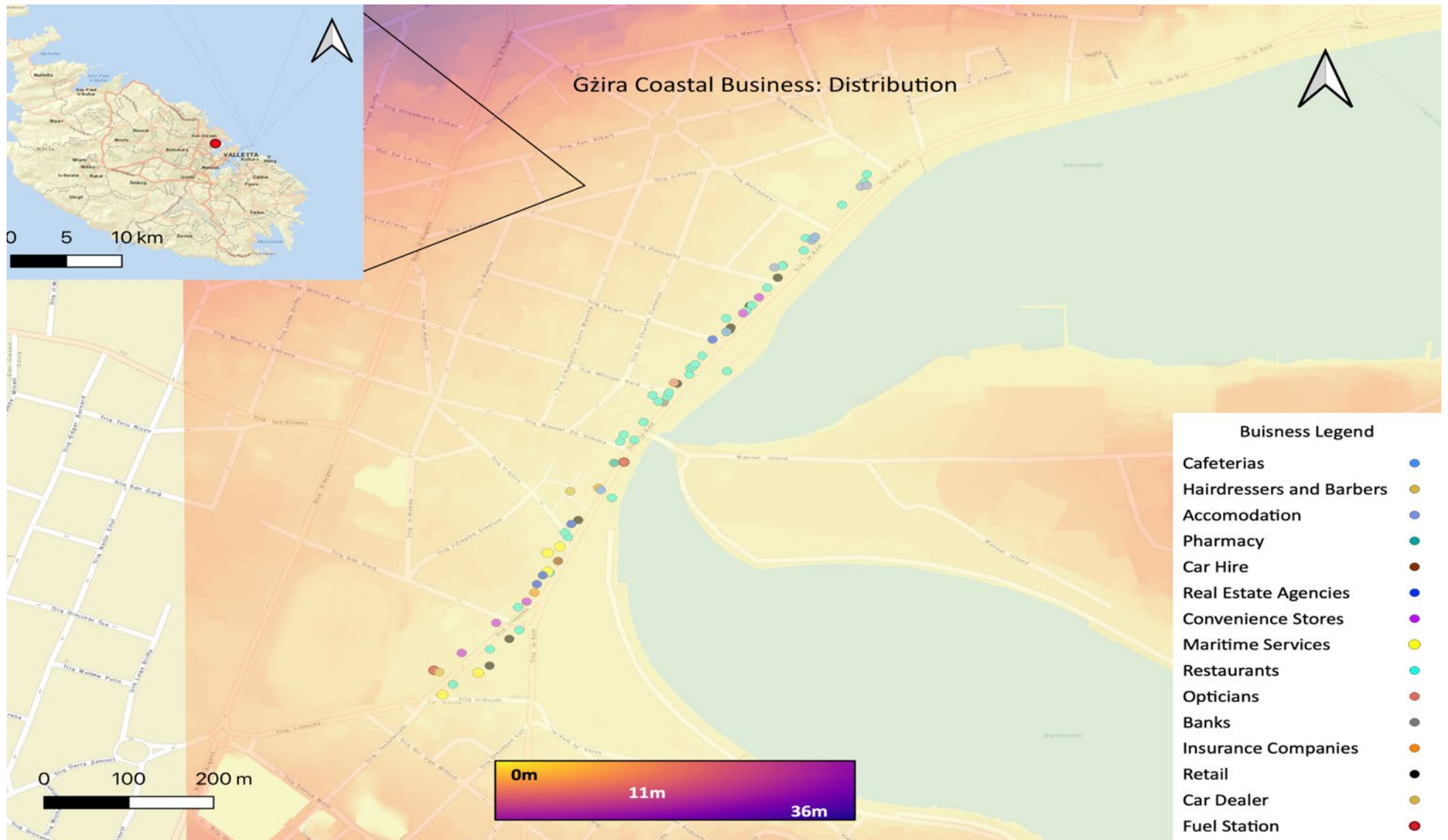


Figure 4.9– Gzira Coastal Business: Distribution (Source: Author, (2021))

All the businesses in the above image (Figure 4.9) are in the lighter color bracket of a 0-1m above sea level elevation; thus, these businesses are designated as high risk to coastal flooding due to the fact they are operating in a low-lying area.

ii. Sliema

Figure 4.12 represents Sliema's coastline which hosts a high number of businesses from different sectors and are mostly concentrated within the elevation range of between 0-15 meters. The business distribution is quite linear, meaning that all the businesses are exposed to fairly the same conditions. Most of the businesses are located at an elevation of around 0-1 meter above sea level, thus these businesses (hospitality, retail, financial and so on.) have been classified as high risk to coastal flooding due to their low-lying area and, like Gżira, these businesses operate maximum of 50 meters away from the sea.



Figure 4.10 – Sliema's Height Profile (Source: Author, (2021)).

The red line on Figure 4.10 indicates the cluster of businesses operating along the coastline. The turquoise dots represent elevation above sea level at specified intervals. Sliema is a major center for tourism, retail, financial services, and real estate with a high concentration of top-brands outlets and shopping centers.

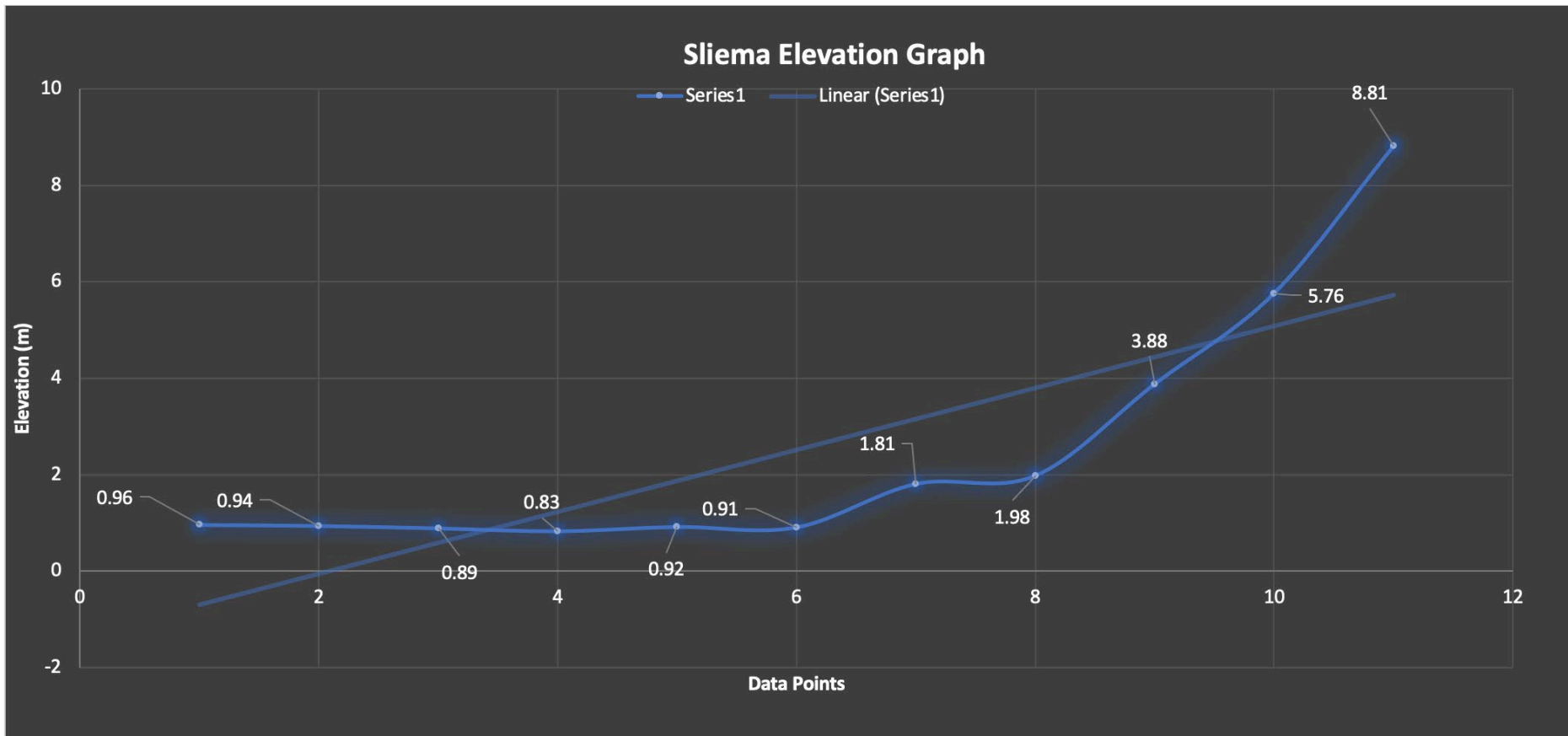


Figure 4.11 - Sliema's height profile graph (Source: Author, (2021)).

Figure 4.11 represents Sliema's elevation height profile shown in Figure 4.10 which, according to the trendline, is rapidly increasing in elevation. As one can see the highest elevation point recorded on the profile was at 8.81m whilst the lowest was at 0.83m.

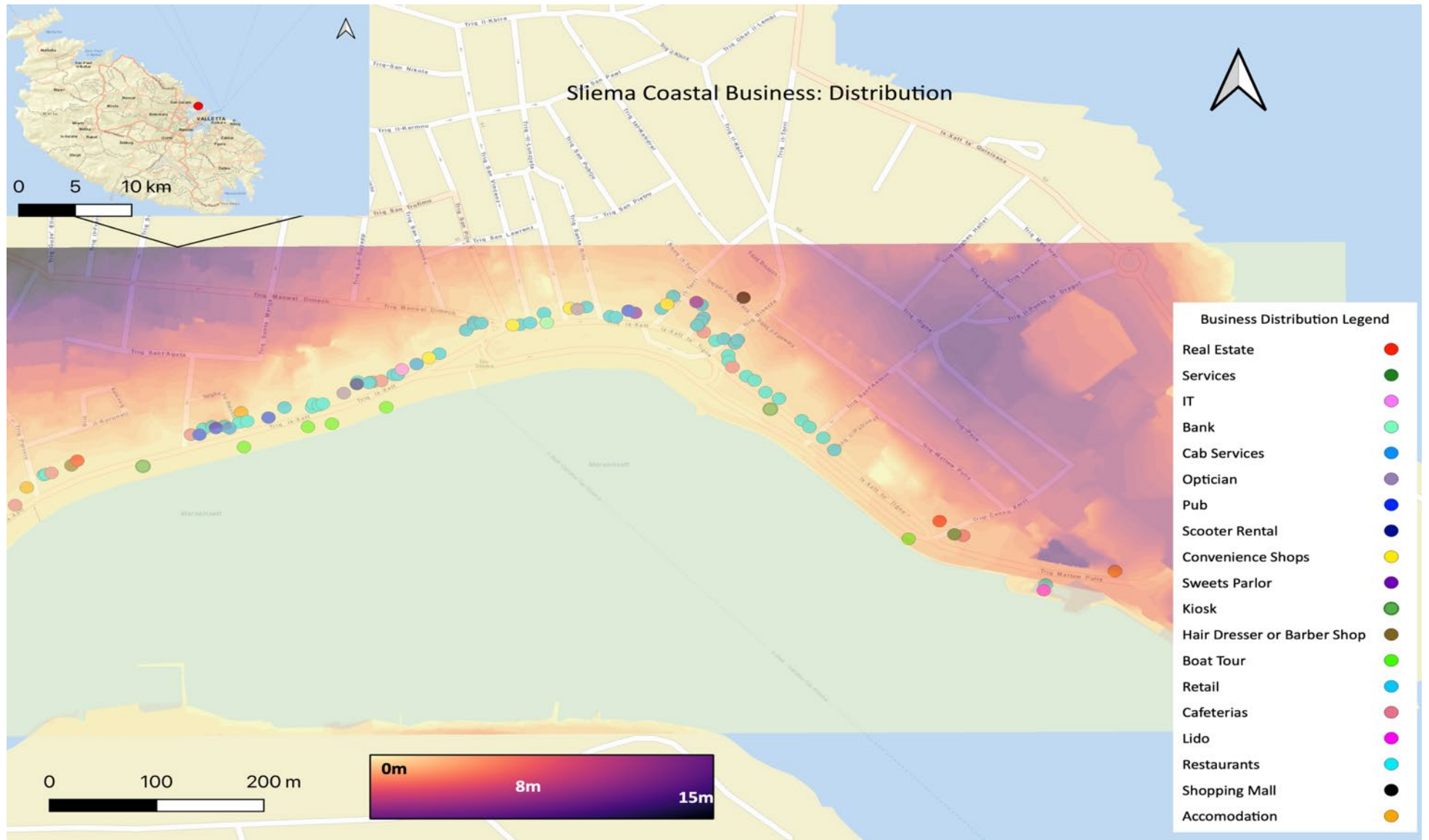


Figure 4.12 - Sliema's Coastal Business: Distribution (Source: Author, (2021)).

iii. St Julian's



Figure 4.13- St Julian's Balluta to Spinola Bay Area Height Profile (Source: Author, (2021)).



Figure 4.14 - St Julian's St George's Bay Area Height Profile (Source: Author, (2021)).

In Figure 4.13 and Figure 4.14 the orange line indicates the cluster of businesses operating along the coastline. The purple dots represent elevation above sea level at specified intervals. Most of the 5-star hotels in Malta are found in St Julian's, together with entertainment centers and it is the mecca for nightlife seekers. In Figure 4.13 businesses operate within a maximum distance of 30m from the coastline while in Figure 4.14 it ranges between 10-80 meters from the coast.

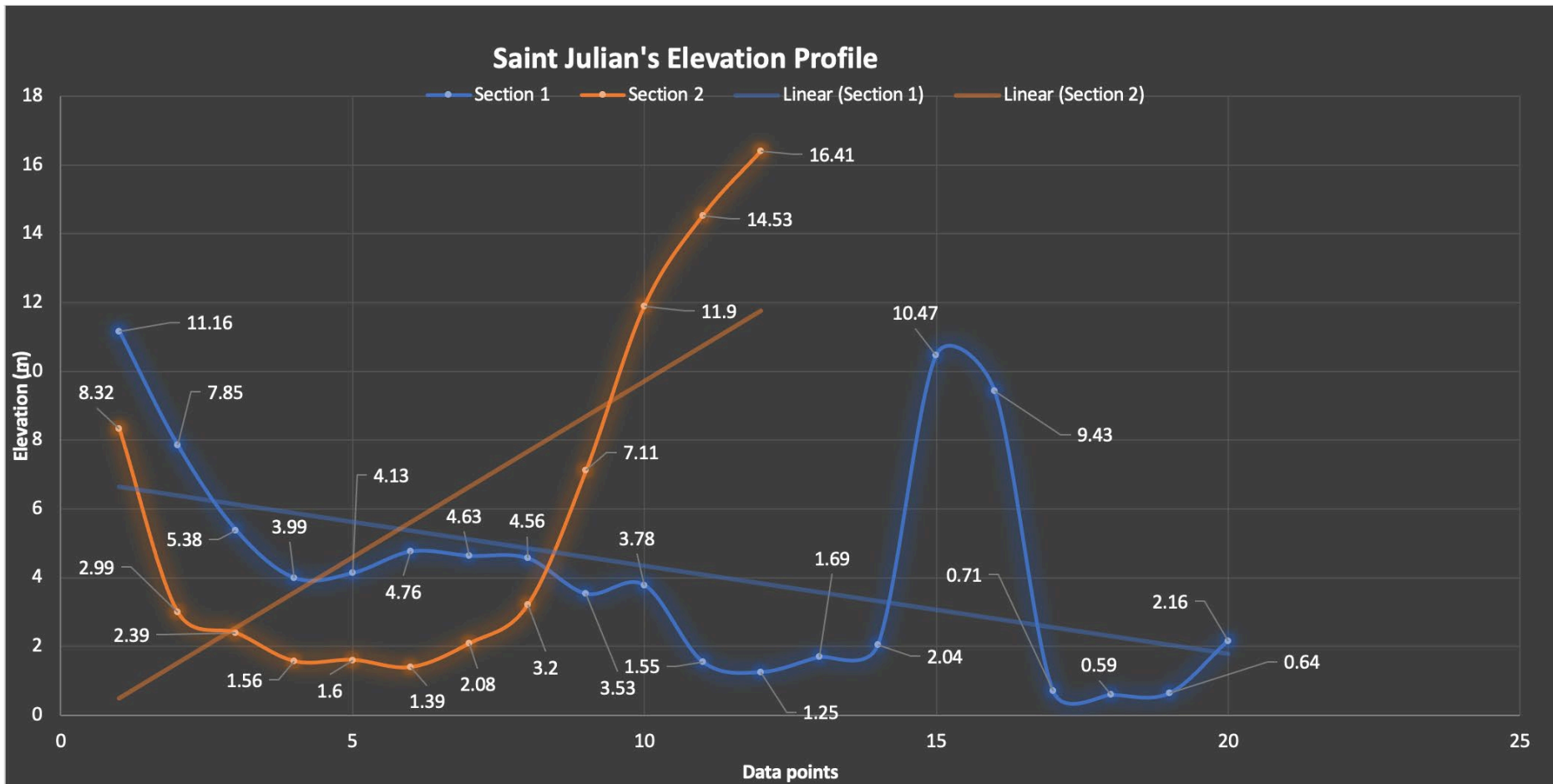


Figure 4.15 - St Julian's height profile graph (Source: Author, (2021)).

According to the trendline for section 1 (see Figure 4.15), the elevation is decreasing whilst in section 2 the elevation is rapidly increasing. The highest and lowest points for both profiles were recorded to be at 11.16m (profile 1) and 16.41m (profile 2) respectively, with the lowest reading at 0.59m for profile 1 and 1.56m for profile 2. Section 1 is represented by Figure 4.13 while Figure 4.14 represents section 2.

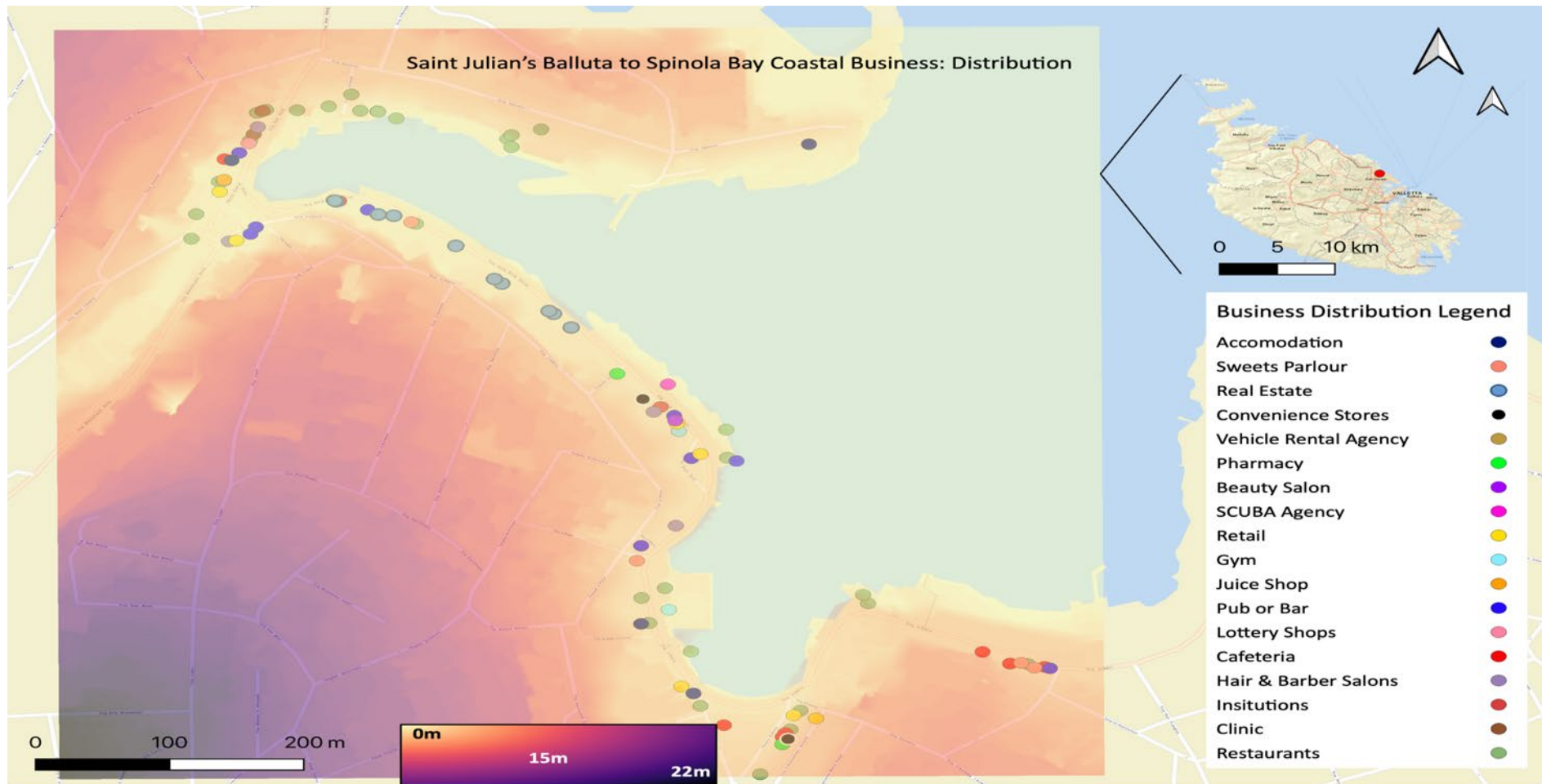


Figure 4.16 – St Julian's Balluta to Spinola Bay Coastal Business: Distribution (Source: Author, (2021)).

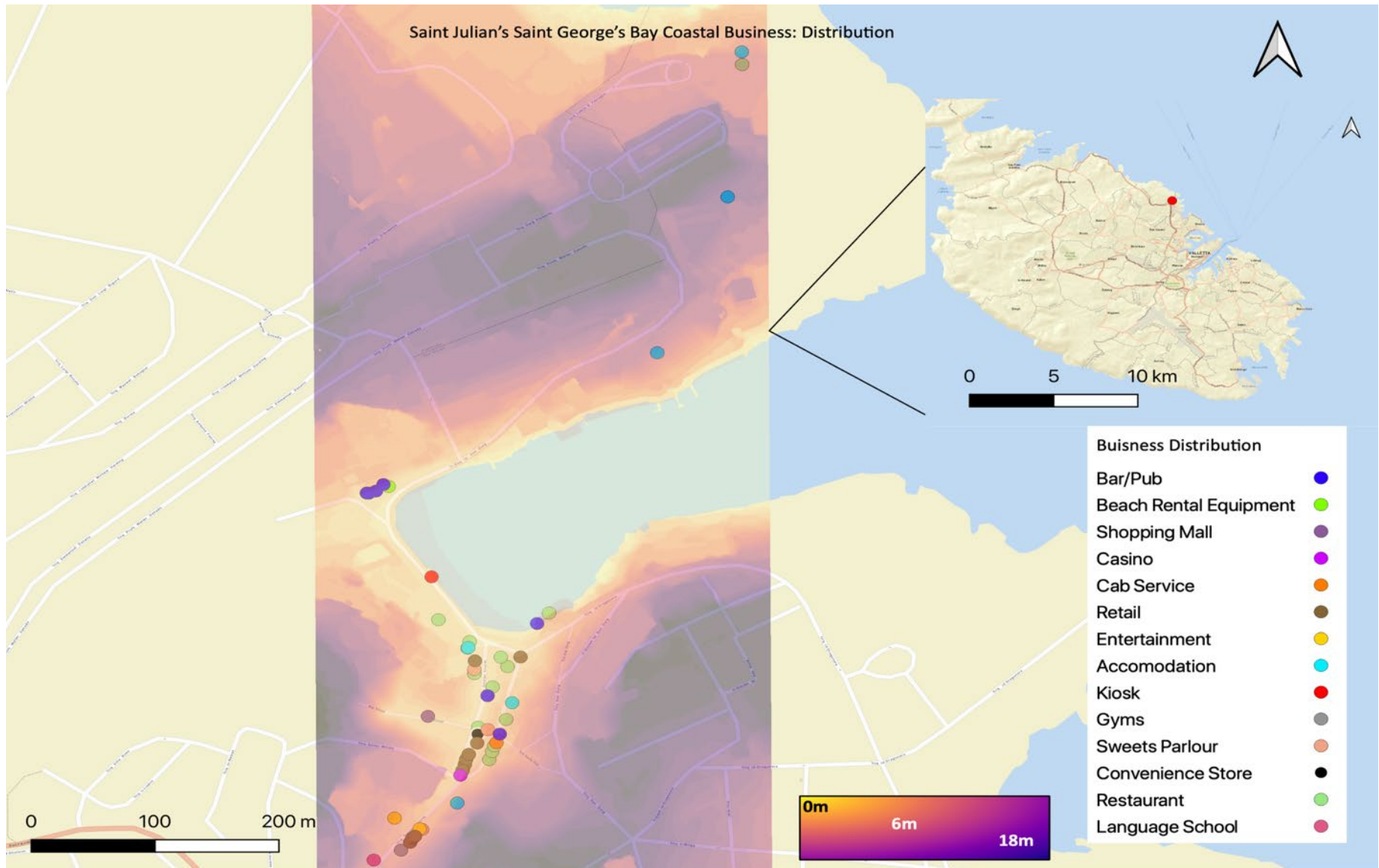


Figure 4.17 - St Julian's St George's Bay Coastal Business: Distribution (Source: Author, (2021)).

Figure 4.16 exhibits St Julian's Balluta to Spinola Bay while Figure 4.17 exhibits St George's Bay. Both coastlines include a high concentration of coastal businesses coming from varying sectors. Figure 4.16 had an elevation range of between 0-22 meters while Figure 4.17 ranged between 0-18m above sea level. The business distribution in Figure 4.16 is spread out across the coastline where the majority of businesses are in the lower elevation range, while in Figure 4.17, the distribution is quite linear with a high percentage of businesses being found in a small area within the research area. This area is quite low lying, as it is the end of a downhill and where the elevation above sea level is close to 0-1 meter. Both areas are exposed to the same climatic risk conditions, however it is important to mention that the businesses in Figure 4.16 have higher exposure as the area is slightly less protected than St George's Bay. Most of the businesses are in the lower range of elevation sea level, thus classifying these businesses as high risk to coastal flooding due to their low-lying area.

iv. Marsalforn

Marsalforn's coastline hosts a large spread of coastal businesses from different sectors with most of them situated within the first 0-10 meters above sea level elevation (Figure 4.20). The business distribution is quite linear and exposed to similar climatic risks as the bay lacks the adequate protection to protect its infrastructure, leaving the business community at the mercy of sea level rise and storm surge flooding. Many of the businesses are located at an elevation of around 0-1m above sea level thus classifying these businesses as high risk to coastal flooding due to their low-lying area and their approximate distance of 15m away from the coast.



Figure 4.18 – Marsalforn’s Height Profile (Source: Author, (2021)).

The green line (Figure 4.18) indicates the cluster of businesses operating along the coastline. The blue dots represent elevation above sea level at specified intervals. Marsalforn is extremely busy in the summer season due to an influx of tourists visiting the area, supplemented by the local and foreign population living in Malta and Gozo.

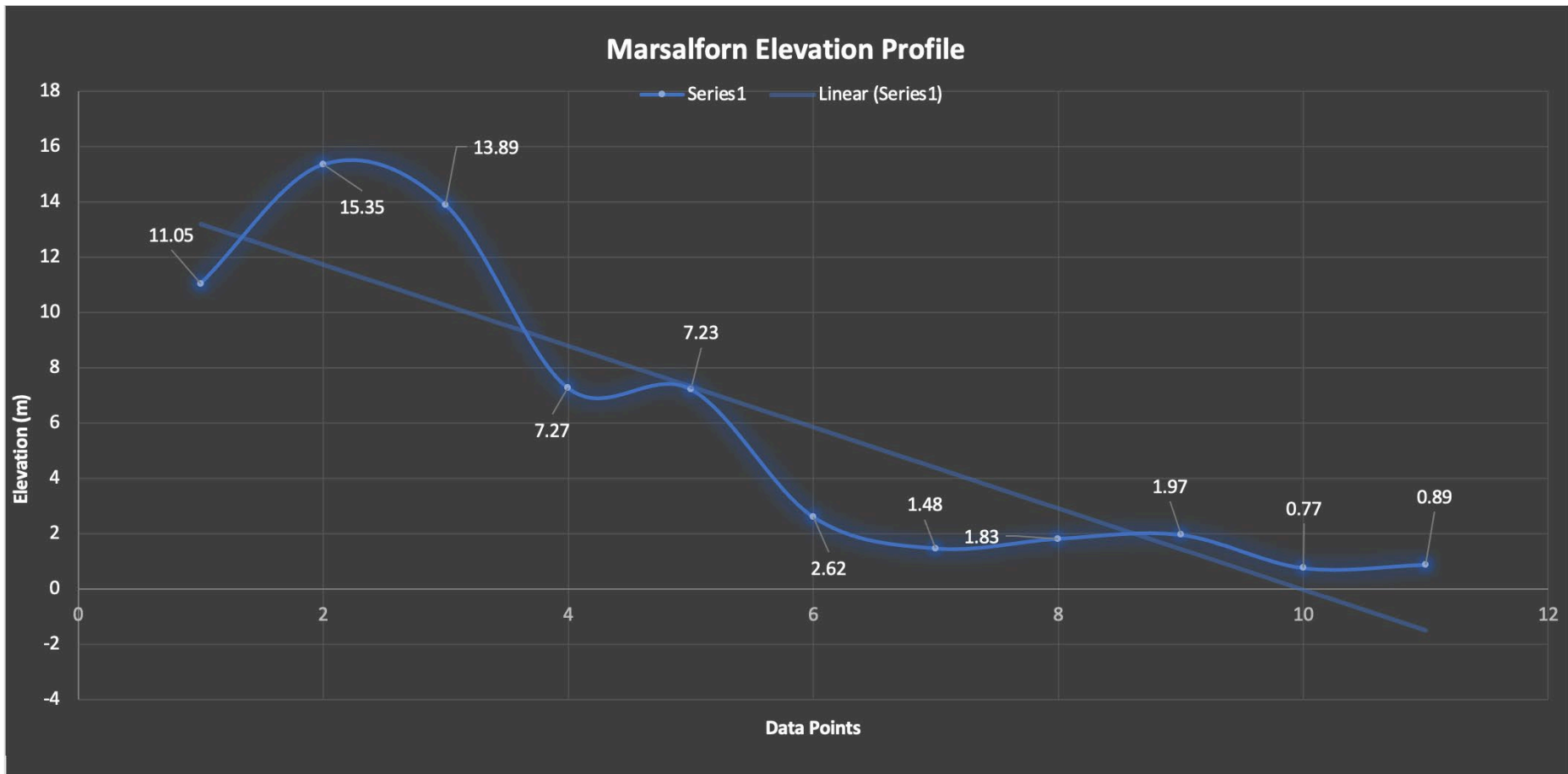


Figure 4.19 – Marsalforn’s height profile graph (Source: Author, (2021)).

Figure 4.19 represents Marsalforn’s elevation height profile shown in Figure 4.18, according to the trendline (Figure 4.19) the elevation is rapidly decreasing. The highest elevation point recorded on the profile was at 15.35m whilst the lowest was at 0.77m.

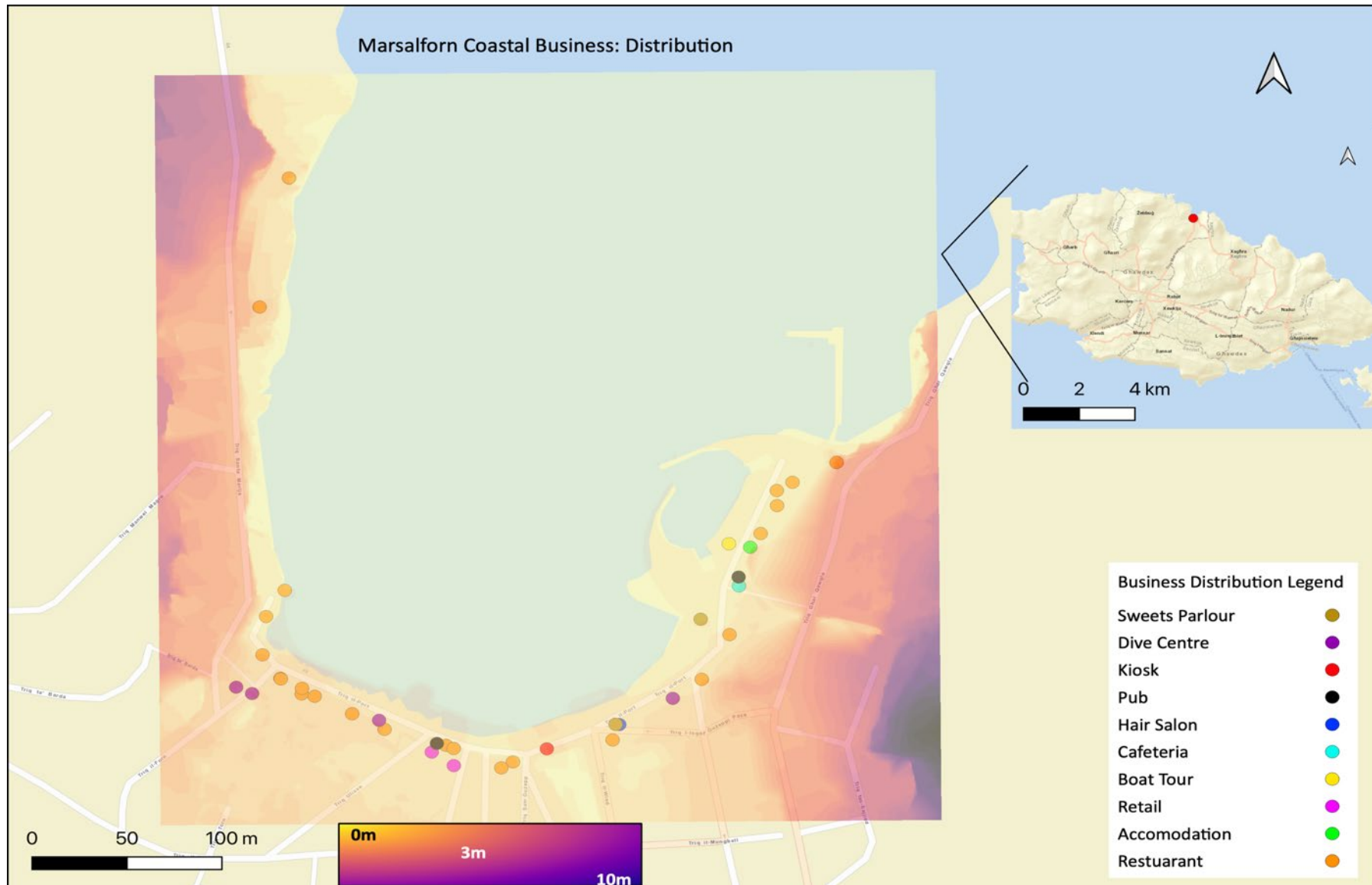


Figure 4.20 - Marsalforn Coastal Business: Distribution (Source: Author, (2021))

v. Xlendi

Figure 4.23 illustrates Xlendi's coastline which is home to a significant number of coastal businesses from different sectors and are located within the 0-34 meters above sea level elevation. The business distribution in the area is clustered, having a high concentration of establishments in a relatively small area. The bay itself is quite enclosed and adequately protected by natural topography for sea level rise, but it is quite prone to storm surge flooding. All business activity is located at an elevation of around 0-1m above sea level thus classifying these businesses as high risk to coastal flooding due to their low-lying area and their 10 meters maximum distance from the shore.

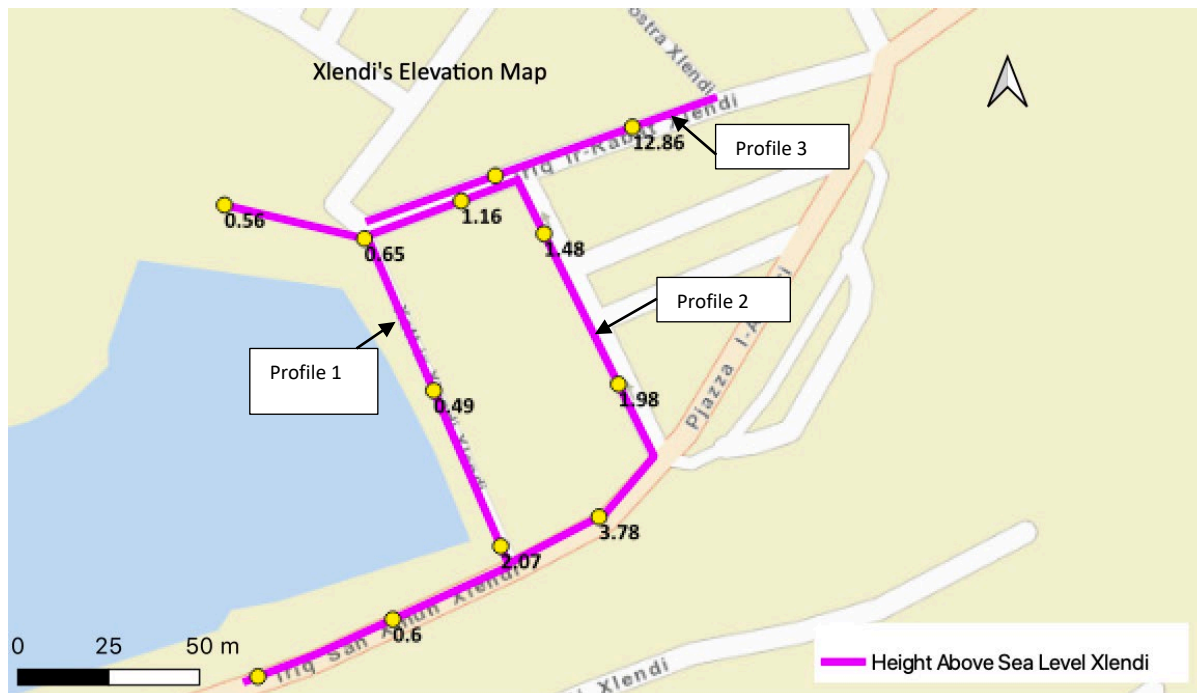


Figure 4.21- Xlendi's Height Profile (Source: Author, (2021)).

The purple line (see Figure 4.21) indicates the cluster of businesses operating along the coastline - an ideal location for research and data collection. The yellow dots represent elevation above sea level at specified intervals. Xlendi is extremely busy in the summer season due to an influx of tourists visiting the area, supplemented by the local and foreign population living in Malta and Gozo.

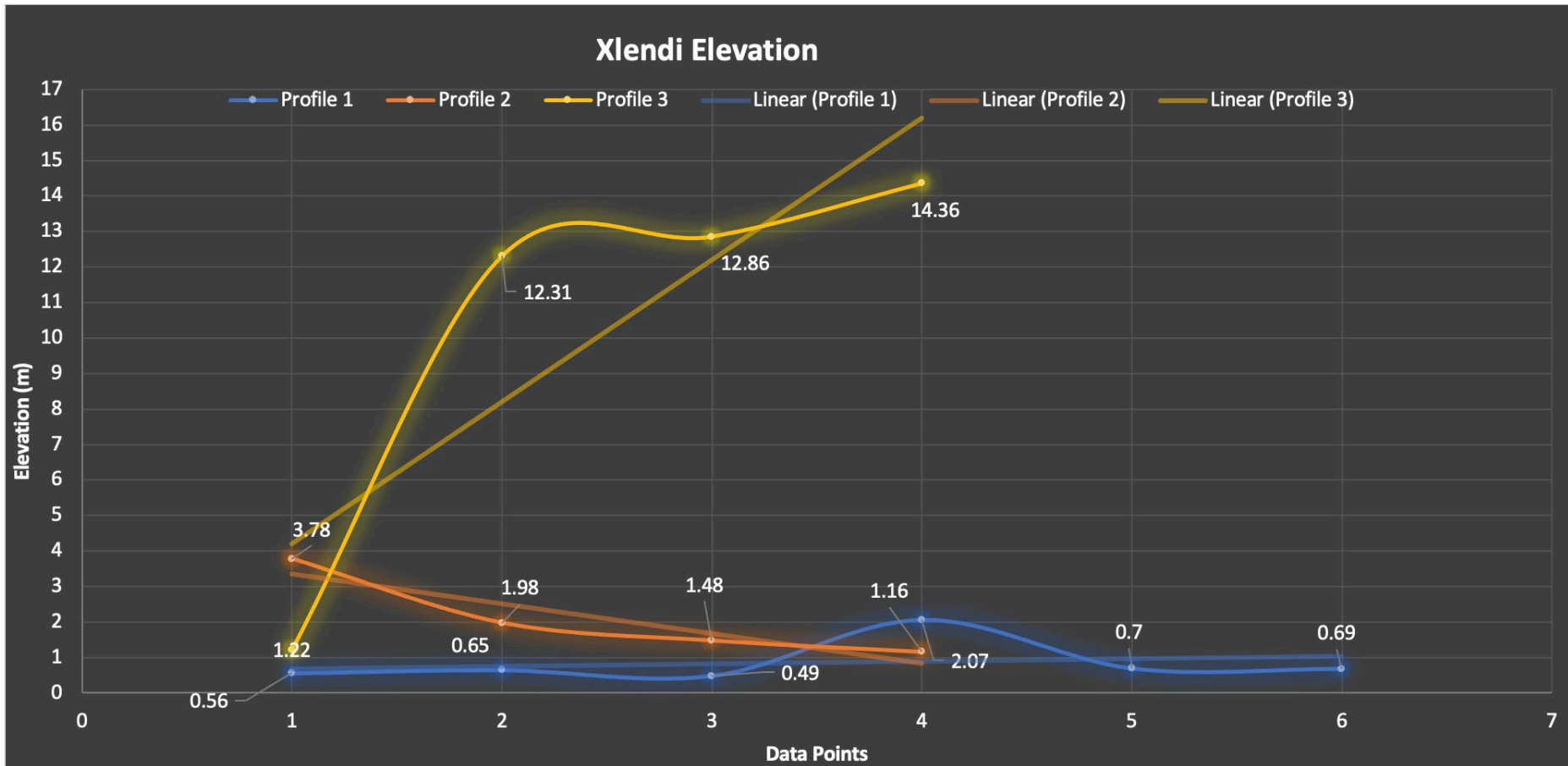


Figure 4.22 – Xlendi’s height profile graph (Source: Author, (2021)).

Xlendi’s area is split up into 3 profiles (see Figure 4.22); the first profile is colored blue, profile 2 is in orange and the third profile is in yellow. The trendline in profile one indicates that the elevation is slightly increasing, in profile 2 it is decreasing and in profile 3 it is rapidly increasing. The highest recorded points for all the profiles were 2.07m (profile 1), 3.78m (profile 2) and 14.36m (profile 3). The lowest points recorded were 0.49m (profile 1), 0.65m (profile 2) and 1.22m (profile 3).

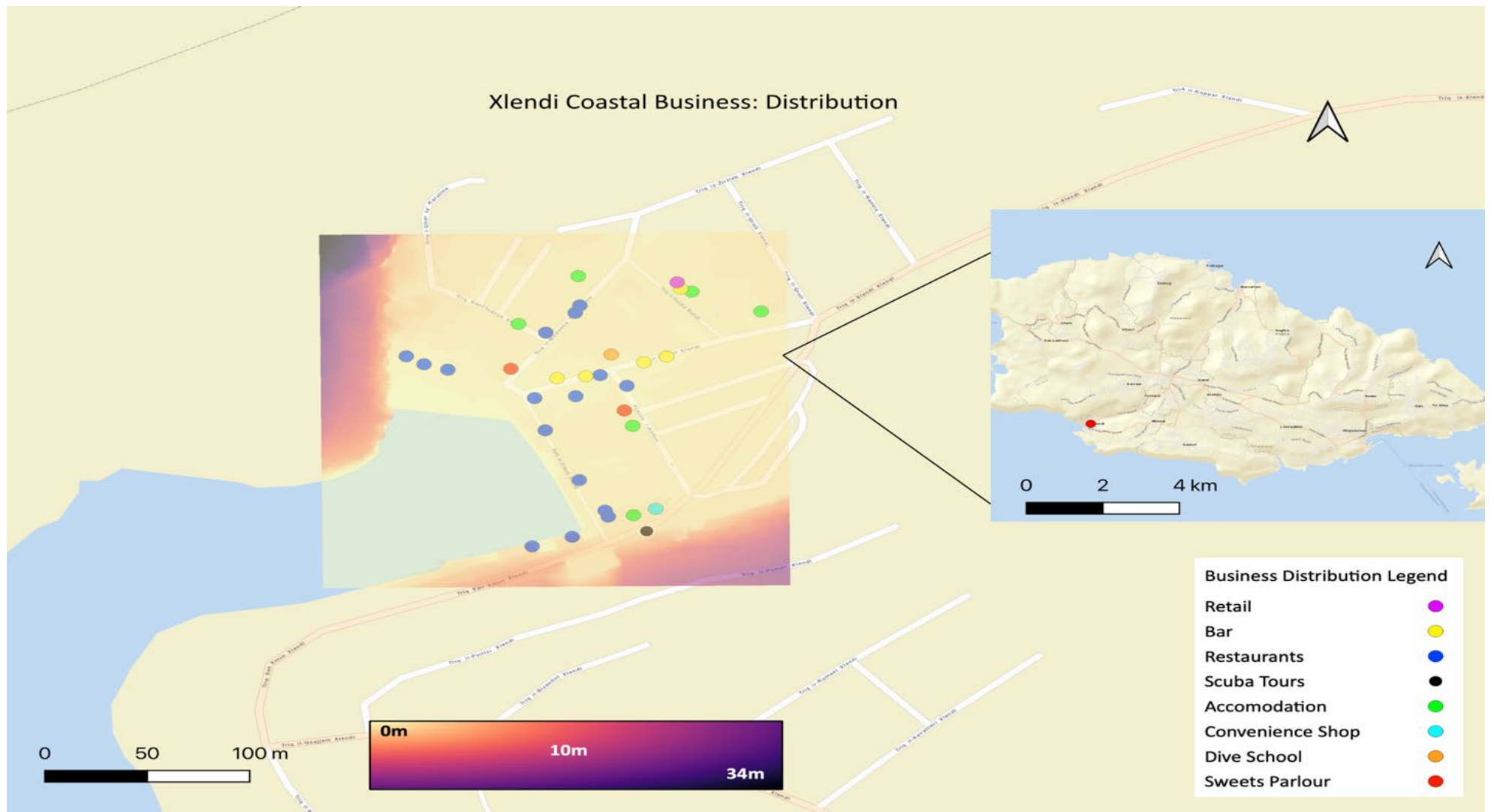


Figure 4.23- Coastal Business: Distribution (Source: Author, (2021)).

4.5.3. Results of Questionnaires

A total of 17 questions were asked to 160 business owners from the five selected localities (see section 3.6.3). Q1 assessed the owner's familiarity with the issues of climate change and its implications. The results show a large variety within and between the local councils in terms of the level of familiarity with the research topic.

Q1. How familiar are you with the issues of climate change and its implications?

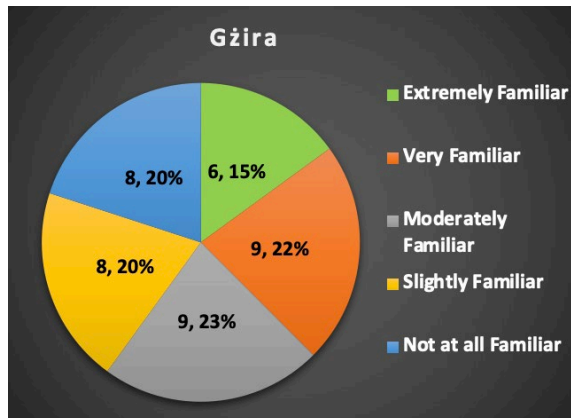


Figure 4.24 – Gzira Question 1 (n=40)

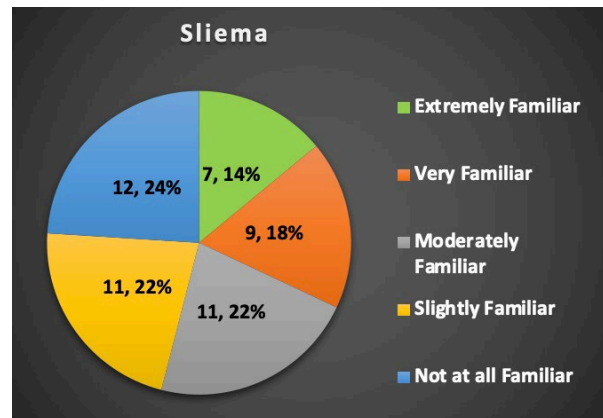


Figure 4.25 – Sliema Question 1 (n=50)

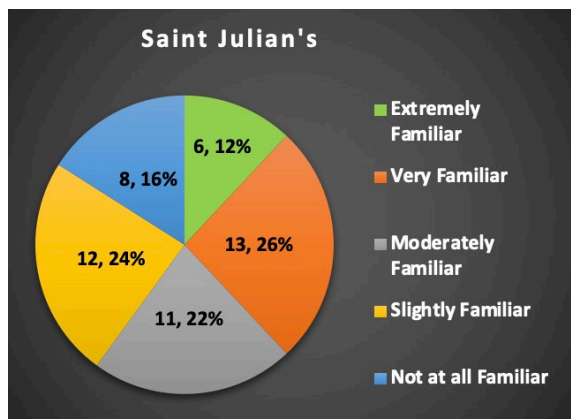


Figure 4.26 – St Julian's Question 1 (n=50)

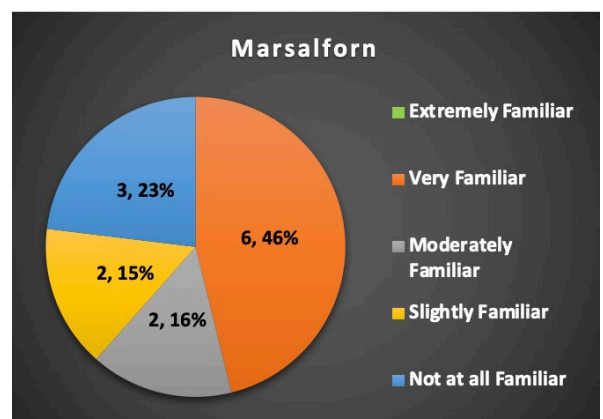


Figure 4.27 – Marsalforn Question 1 (n=13)

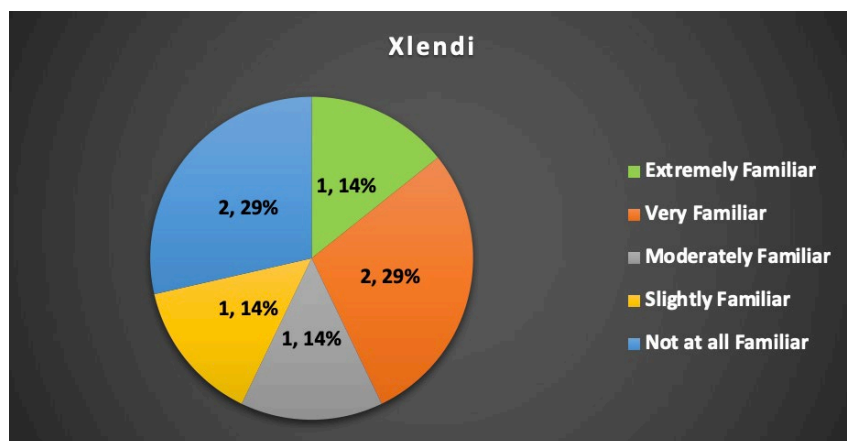


Figure 4.28 – Xlendi Question 1 (n=7)

Amongst the Maltese localities, the last two columns (slightly, and not at all familiar) consisted of more than 40 percent of their respective community while in Marsalforn the very familiar category included most of the businesses. Meanwhile, in Xlendi the last and top two categories were equivalent. It appears that Marsalforn’s community is more aware of with the issues and implications of climate change when compared to their Maltese and Gozitan counterparts.

Question 2 assessed the owner’s familiarity with coastal flooding in his/her locality.

Q2. How knowledgeable are you about coastal flooding (in your locality)?

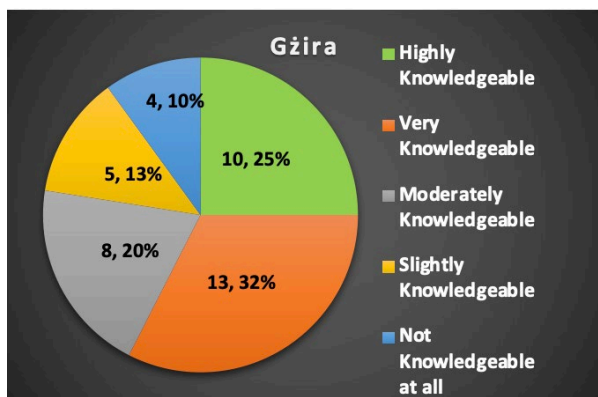


Figure 4.29 – Gżira Question 2 (n=40)

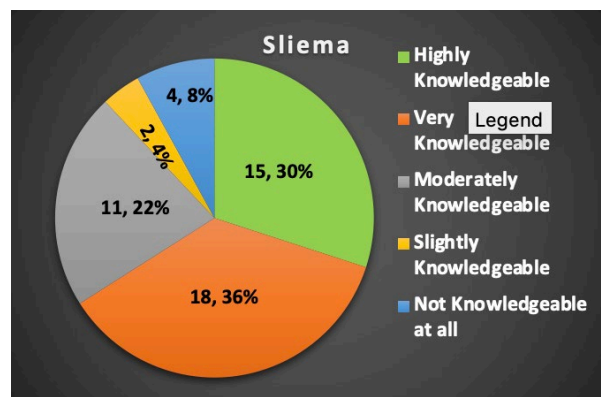


Figure 4.30 – Sliema Question 2 (n=50)

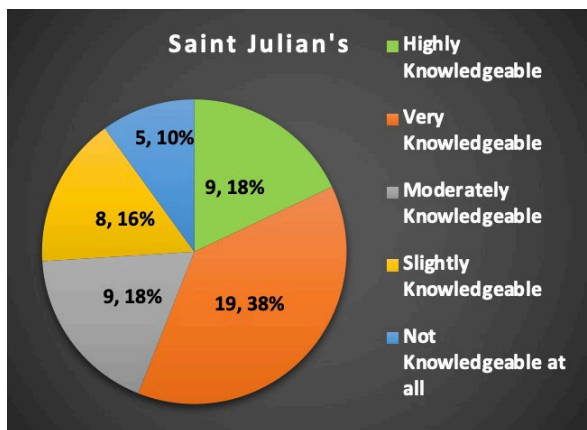


Figure 4.31 – St Julian’s Question 2 (n=50)

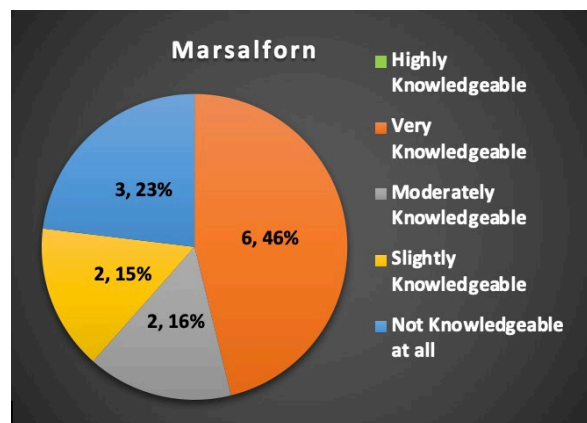


Figure 4.32 – Marsalforn Question 2 (n=13)

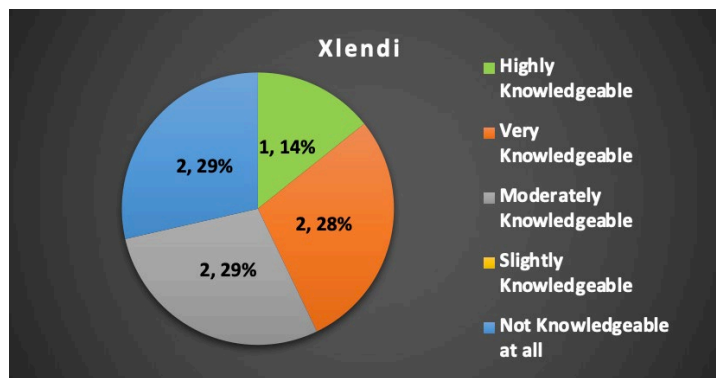


Figure 4.33 – Xlendi Question 2 (n=7)

It appears that a significant number of each locality’s business community are familiar with sea level rise and storm surge flooding within their locality, with Sliema being the most familiar. On the other side of the spectrum, for the last categories, smaller percentages were noticed for all localities with Marsalforn ranking as the highest locality as being most unfamiliar. This is possibly because the first question (Q1) was generic whilst the second question (Q2) was specific to their own locality; meaning that businesses are not that familiar with the global issues of climate change but are very familiar on local issues such as flooding. In fact, when comparing both questions, one notices a sizable shift from the lower end in Q1 to the upper end of the scale in Q2. This shift could be noticed in all Maltese localities while in Marsalforn it remained at equilibrium and in Xlendi, interestingly it was discovered there was a sizeable shift towards the bottom end of the spectrum.

Question 3 took an inventory of the sectors operating in each area along with those sectors that participated in the data collection.

Table 4.5 – Percentage results for Question 3: What sector does your business fall under?

Locality	Business Sectors					
	Accommodation	Catering	Retail	Services	Bank/Finance	Others
Gżira (n=40)	5% n=2	40% n=16	55% n=22	0%	0%	0%
Sliema (n=50)	0%	46% n=23	54% n=27	0%	0%	0%
St Julian’s (n=50)	12% n=6	54% n=27	34% n=17	0%	0%	0%
Marsalforn (n=13)	8% n=1	69% n=9	23% n=3	0%	0%	0%
Xlendi (n=7)	14% n=1	29% n=2	57% n=4	0%	0p%	0%

Amongst all the localities, Xlendi had the highest percentage of interviewed businesses in the accommodation industry, followed closely by St Julian’s, with the lowest being Sliema, where no hotel representatives were interviewed within this sample. Most of the businesses for all localities fall under the catering and retail industries. Within the catering industry such as restaurants, bars, pubs, cafeterias and so on, Marsalforn ranked the highest while Xlendi ranked the lowest. The retail industry was found to be in more than half of the sample for Gżira, Sliema, and Xlendi, with Xlendi being the highest and Sliema the lowest. St Julian’s and Marsalforn figures are relatively low when compared with the other three localities.

Question 4 assessed the owner’s awareness about whether he/she were aware with the risks associated with sea level rise and storm surge flooding when he/she established their current business.

Q4. Were you aware about the risk of sea level rise and possible coastal flooding when you opened your current business?

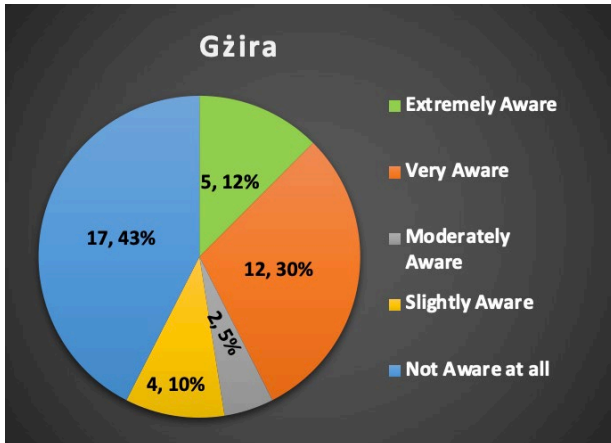


Figure 4.34 – Gżira Question 4 (n=40)

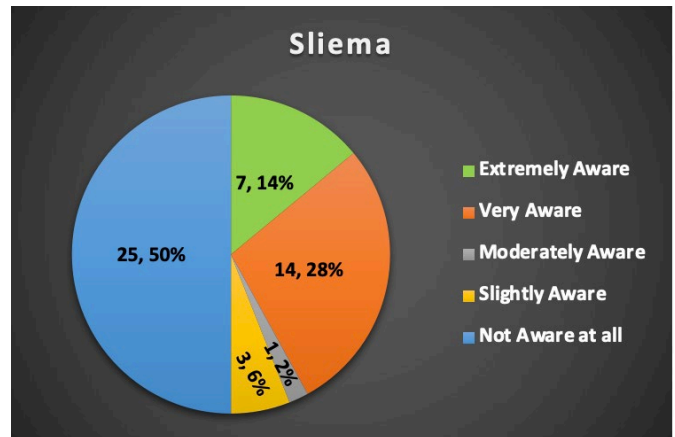


Figure 4.35 – Sliema Question 4 (n=50)

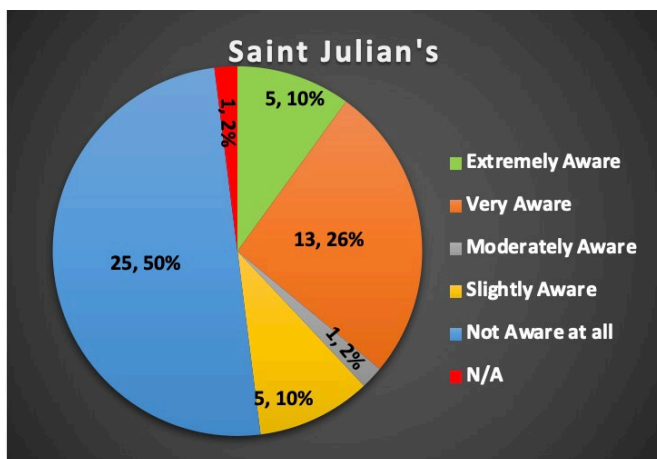


Figure 4.36 - St Julian’s Question 4 (n=50)

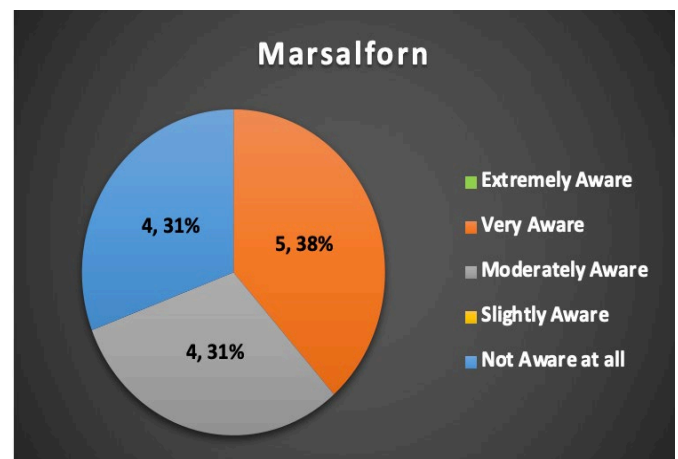


Figure 4.37 – Marsalforn Question 4 (n=13)

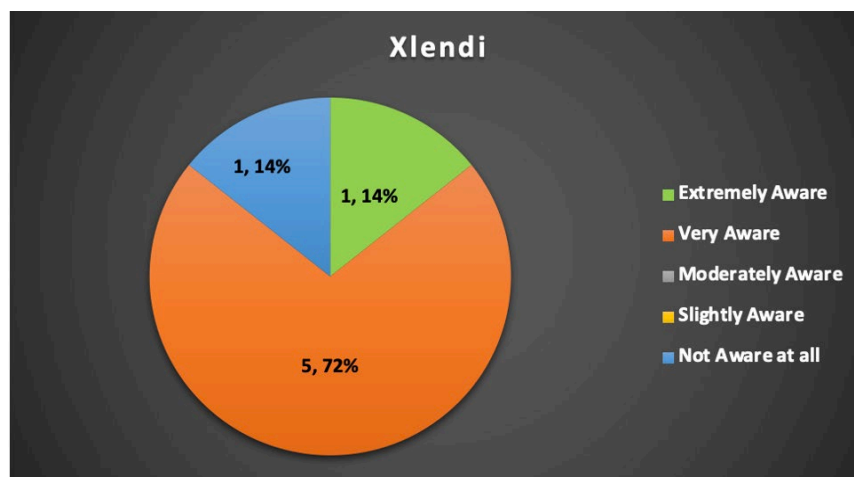


Figure 4.38 - Xlendi Question 4 (n=7)

Most of the Maltese business community in each locality fell under the unaware side, while in Marsalforn the 'very aware' category represented the largest number of businesses and in Xlendi, many of the businesses fell under the aware side. When comparing the first and last two categories of each locality, one notices that in all five localities, except Xlendi, the scale was tipped towards the unaware section, while in Xlendi more than 75 percent of the interviewed business community reported that they knew about such risk beforehand.

Question 5 assessed whether owners have recently experienced coastal flooding.

Q5A In recent years, have you experienced coastal flooding?

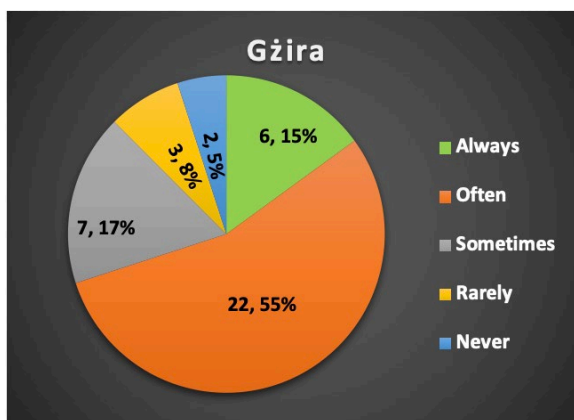


Figure 4.39 – Gżira Question 5 (n=40)

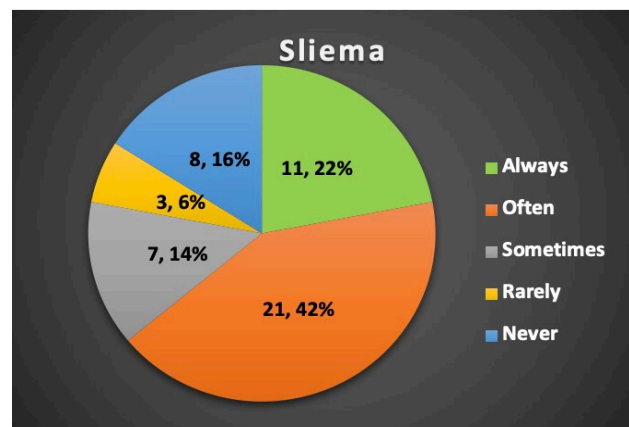


Figure 4.40 – Sliema Question 5 (n=50)

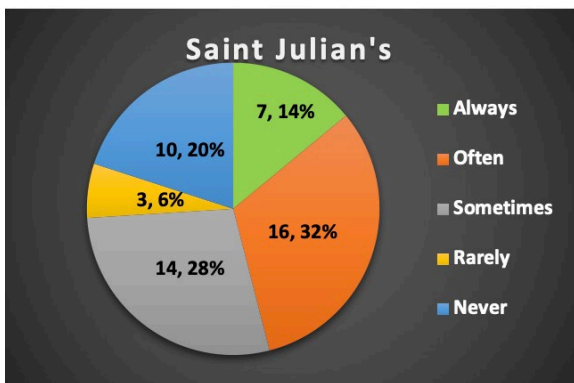


Figure 4.41 – St Julian's Question 5 (n=50)

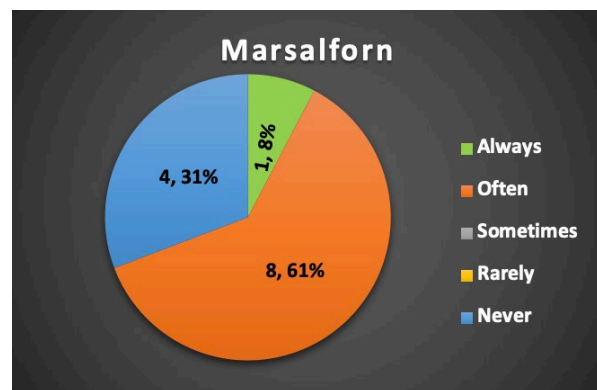


Figure 4.42 – Marsalforn Question 5 (n=13)

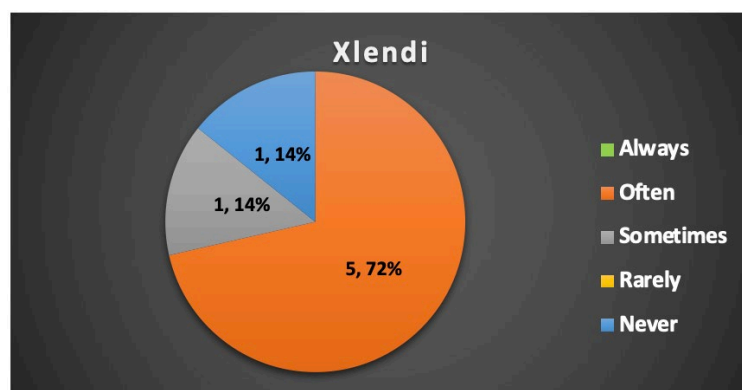


Figure 4.43 – Xlendi Question 5 (n=7)

Many businesses in all localities do experience flooding events: 72 percent of Xlendi's business community have reported that they do flood while St Julian's has the lowest percentage (46 percent) of reported cases. Such high numbers were expected as the chosen areas for this study are well known to be highly susceptible to flooding. When adding and comparing the first and last two categories, a marked reduction is noticed in all localities, with just a small minority reporting that they rarely or have never flooded. As for the businesses in the middle category, they reported that they do flood, although not often and only during powerful weather events.

In the second part of the question, the owners that answered in the top three frequent categories ("always", "often", "sometimes") were also asked to provide additional details of their experiences. All the damages and disruptions mentioned by the owners throughout the five localities are listed in Table 4.17. All owners who have responded to this question have experienced various levels of coastal flooding and as a result, suffered damages followed by significant financial burdens when repairing the sustained damages and ironing out the disruptions suffered. Amongst all the disruptions mentioned in Gżira, accessibility was an interesting indirect effect, as due to flooding, customers would not be able to reach their establishment as it was no longer accessible. In Sliema, another interesting point was brought up, that during such events, some businesses in the catering sector claim to work with reduced operational capacity, as they only use the indoor areas due to health and safety reasons. Most of the seating capacity of these establishment is found outside and not inside, so, when they close off their outside areas, they lose more than 50 percent of their overall customer intake, leading to a huge reduction in their daily sales and revenue.

Table 4.6 – Question 5 Reasons

Locality	Reasons				
Gżira	Flooding n=20	Business Disruptions n=30	Damages n=10	Preventive Measures n=3	N/A n=3
Sliema	Flooding n=19	Business Disruptions n=42	Damages n=4	Preventive Measures and Higher Elevation n= 2	N/A n=11
St Julian's	Flooding n=9	Business Disruptions n=23	Damages n=10	Safety Precautions n=6	N/A n=11

Marsalforn	Flooding n=2	Business Disruptions n=4	Damages n=6		N/A n=5
Xlendi	Flooding n=2	Business Disruptions n=7	Damages		N/A =1

All reasons provided in Table 4.6 work interchangeably as the first three columns are common in each locality. The difference was in the fourth column amongst the Maltese business community. Gżira’s and Sliema’s business community claimed that they employed their own preventive measures (see Table 4.19), although these effects are classified as short term. Additionally, in Sliema, some establishments said that they are lucky to sit on a higher elevation due to land topography, thus they do not flood. In St Julian’s, businesses reported that they took safety precautions to protect their customers and employees from flooding hazards. As for the N/A column, there were businesses that declined to provide answers or were ineligible to answer this question. It is vital to note that by the time the establishment reopens at full operational capacity, the owner would have lost a significant amount of money while still having to pay daily overheads like rent, salaries, and utilities.

Question 6 assessed whether owners have ever envisaged that future sea level rise and storms would threaten their business.

Q6. Have you ever envisaged that future sea level rise and coastal flooding could threaten your business?

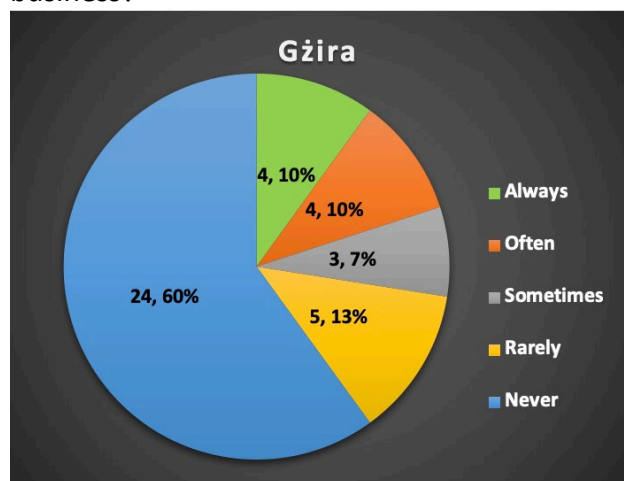


Figure 4.44 – Gżira Question 6 (n=40)

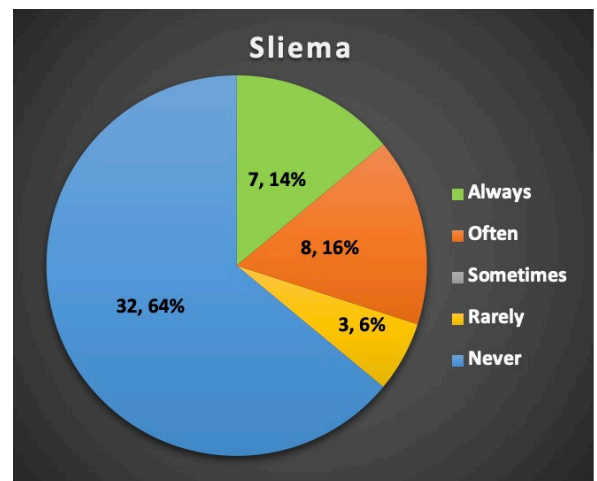


Figure 4.45 – Sliema Question 6 (n=50)

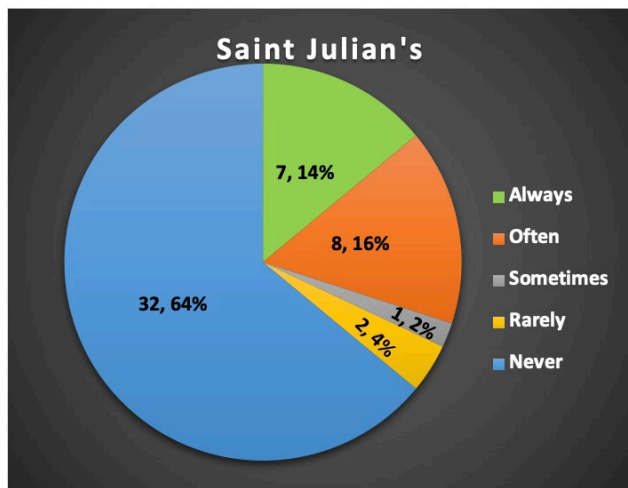


Figure 4.46 – St Julian's Question 6 (n=50)

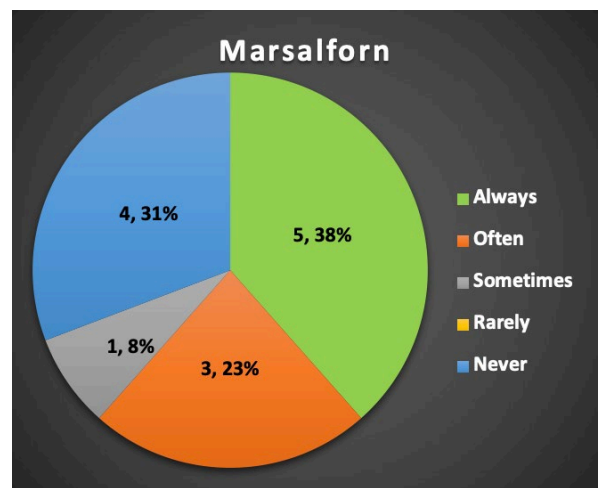


Figure 4.47 – Marsalforn Question 6 (n=13)

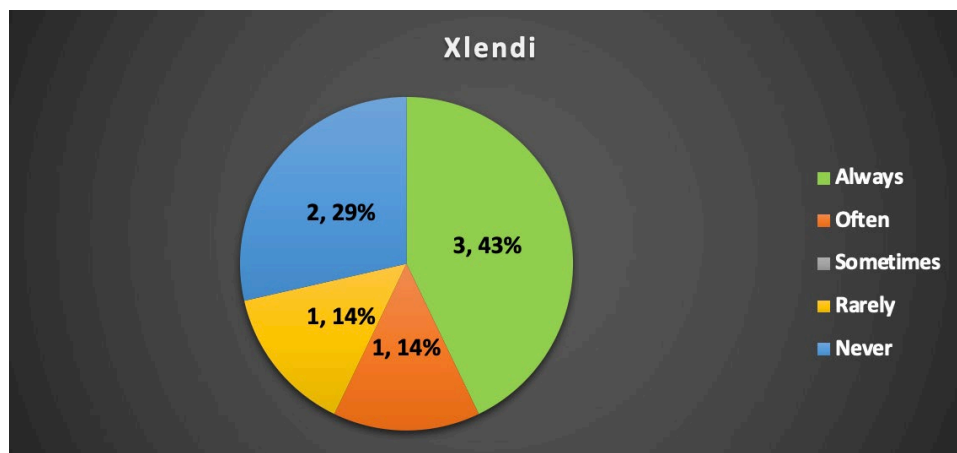


Figure 4.48 – Xlendi Question 6 (n=7)

Amongst the Malta localities, only a small percentage claimed to have foreseen such a threat while much of the business community in Gozo did envisage such a threat. There is a significant difference when comparing the first two and last two categories. Much of the Maltese business community did not anticipate such a threat; in Gozo that number is only a small minority.

In Question 7, the owners' opinion was assessed whether they think that sea level rise and storm surge flooding will affect their business.

Q7A. How likely do you think sea level rise and coastal flooding will affect your business?

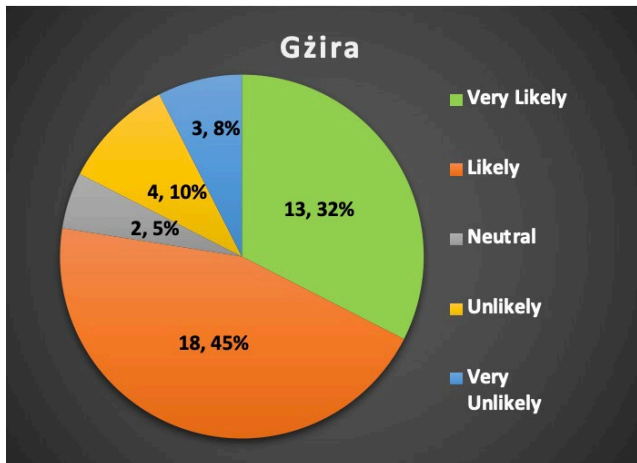


Figure 4.49 – Gżira Question 7 (n=40)

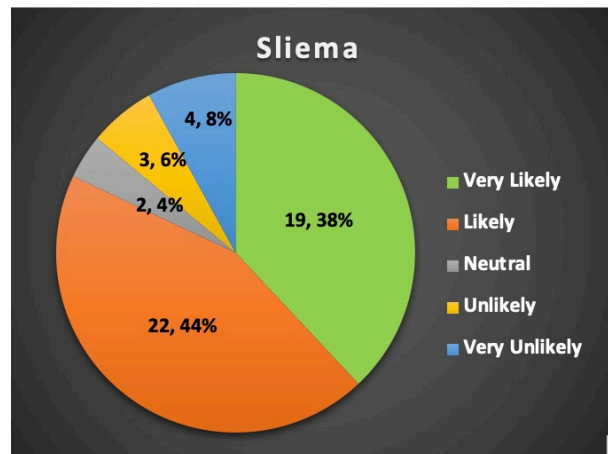


Figure 4.50 – Sliema Question 7 (n=50)

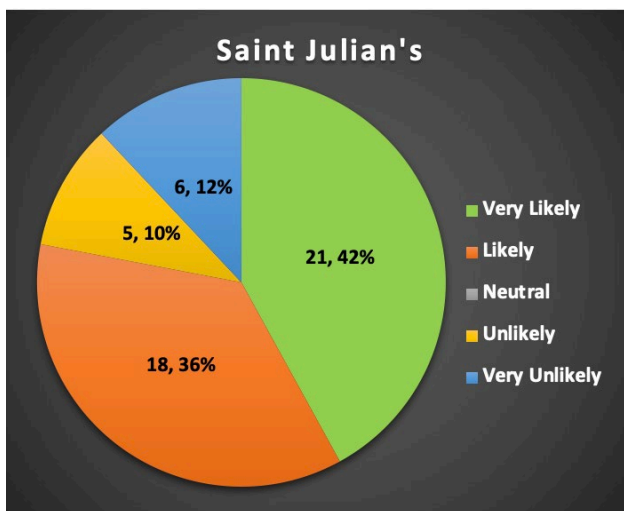


Figure 4.51 – St Julian's Question 7 (n=50)

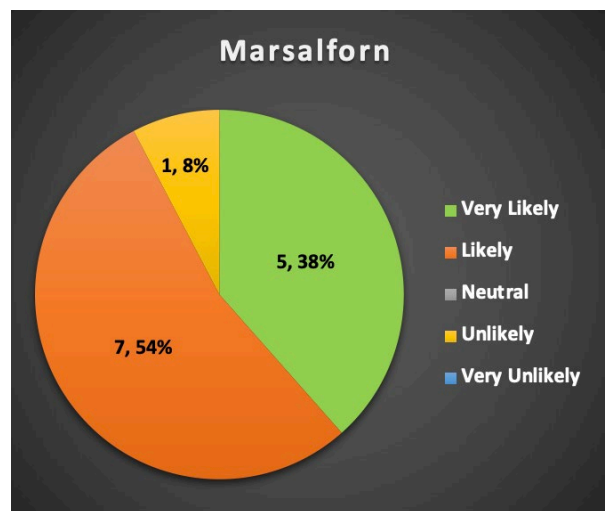


Figure 4.52 – Marsalforn Question 7 (n=13)

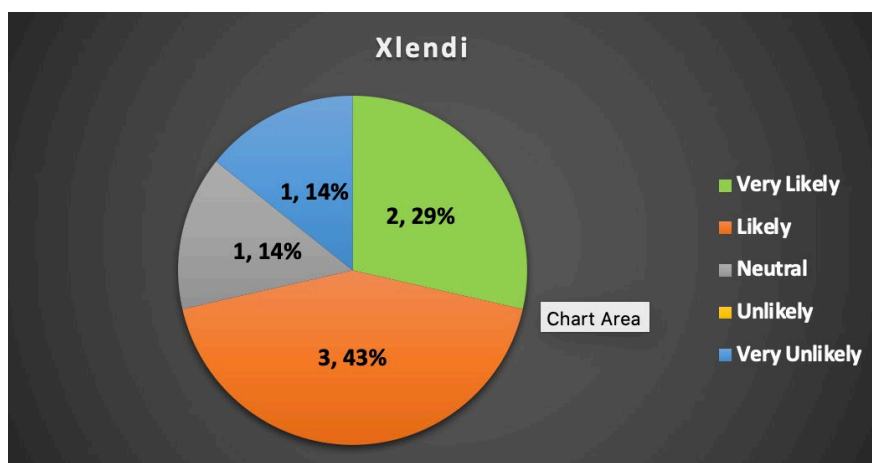


Figure 4.53 – Xlendi Question 7 (n=7)

Most of each business community agree that sea level rise and storm surge flooding will affect their business; note the high percentages, with St Julian’s having the highest minority percentage (weighing 22 percent of the sample). When analyzing this question, one notices that the businesses all agree that this phenomenon will affect their business regardless of the owner’s awareness and whether they knew about the risk beforehand.

The second part of the question asked those owners who answered in the top three frequent categories (“very likely”, “likely”, “neutral”) to provide their opinion on the way they think that sea level rise and storm surge flooding will affect their business.

Table 4.7 – Question 7 Responses

Locality		Responses			
Gżira	Flooding n=33	Business Disruptions n=4			N/A n=7
Sliema	Flooding n=39	Business Disruptions n=11			N/A n=12
St Julian’s	Flooding n=35	Business Disruptions n=6	Damages n=5		N/A n= 10
Marsalforn	Flooding n=10	Business Disruptions n= 5			N/A n=2
Xlendi	Flooding n=6			Bankruptcy n=1	N/A n=1

The first column was identified in each locality as all experience flooding during storm events, while business disruptions (see Table 4.17) was identified in all localities except Xlendi. In St Julian’s the business community provided an additional reason (see Table 4.17 for damages inventory), that of sustaining damages during a flooding episode with expenditures depending on the storm, seas category and elevation above sea level. As for Xlendi, the business community knows that past experiences have shown them that previous establishments were forced to close and declared bankruptcy following flooding events. They also fear that if flooding becomes more frequent, they might have to follow suit. Pertaining to the final column, each business community had businesses which were ineligible or declined to answer this question.

In Question 8, the owners were assessed on whether they would have chosen the same location for their business, had they known beforehand about the risks associated with their coastal location.

Q8A. If you knew the risks that coastal flooding (due to sea level rise and storm surges) could have on your business, how likely would you still have chosen a location along the coast?

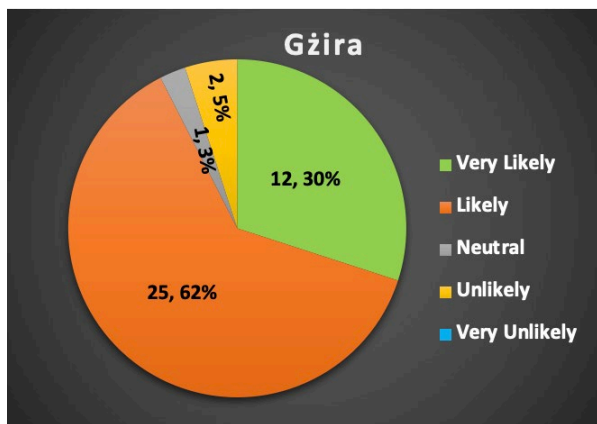


Figure 4.54 – Gżira Question 8 (n=40)

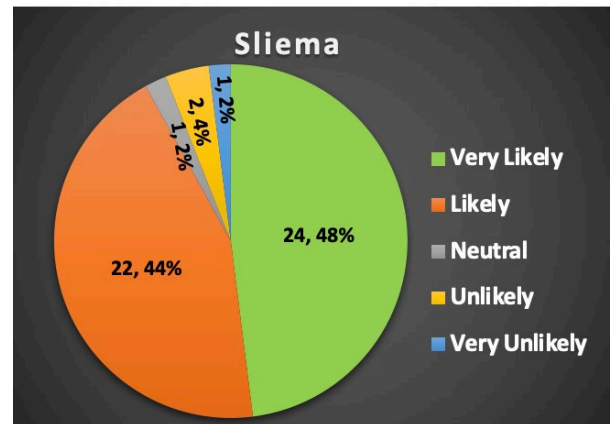


Figure 4.55 – Sliema Question 8 (n=50)

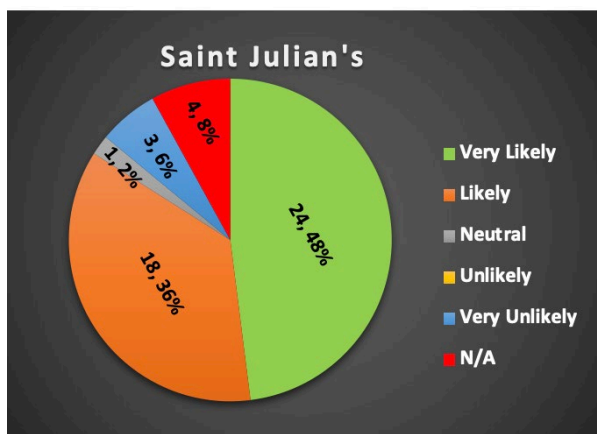


Figure 4.56 – St Julian's Question 8 (n=50)

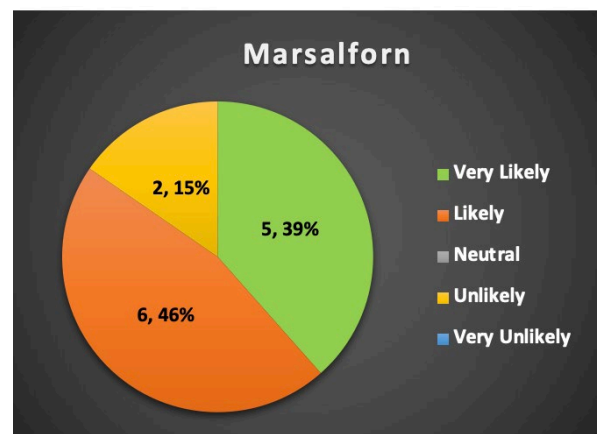


Figure 4.57 – Marsalforn Question 8 (n=13)

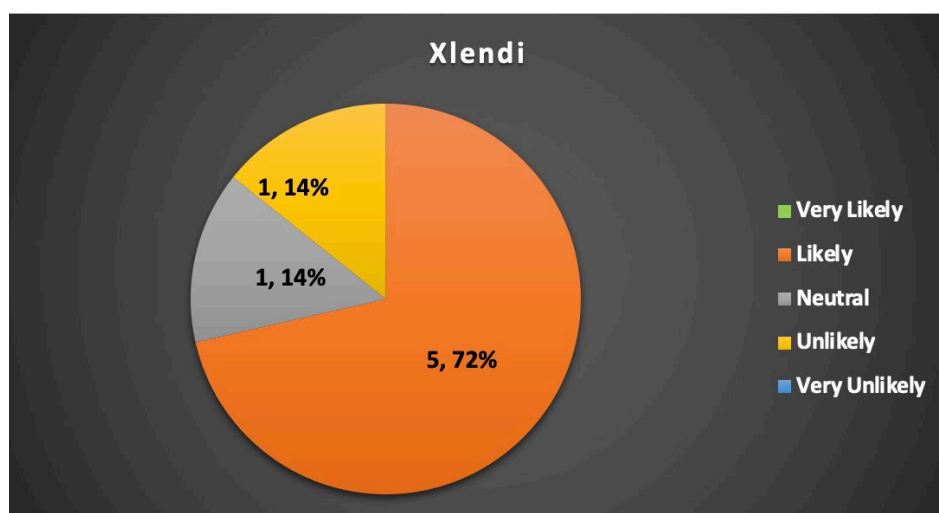


Figure 4.58 – Xlendi Question 8 (n=7)

The above percentages clearly show that most of the businesses in each locality are not willing to relocate, despite the current and predicted future scenarios. Only a very small minority of businesses amongst the Maltese localities reported uncertainty about what course of action they would have taken. In Gozo, Xlendi has the highest percentage, with 14 percent of the community uncertain on what they would have done. As for the remaining two categories, only Sliema and St Julian's ranked within either of the two. Owners stated that if they had that type of information before, they would have given it a much higher weight in their decision-making process.

The second part of the question asked the owners to provide reason/s to back up their answer (Table 4.8).

Table 4.8 – Question 8 reasons

Locality		Reasons										
Gżira	Location n=30	Tourism n=12	Demand n=4	Problematic n=2	Relocation n= 1							N/A n=1
Sliema	Location n= 29	Tourism n= 20	Demand n= 10	Problematic n=3	Relocation n=1	Seasonal n=3	Minor Issues n=1					N/A n= 5
St Julian's	Location n= 34	Tourism n= 10	Demand n= 15			Seasonal n= 2		Risk n=1	Flooding n=1			N/A
Marsalforn	Location n=9	Tourism n=2	Demand n=11	Problematic n=2								N/A n=2
Xlendi	Location n=1	Tourism n=5	Demand n=5	Problematic n=1							Adaptation n=1	

The following columns: location, tourism, demand, seasonal, adaptation and minor impacts illustrate that despite flooding, these businesses would have still opted for a coastal location. The first three columns were common for all the five localities. For the Maltese localities, tourism is all year-round while for Gozo tourism is mainly restricted to summer, but the business community still experiences demand from the Gozitan, Maltese and foreign population living in the Maltese Islands. In Sliema and St Julian's, owners claimed that it is seasonal, thus they would still choose these localities to operate, as according to them coastal flooding is a seasonal issue. They reported that the climate for the Maltese Islands is relatively warm and sunny throughout the year and its winters are mild; meaning this issue only presents itself during storms which are also uncommon. In their opinion, it is still profitable to operate in these areas. In Xlendi, some owners reported that they would still choose Xlendi, as businesses would become more experienced in adapting to coastal flooding and the

lessening of its impacts. Some businesses in Sliema reported that when flooding occurs, they only suffer minor impacts – so they would still opt for Sliema as a locality.

As for the remaining four reasons: relocation, problematic, flooding and risk, the data represents those businesses which reported that if they knew the risks associated with coastal flooding beforehand, they would not have established their shop in a coastal location. The problematic reason was identified in all localities except in St Julian’s. Here, businesses reported that coastal flooding causes major problems to the business establishment and operations. As for relocation, owners in Gżira and Sliema reported that they are aware of their mistake and are considering relocating their business further inland to eliminate flooding issues which also ties in with the problematic reason. Two reasons unique to St Julian’s were flooding and risk. Businesses which ranked within the flooding reason reported that the areas always flood during storms and rough seas. As for the risk reason, businesses reported that a coastal location is a legitimate risk due to flooding.

In Question 9, the owners were assessed on their future business recovery capability in case they suffer a coastal flooding setback.

Q9A. If such an event does happen in future how likely do you think your business can recover from such a setback.

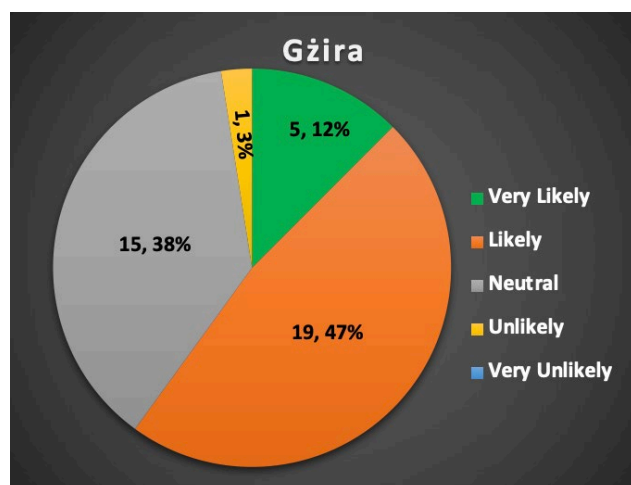


Figure 4.59 - Gżira Question 9 (n=40)

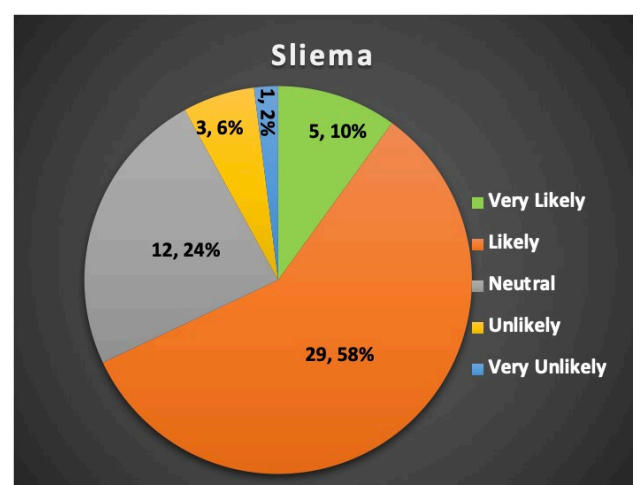


Figure 4.60 – Sliema Question 9 (n=50)

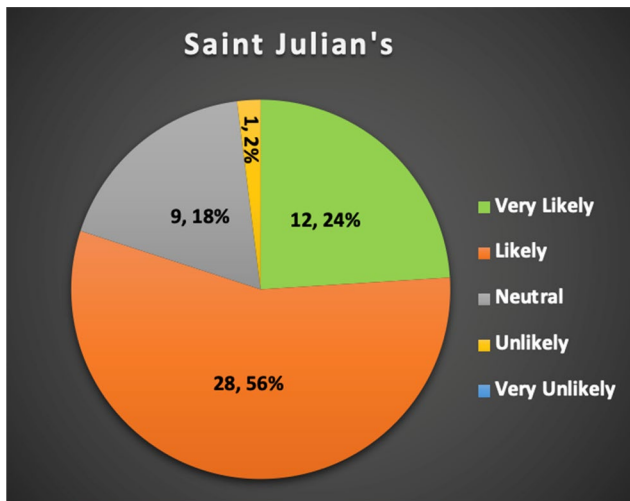


Figure 4.61 – St Julian's Question 9 (n=50)

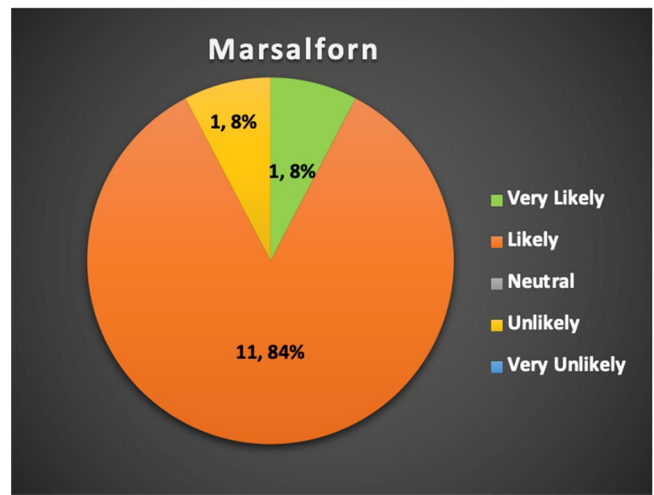


Figure 4.62 – Marsalforn Question 9 (n=13)

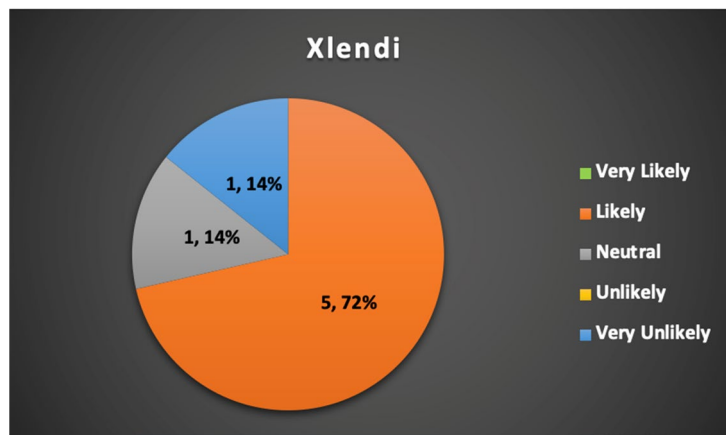


Figure 4.63 – Xlendi Question 9 (n=7)

In all localities, owners were confident that recoveries are possible. The “unlikely” and “very unlikely” categories only represent a small minority while the largest minority groups were identified in Gozo when comparing them with their Maltese counterparts. As for the third category, Xlendi ranked the highest with its community was not sure if recovery is possible. Within St Julian's, 12 percent of the interviewed businesses in this sample declined to answer the question. It is crucial to mention that these businesses are basing their decision on current or past experiences. The second part of the question asked the owners to provide reason/s to back up their answer (Table 4.9).

Table 4.9 – Question 9 Reasons

Locality		Reasons					
Gżira	Preventive Measures n=10	Insurance n= 18	Lack of Knowledge n=1	Depending on the situation n=13	Minimal Effect n=2	N/A n=2	
Sliema (n=50)	Preventive Measures n=8	Insurance n=30	Lack of Knowledge n=4	Depending on the situation n=8	Minimal Effect n=4	Frequency n=3	N/A n=7
St Julian's	Recovery Period n=2	Insurance n=28	No Damages n=4	Depending on the situation n=4	Minimal Effect n=11	N/A n= 7	
Marsalforn	Preparation n=5	Insurance n= 8	Recovery Difficulties n=1	Minor Damages n=1			
Xlendi	Damages n=1	Insurance n=5	Finance n=1				

In each locality, reasons were identified which indicate that businesses are confident that recovery is possible. Reasons such as preventive measures, insurance, frequency, minimal effect, no damages, preparation, recovery period and minor damages all point to a high degree of confidence amongst the business community. Insurance was common for all localities, believing that insurance companies will make good for any damages sustained by coastal flooding. They reported that to date, any claim was always honored and paid up and they are also confident that this trend will continue in future. This shows that there is a heavy reliance on insurance companies.

As for those businesses which believed that recovery is not possible, the following reasons were identified: damages and recovery difficulties. These two reasons indicate that these businesses believe that recovery is extremely difficult. They are of the opinion that the damages incurred will become more expensive to finance, and as floods worsen and become increasingly frequent, these costs will make it very difficult to recover. Their financial position and other factors at play at that time are the main reasons which will decide whether recovery is possible or not. Businesses which answered finance, reported that their financial situation during that time will determine if recovery is possible. As for the conditional theme, businesses reported that it depends on the kind of setback they endure. As for the 'lack of

knowledge' theme, the owners reported that they do not have a clue if recovery is possible. As for the last column, there were Maltese businesses who declined to answer.

In Sliema, an interesting observation was noted. Here the business community believes that coastal flooding is impossible to predict and difficult to determine the extent of damages this phenomenon will have. Any business entity must be covered by a relevant insurance policy to cover for any unforeseen emergency like damages incurred from future sea level rise and storm surge flooding. Up till now, these business owners claimed that the insurance companies have always honoured their claims to cover any expenses, thus enabling them to continue with their activity. This could be the reason why the majority answered likely or very likely.

Question 10 asked about contingency plans in case business fails due to irrecoverable costs caused by coastal flooding damages. Each business community reported that to date, no contingency plans have been drawn up and implemented. The second part of this question was skipped as it asked the owners to provide additional details on their contingency plan; however, none of the businesses across the entire sample were eligible to answer this question as they all answered "no".

Each business community was asked to provide reasons why they do not have any contingency plans in place (Table 4.10).

Table 4.10 – Question 10 Reasons

Locality		Reasons							
Gżira (n=40)	Preventive Measures n=6	Will not Run out of business n=19	No plan needed n=2	Retirement n=2	Lack of thought n=5	Minor Impacts n=1	Seasonal n=2	Rarely n=1	N/A n=7
Sliema (n=50)	Preventive Measures n=10	Will not Run out of business n=21	Moving n=1	Retirement n=1	Lack of Knowledge n=2	No major incidents n=1	Seasonal n=11	Planning Process n=1	N/A n=14

St Julian's (n=50)	Mitigation / Adaptation Measures n=7	Will not Run out of business n=21	No risk n=1	No Extensive / Permanent damages n=1	Lack of Awareness n=5	Minor Business Disruptions n=2	Seasonal n=3	N/A n=16	
Marsalforn (n=13)	Hope n=2	Will not Run out of business n=1	Lack of Knowledge / Awareness n=7	Seasonal n=2					
Xlendi (n=7)	Difficulties n=1	Lack of Knowledge/ Awareness n=6							

Several reasons were common amongst all five localities while others were common in four localities. The reason that was common to all, was the lack of knowledge/awareness/thoughts where businesses reported that they did not know or were not aware about the threat imposed on their business by coastal flooding, or that they have never thought that this issue will drive them out of business, hence the lack of contingency plans. The following two reasons were found in every locality except Xlendi. The first reason is that businesses have strong confidence that coastal flooding will not drive them out of business. They base their beliefs on past experiences where these floods have not forced them to cease operations; even if they are aware that these events are predicted to worsen. The situation in Xlendi is different; here businesses reported that this issue has forced establishments to go bankrupt.

The second reason was seasonal, where businesses reported that this issue is only seasonal and restricted to the winter season, during which period their business is always slow. It never happens in summer when tourism is at its peak, therefore, they can quickly recover the expenses of such events. This seasonality theme amongst the business communities may indicate that the non-winter months could offset the winter disruptions. In Marsalforn, a unique reason was given in which businesses reported that they hope that in the future, their business will be strong enough to withstand such flooding events on an annual basis. A very interesting reason was identified in Sliema with a minority percentage reported that to date, they do not have any plans, but they are in the planning stage of formulating a reduction adaptation and mitigation plan to be implemented within their establishment to reduce

flooding impacts. They are also formulating a relocation plan in case all measures proposed in the other plan fail. These plans are being implemented so that the business continuity will not have to shut down permanently. In addition, a unique adaptation measure was found in St Julian's. Some retail outlets claimed that there is a high possibility of coastal flooding, forcing management to adapt a 'work-from-home' policy and that all non-essential personnel are sent home. This measure is classified as an adaptation measure, and it is mostly used in the real estate industry.

Q11 asked if they have ever been invited by the competent authorities to attend any talks/discussion on this subject (Table 4.11).

Table 4.11 – Question 11

Locality	Yes	No
Gżira (n=40)	5%	95%
Sliema (n=50)	6%	94%
St Julian's (n=50)	2%	98%
Marsalforn (n=13)	31%	69%
Xlendi (n=7)	14%	86%

Many businesses reported that they were never invited by the competent authorities to attend talks on the subject. Even though most of each business community reported in the negative, there was a significant difference in percentages between the Maltese and Gozitan localities. The business community for each locality was asked to provide further details of what was discussed in these talks/discussions (Table 4.12).

Table 4.12 - Question 11 Topics Comparison

Locality	Topics		
Gżira n=40	Mitigation and Adaptation Measures n=2	N/A n=38	
Sliema n=50	Measures n=3	N/A n=47	
St Julian's n=50	Climate Change Mitigation and Adaptation Measures n=1	N/A n=49	
Marsalforn n=13	Mitigation Measures n=3	Climate Change Issues n=1	N/A n=9
Xlendi n=7	Impacts n=1	N/A n=6	

Q12 asked about the type of steps that should be taken to mitigate the negative effects of coastal flooding. Table 4.13 lists all the replies related to the infrastructure measures that all owners mentioned while Table 4.14 lists and compares all the replies.

Table 4.13 – Infrastructure inventory for question 12,13, and 14.

Early warning system
Road redesign
Road decline orientation towards the sea
Reservoirs
Water capture systems
Raise land elevation
Breakwaters
Gutters
Upgraded drainage systems
Small dams
Soft engineering beach techniques
Underground tunnels
Gullies

Table 4.14 – Question 12 Responses Comparison

Locality		Responses								
Gżira (n=40)	Management and Planning n= 16	Lack of Knowledge/Awareness n= 2	Climate Change Adaptation and Mitigation n=7	Infrastructure n=19	Environment Protection n=1	Reduce Emissions n=1	Clean n=18	Cease Development n=1	N/A n=2	
Sliema (n=50)	Management and Planning n=10	Lack of Knowledge/Awareness n=13	Coordination n=1	Infrastructure n=20	Environment Protection n=1	Preventive measures n=5	Clean n=7	Cease Development n= 4	N/A n=4	
St Julian's (n=50)	Management and Planning n=7	Lack of Knowledge/Awareness n=9	Attempt to solve the problem n=1	Infrastructure n=26	Prevent/reduce climate change =3	Studies n=2	Investment n= 2	Cease Development n=3	Measures n= 6	N/A n= 4
Marsalforn (n=13)	Management and Planning n=3	Lack of Knowledge/Awareness n= 1	Actions against climate change n=2	Infrastructure n=12	Investment n=2	Cease Development n= 1				
Xlendi (n=7)	Management and Planning n=2	Lack of Knowledge/	Cease Development n=1	Infrastructure n=7						

		Awareness n=1								
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For all localities except Xlendi, the talks were on mitigation and adaptation measures along with their benefits. In addition, climate change issues on a national and local level were also communicated to Marsalforn’s business community. As for Xlendi the talks/discussions were based upon climate change impacts and effects on a national and local level. Opinions related to management and planning, lack of knowledge/awareness, infrastructure, cleaning, and halt further development were all identified in each locality, indicating the similarities among the business community’s way of thinking. Excluding these common opinions, there were others that were unique to their respective locality. In Gżira, two unique opinions were identified: “climate change adaptation and mitigation” and “emission reduction”. Some owners believe that for coastal flooding in Gżira to be reduced, then climate change mitigation and adaptation measures need to be implemented on a local and national scale as only with such measures will Gżira will experience a reduction in coastal flooding.

As for emission reduction, businesses believe that because of climate change, sea level rise will continue to rise rapidly and that storms will become more frequent and violent. The two unique opinions for Sliema were “coordination” and “preventive measures”. With the coordination, businesses believe that coordination between the business community, local council and the government is the key to effectively manage and mitigate coastal flooding within the locality as all stakeholders would be working towards the same goal. As for preventive measures, the businesses believe that adequate coastal flooding measures should be implemented to effectivity deal with coastal flooding. An interesting point brought up by a minority group was that according to them, the promenade was reclaimed from the sea which is one of the main reasons why the area suffers flooding.

The following were found to be unique in the St Julian’s sample: attempt to solve the problem, prevent/reduce climate change, and studies. The first hinted that the business owners do not believe that the local council and the government are capable in solving the issue. They are of the opinion that coastal flooding could be solved or significantly reduced; foreign nations have already solved coastal flooding issues. However, they have little or no trust that the

Maltese government will follow suit. As for the second, the business community believes that by reducing climate change (rather than preventing it - as it is impossible to do so), the impacts of sea level rise and storm surge flooding during extreme weather events will be greatly reduced, leading us to an overlap with preventive measures. As for the final opinion, the business community expressed that the first step to mitigation is by researching coastal flooding impacts on the business community and the town (same line of this study). After the studies have been completed, then the government will be in a better position to assess the impacts and the recommendations put forward by this study, so that he can then coordinate and implement effective mitigation measures.

In Q13, owners' opinions were assessed on what they think the local council should do to mitigate the negative effects of coastal flooding. This question is quite like the previous question (Q12), hence the similarities in the results. St Julian's, Marsalforn and Xlendi all had the same opinions listed in Table 4.13. As for Gżira and Sliema, there was only one opinion in each locality that was different. Some of Gżira's business community reported that the local council must coordinate, enforce, pressure, and cooperate with the central government to solve the issues of coastal flooding, drawing up a framework plan to effectively deal and manage it within the locality. These businesses do acknowledge that the local council does have financial constraints, lack of resources and expertise so the council cannot implement any large-scale projects within their community without the aid from the central government. Owners also think that the council should organize meetings with the local business community and work together to develop measures to deal with flooding, such as consultancy on the best ways for a business owner to protect his/her business.

As for Sliema, businesses reported that they expect the local council to implement measures within the town and offer the business community their support to eliminate coastal flooding. The support could be in any shape or form that the business community deems fit such as consultations, financial, measures implementation, distribution of information and so on. The difference between these two localities is that in Gżira, the business community acknowledges the council's limitations and expects them to work with the central government, while in Sliema, the business community expects that the local council should implement mitigation measures and offer the required support to their business community.

A highly interesting finding is that owners want experts on coastal flooding hired by the local council or government to consult each business on the best mitigation options they need to take/implement to protect their business.

In Q14, owners were assessed on what they think governmental authorities should do to protect businesses against coastal flooding due to sea level rise and storm surges (Q13). The two main differences are that Gżira seems to have the lack of knowledge/awareness opinion absent from this question, which is a positive sign. Within lack of knowledge/awareness opinion, owners did not know what needs to be done and how to do it, but here they seem to know what the government should be doing. The second difference was identified in St Julian’s where the opinion on how to solve the problem is absent. Again, like in Gżira, it is a positive sign as this attempt to solve the problem opinion hinted that the business community does not believe that the local council can solve the issue, but looks like they are more confident that the central government is able to solve the issue and knows what needs to be done and how to do it.

In Q15, owners’ opinions were assessed on business diversification in case their current operations would be no longer be feasible due to future impacts of coastal flooding.

Q15A. Would it be possible to diversify your business operations, should current business operations not be possible anymore due to future impacts of coastal flooding?

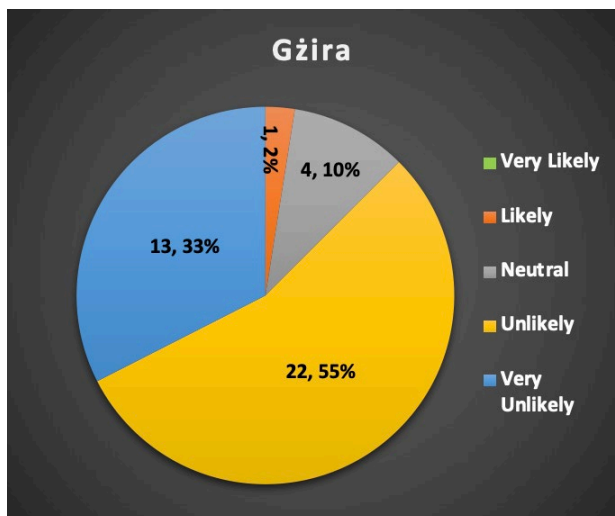


Figure 4.64 – Gżira Question 15 (n=40)

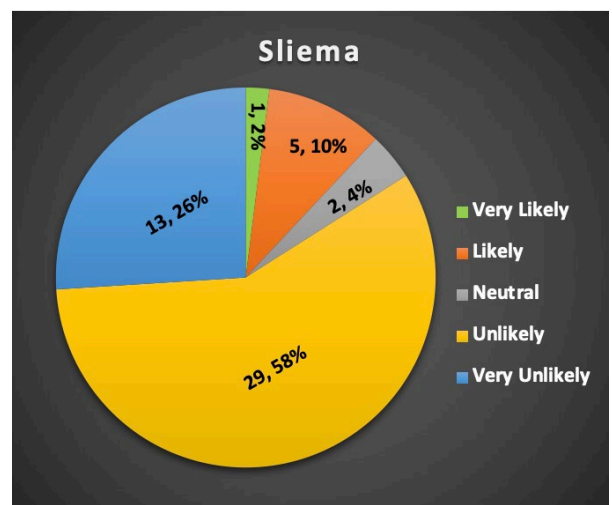


Figure 4.65 – Sliema Question 15 (n=50)

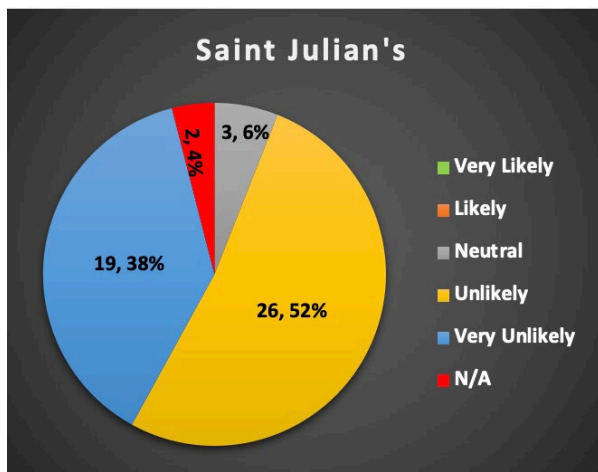


Figure 4.66 – St Julian's Question 15 (n=50)

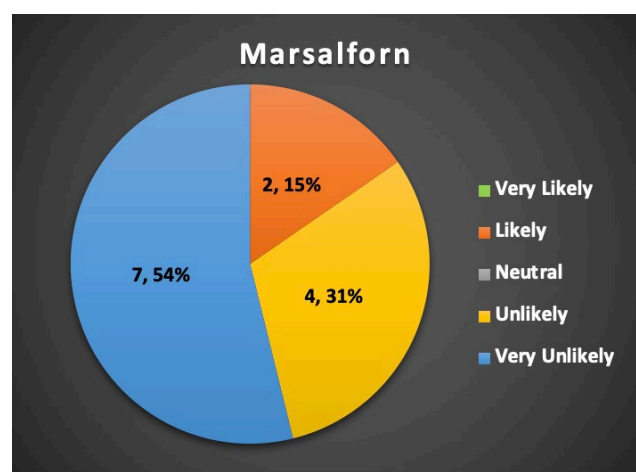


Figure 4.67 – Marsalforn Question 15 (n=13)

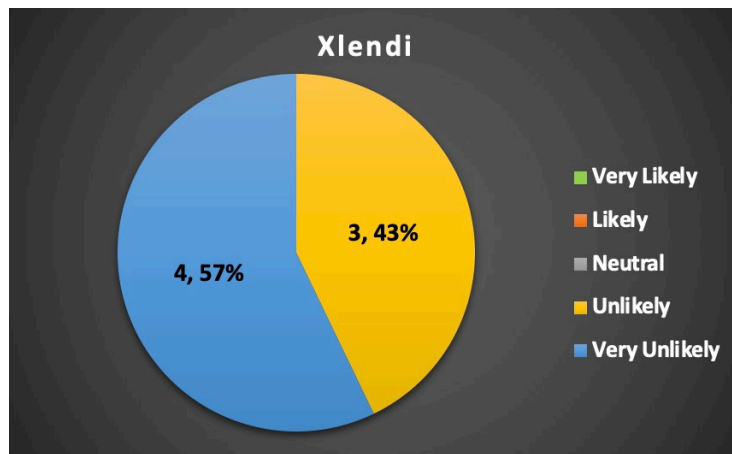


Figure 4.68 – Xlendi Question 15 (n=7)

The first three categories represent a minority percentage in their respective locality while the majority all lie within the “unlikely” and “very unlikely” categories. The “unlikely” and “very unlikely” represent more than three quarters in each sample, apart from Xlendi, where none believe business diversification is possible. This could be due to two main reasons: the new sector chosen could be already saturated or the establishment itself cannot be diversified due to its size. Most catering establishments rely on outside capacity and due to their limited internal space, if the outer part of the establishment is being constantly flooded, diversification could be not feasible.

This is a major issue for all localities, and they are at risk of losing a sizeable chunk of their economic activity if their businesses will cease operations due to coastal flooding and if diversification is not possible. Xlendi will see all its economic activity stop. Since all localities are extremely important to the Tourism industry, any loss would ultimately also leave an impact on the national economy. According to the Ministry for Tourism (2015), the

accommodation and food sector generated 0.9 billion euro in 2014, 74 percent of which from tourism only, while in Gozo, 50 percent of its GDP and 20 percent of its employment depends on its tourism industry. As for St Julian’s, there was 4 percent of the business sample that declined to answer.

The following part of this question assessed the opinions of those owners who responded, “very likely”, “likely”, or “neutral” (Table 4.15).

Table 4.15 – Question 15B Responses Comparison

Locality		Responses		
Gżira n=40	Same operation carried out differently n=4	N/A =36		
Sliema n=50	Same operation carried out differently N=2	Change of business n=1	Will not Happen n=1	N/A n=46
St Julian’s n=50	Deliveries n=1	N/A n=49		
Marsalforn n=13	Same operation carried out differently n=1	N/A n=12		
Xlendi n=7	N/A n=7			

In Gżira, Sliema and Marsalforn their respective business community responded that they would continue to operate as before but carried out differently according to what the current coastal flooding situation might be. An additional two more opinions were identified in Sliema, the first being “change of business”. Businesses reported that if coastal flooding does present this situation, owners would diversify their business to whatever they deem possible depending on the situation at that time. Another identified opinion for Sliema was that even though some businesses believe in diversification, they will never reach that point of having to diversify as such phenomena (coastal flooding) will never happen. In St Julian’s, a “deliveries” theme was identified, where businesses reported that if, due to coastal flooding they will lose most of their seating capacity (especially their outdoor section), the owners claimed that they will still carry on with their current operations but as take away restaurants. None of Xlendi’s business community were eligible to participate as none of them responded within the eligible parameters of this question.

In Q16, the owners were asked if they are willing to consider business relocation.

Q16A. How likely would you consider relocating your business to another site?

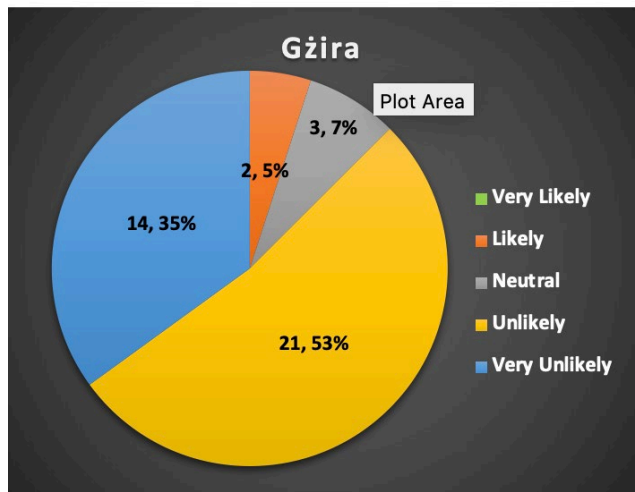


Figure 4.69 – Gzira Question 16 (n=40)

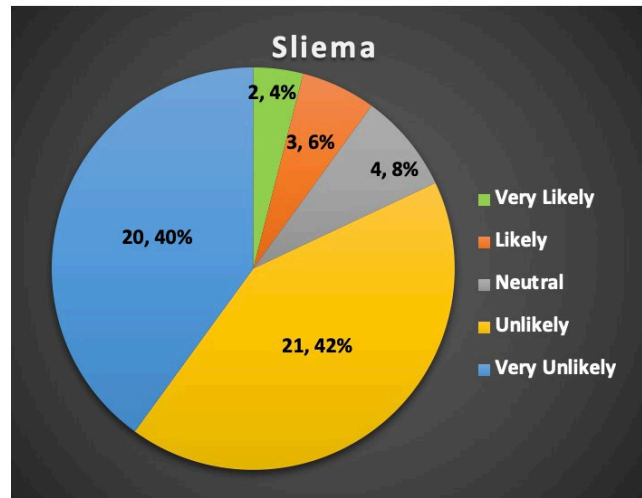


Figure 4.70 – Sliema Question 16 (n=50)

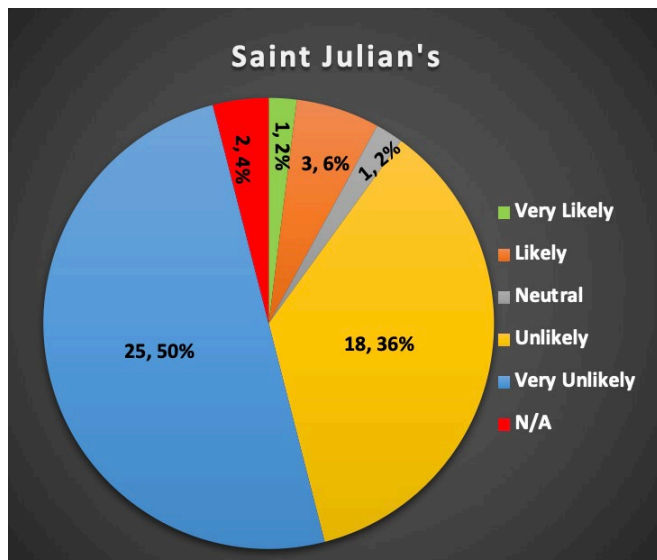


Figure 4.71 – St Julian's Question 16 (n=50)

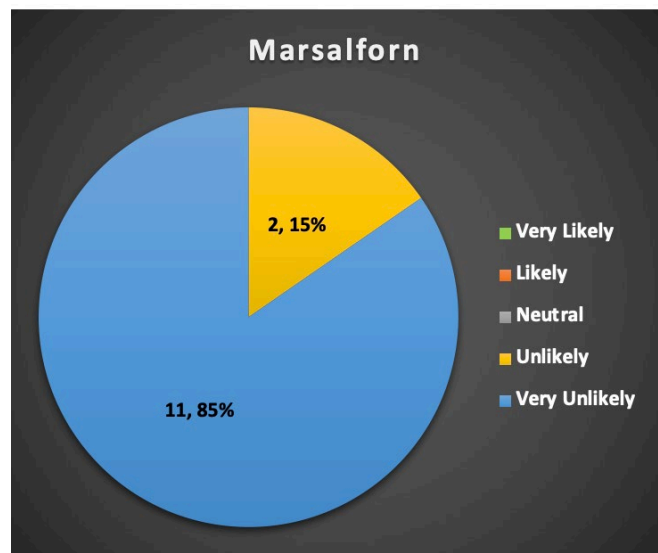


Figure 4.72 – Marsalforn Question 16 (n=13)

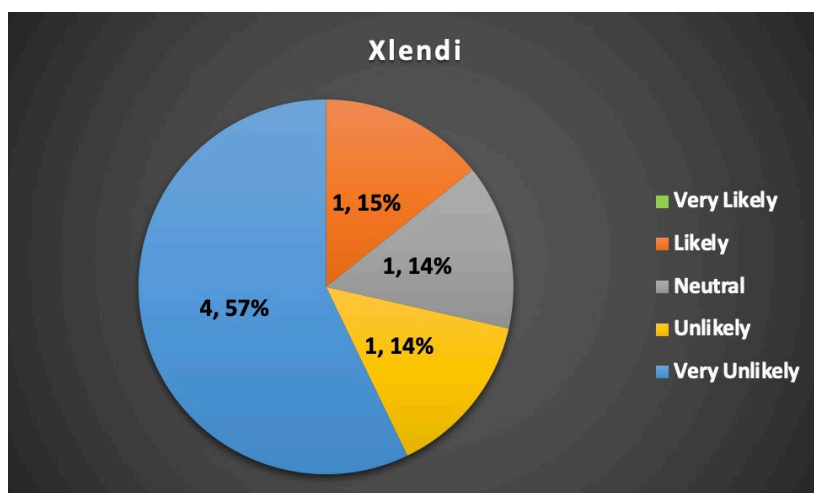


Figure 4.73 – Xlendi Question 16 (n=7)

Like the previous question, the first three categories represent a small minority percentage with the bulk of the sample lying in the “unlikely” and “very unlikely” categories. Within the Maltese localities, most of each business community explicitly stated that they will be reluctant to relocate from their current location. As for the Gozitan business community, none of the businesses in Marsalforn and Xlendi are willing to relocate. This unwillingness comes from the value of the location itself which compensates and offsets any risks involved, and disruptions incurred by the owners during these events. The popularity of these localities would ensure that they will generate enough income in the shortest period to recover any losses. They consider that this high demand for these locations is not likely to change for the foreseeable future and so it is very unlikely that they would consider relocation.

The response of this question ties in with the responses in question 8. This unwillingness could adversely affect the Tourism sector and according to the (Maltese Ministry of Tourism, 2015), tourism plays a crucial role for these towns and the country’s GDP.

Table 4.16 – Question 16 Responses

Locality	Responses		
Gżira n=40	Central but close to shore n=1	N/A n=39	
Sliema n=50	Close but far enough from the shore n= 2	Further Down n=1	N/A n=47
St Julian’s n=50	Depends on where trade is flourishing n=1	Higher Elevation n=3	N=46
Marsalforn n=13	N/A n=13		
Xlendi n=7	Further inland at higher elevation n=1	N/A n=6	

Gżira and Sliema had a common opinion where businesses in both localities reported that they would consider relocation to a central area which is also close to the shore but at a safer distance from any coastal flooding related issues (Table 4.16). Businesses explicitly stated that it is imperative for any potential location to meet these criteria before it is even considered, as demand for goods and services is at its highest along the coast. As for Sliema’s second theme, some businesses reported that a potential location is further down the promenade, where the issue is significantly reduced as the area has higher elevation. In St Julian’s two opinions were identified. the first one is where businesses reported that if they must relocate, they will relocate according to the demand during that time. So basically, business demand for that sector would be the determining factor that decides where to relocate. As for the

second opinion which is also applicable to Xlendi, owners reported that they would relocate to an area within the town that is on a higher elevation than their current position. However, they are unwilling to move to another town; relocation would be within the same locality due to the market value, popularity and constant demand for goods and services. None of Marsalforn’s business community were eligible to participate as none of them responded within the eligible parameters of this question.

4.5.4. Business Damages and Disruption Inventory

Table 4.17 below represents business disruptions and damages inventory that owners mentioned during the interviews in Q5 and Q7B where owners were asked to provide their opinions of how sea level rise and storm surge flooding affect their business. As one can see in this inventory there are various issues; some are economical, infrastructural, health and safety issues, long-term maintenance, and finally some are definite such as closure. Some of these damages and disruptions are manageable and short term; for instance, loss of sales is only temporary during the flooding episode. However, some are more major that may require a temporary shutdown until fixed such as internal and external piping damages, while others could be more serious such as closure of businesses. Closure would cause major economic problems to the towns and the country’s economy which, when considering that these events are predicted to become more frequent and intensive, these businesses might decide to close due to the constant flooding setbacks which would significantly increase unemployment in the country.

Table 4.17 - An inventory of the business communities sustained damages and disruptions.

Damages	Disruptions
Broken glass	Loss of sales
Shorted appliances	Loss of revenue
Repainting	Reduction in operational capacity
Products discard	Accessibility
Overflowing of internal and external drainage systems	Closure
Internal and external piping damages	Foul smells derived from overflowing drainage
Broken doors	Overflowing of drains result in drainage release of drainage bugs and insects
Broken windows	Maintenance
Ruined furniture	Cleaning
Plumbing	

4.5.5. Reasons' Inventory

Table 4.18 below consists of all the reasons that owners provided during the interviews. This table contains all the reasons provided by owners for each question categorized by locality. This table is critical as it easily facilitated the identification of the key themes in each question within each locality while also facilitating with ease the comparison in responses for each question within all five localities.

Table 4.18 – Reasons provided by the owners in the qualitative section

Question	Localities				
	Gżira	Sliema	St Julian's	Marsalforn	Xlendi
Question 5 If answered in the top three frequent categories, could you provide more details of your experience?	Flooding, business disruptions, and preventive measures	Flooding, business disruptions, damages, preventive measures	Flooding, business disruptions, damages, safety precautions	Flooding, business disruptions	Flooding, business disruptions
Question 7 If you selected the top three of the likelihood (i.e., Very Likely, Likely, Neutral) in what way do you think it will affect your business?	Flooding, and business disruptions	Flooding, and business disruptions, damages, wake.	Flooding, business disruptions, damages, elevation.	Flooding, business disruptions	Flooding, bankruptcy
Question 8 Give reasons for your answer?	Location, tourism, demand, challenges, and relocation	Location, tourism, seasonality, lack of knowledge/awareness, relocation, minor impacts	Location, tourism, demand, flooding, seasonality, risk	Location, tourism, challenges	Location, tourism, challenges
Question 9 Can you provide reasons for your answer?	Preventive measures, insurance, and conditional	Insurance, preventive measures, conditional, little to no damages	Insurance, never/rarely flood, damages, recovery confidence, conditional, recovery period.	Insurance, preparation, minor damages, recovery difficulties.	Insurance, finance, damages
Question 10 If you answered 'No', can you provide reasons for not having such a contingency plan?	Preventive measures, lack of knowledge/awareness, operational continuity, retirement, minor effects, and rare flooding events	Preventive measures, seasonality, operational continuity, retirement, relocation, lack of knowledge, no major incidents, and planning process	Mitigation/adaptation measures, operational continuity, lack of knowledge/awareness, seasonality, business disruptions, no risk, never sustained any extensive or permanent damages	Lack of knowledge/ awareness, seasonality, operational continuity, hope	Lack of knowledge/awareness, hope

Question 11 If you answered 'Yes', who were these authorities and what was the agenda of the talk/discussions?	Mitigation and adaptation measures	Mitigation and adaptation measures	Climate change and coastal flooding mitigation and adaptation measures and their implementation	Climate change mitigation and adaptation measures, background information on climate change, its consequences, and impacts	Climate change impacts
Question 12 In your opinion, what steps should be taken to mitigate the negative effects of coastal flooding?	Management and planning, cleaning of roads and drains, implementation of climate change mitigation adaptation measures, infrastructure, cease coastal development, and lack of knowledge	Infrastructure, lack of knowledge/awareness, management, and planning, ceasing coastal development, environmental protection.	Infrastructure, lack of knowledge/ awareness, management and planning, government, reduce and manage climate change, ceasing coastal development, scientific studies, financial and scientific priority	Infrastructure, lack of knowledge/awareness, preventive measures	Infrastructure, lack of knowledge/awareness, management, and planning, cease coastal development
Question 13 What do you think the local council should do to protect businesses against coastal flooding due to sea level rise and storm surges?	Cleaning of roads and drains, management and planning, infrastructure, climate change mitigation and adaptation measures, government, lack of knowledge/awareness, and cease coastal development	Infrastructure, lack of knowledge/awareness, management, and planning, ceasing coastal development, environmental protection, mitigation, and support	Infrastructure, lack of knowledge/ awareness, management and planning, government, reduce and manage climate change, ceasing coastal development, scientific studies, financial and scientific priority, local council	Infrastructure, management and planning, local council, investment (educational and financial), lack of knowledge/ awareness, land reclamation, cease development	Infrastructure, lack of knowledge/awareness, management, and planning,
Question 14 What do you think governmental authorities should do to protect businesses against coastal flooding due to sea level rise and storm surges?	Cleaning of roads and drains, management and planning, infrastructure, climate change mitigation and adaptation measures, government, lack of knowledge/awareness, and cease coastal development	Infrastructure, lack of knowledge/awareness, management, and planning, ceasing coastal development, environmental protection, mitigation, and support	Infrastructure, lack of knowledge/ awareness, management and planning, government, reduce and manage climate change, ceasing coastal development, scientific studies, financial and scientific priority	Infrastructure, management and planning, local council, investment (educational and financial), lack of knowledge/ awareness, land reclamation, cease development	Infrastructure, lack of knowledge/awareness, management, and planning,
Question 15B If you answered the top three categories of likelihood in Question 15a (i.e., Very likely, Likely, and neutral),	Same operation carried out differently	Same operation carried out differently, hope	Deliveries	Same operation carried out differently, never thought of it	N/A

what would the new business operation entail?					
Question 16B If you answered very likely or likely to Question 16a, which new site would you consider?	Relocation within the same area	Relocation within the same area, further inland	Depends on trade, relocation within the same area but at higher elevation	N/A	Relocation within the same area but at higher elevation

4.5.6. Preventive/Adaptation Measures Inventory

Table 4.19 includes the owners' opinions on what physical preventive/adaptation measures they implemented within their establishment to mitigate the effects of sea level rise and storm surge flooding. Despite some measures, (such as teleworking) are better than others, all the measures they mentioned are all short-term which might prove costly and less effective in the future when these two phenomena become more frequent. Given that all these are small or medium businesses, their financial resources might be limited, thus they cannot implement more effective long-term measures which explains these types of measures. However, on a positive note these owners are willing and trying to combat the issue of coastal flooding.

Table 4.19 – Preventive/adaptation measures inventory

Gżira	Sliema	St Julian's	Xlendi
Placing high enough slabs against the entrance	Higher land topographic elevation	Higher land topographic elevation	Waterproofing
Entrance elevation	Entrance elevation	Entrance elevation	Placing high enough slabs against the entrance
Waterproofing	Waterproofing	Waterproofing	
		Placing high enough slabs against the entrance	
		Work from home policy	

4.5.7. Business Community Recommendations

Table 4.20 lists the recommendations put forward by all business owners that they believe would be effective in managing and mitigating the effects of sea level rise and storm surge flooding within their respective locality. According to them, if their proposed measures are taken seriously and implemented, coastal flooding itself would significantly decrease and become more manageable.

Table 4.20 - Business community recommendations to mitigate coastal flooding

Management and Planning
Construction of new or upgraded infrastructure along with the necessary all year-round maintenance.
The business community wants scientific experts on coastal flooding hired by local or central government to consult businesses on the best feasible mitigation options.
When coastal flooding occurs, roads are completely flooded as drainage systems would become clogged and eventually overflow from rain and sea water. The area ends up being dangerous to both pedestrians and traffic alike and becomes inaccessible. They are of the opinion that there should be a complete redesign of road and drainage infrastructures, along with the required cleaning and maintenance. A warning system should also be implemented to alarm people and businesses to avoid the area, as in most storms people get trapped and require rescuing. Within the valley, small dams should be built to stop rainwater in its tracks resulting in a drastic decrease of the area at the end of the valley that is flooded. This new captured water could be reused for secondary uses.
Prioritize the issue and attempt to solve it.

4.5.8. Key Findings

4.5.8.1. Gzira Key Findings

Around 57 percent of the business owners ranked in the upper spectrum of the Likert scale on Gzira’s coastal flooding knowledge. Fifty three percent of the business owners were not aware about the risk of sea level rise and storm surge flooding before they established their business. Approximately 73 percent of the business owners did not or rarely envisage that sea level rise and storm surge flooding could pose a threat to their business. Roughly 77 percent of the business owners think that sea level rise and storm surge flooding will affect their operations. None of the business owners have any contingency plan in place in case coastal flooding would bankrupt them. Around 92 percent of the business owners claimed that if they knew the risks and impacts of sea level rise and storm surge flooding beforehand,

they would have still opted to choose a coastal site because of its location and demand from local population and tourists alike and due to this demand, most of the businesses refuse to consider relocation. Business owners believe that to solve coastal flooding the government needs to build the necessary infrastructure, carry out regular cleaning, maintenance and adequate management and planning of such infrastructure within the area.

4.5.8.2. Sliema Key Findings

Around 66 percent of the business owners ranked in the upper spectrum of the Likert scale on Sliema's coastal flooding knowledge. Approximately 56 percent of the business owners were not aware about the risk of sea level rise and storm surge flooding before they established their business. About 70 percent of the business owners did not envisage that sea level rise and storm surge flooding could pose a threat to their business. Proximately 82 percent of the business owners do think that sea level rise and storm surge flooding will affect their operations. None of the business owners have contingency plans in place as they are of the opinion that coastal flooding will not lead them to bankruptcy. Around 92 percent of the business owners claimed that if they knew the risks and impacts of sea level rise and storm surge flooding beforehand, they would have still opted to choose a coastal site due to the high demand for economic activity and market value. Most of the businesses refuse to consider relocation. Business owners believe that to solve coastal flooding, the government needs to plan, manage, and build the infrastructure to effectively solve coastal flooding. Also, within this locality, a few businesses do not know what can be done and believe that it is practically impossible to solve.

4.5.8.3. St Julian's Key Findings

Around 56 percent of the business owners ranked in the upper spectrum of the Likert scale on St Julian's coastal flooding knowledge. Proximately 60 percent of the business owners were not aware about the risk of sea level rise and storm surge flooding before they established their business. Around 68 percent of the business owners did not envisage that sea level rise and storm surge flooding could pose a threat to their business. Approximately 78 percent of the business owners do think that sea level rise and storm surge flooding will

affect their operations. None of the business owners have any contingency plans, as again, they do not believe that coastal flooding will lead them to bankruptcy. About 84 percent of the business owners claimed that if they knew the risks and impacts of sea level rise and storm surge flooding beforehand, they would have still opted for a coastal location as such locations are where businesses thrive and prosper. Most of the businesses refuse to consider in relocation. Business owners believe that to solve coastal flooding the government needs to plan, manage, and build the infrastructure to effectively solve coastal flooding. Also, within this locality, several businesses do not know what can be done and believe that it is practically impossible to solve.

4.5.8.4. Marsalforn Key Findings

Around 46 percent of the business owners ranked in the upper spectrum of the Likert scale on Marsalforn's coastal flooding knowledge. Within this locality, the upper spectrum outweighed the lower spectrum of the Likert scale which indicates that Marsalforn's business community is more familiar with coastal flooding than their Maltese counterparts. Around 61 percent of the business owners did envisage that sea level rise and storm surge flooding could pose a threat to their business. About 92 percent of the business owners do think that sea level rise and storm surge flooding will affect their operations. None of the business owners have any contingency plans as they also believe that coastal flooding will not put them out of business. About 85 percent of the business owners claimed that if they knew the risks and impacts of sea level rise and storm surge flooding beforehand, they would have still opted to choose a coastal site. Same reasons cited as other localities – businesses grow and prosper when located along the coast. Many of the businesses refuse to consider in relocation. Businesses believe that to solve coastal flooding the government needs to build the infrastructure that will serve as preventive measures to effectively solve coastal flooding. Also, within this locality several businesses do not know what can be done and believe that it is practically impossible to solve.

4.5.8.5. Xlendi Key Findings

Around 42 percent of the business owners ranked in the upper spectrum of the Likert scale on Xlendi's coastal flooding knowledge. Within this locality the upper spectrum outweighed the lower spectrum of the Likert scale which indicates that Xlendi's business community is more familiar with coastal flooding than their Maltese counterparts. Roughly 57 percent of the business owners did envisage that sea level rise and storm surge flooding could pose a threat to their business. About 72 percent of the business owners do think that sea level rise and storm surge flooding will affect their operations. None of the business owners have any contingency plans as they also believe that coastal flooding will not put them out of business. Roughly 72 percent of the business owners claimed that if they knew the risks and impacts of sea level rise and storm surge flooding beforehand, they would have still opted for a coastal location due to its high demand for goods and services. Most owners refuse to consider relocation. Businesses believe that to solve coastal flooding the government needs to plan, manage, and build the necessary infrastructure to effectively solve coastal flooding. In addition, the business community also believes in putting a stop to any unnecessary coastal development, as this development impedes water flow and leads to more coastal flooding. Also, within this locality a few businesses do not know what can be done and believe that it is practically impossible to solve.

4.5.9. Descriptive Analysis Conclusion

These localities are highly popular with tourists and local population alike; there is a high concentration of upmarket, 5-star hotels and accommodation complexes together with several retail outlets and shopping centres representing prestigious, internationally known brands. This is the ideal environment for any business venture to establish itself, as sales are guaranteed. Location is a key factor for the hospitality, catering, and real-estate industry and crucial to the retail industry (designer brands) due to the constant stream of tourists and local population alike.

4.6. Inferential Statistical Analysis

4.6.1. Introduction

This section tests some of the replies from the business questionnaires in an inferential statistical approach to test whether differences or similarities exist between the replies of owners according to their category of business and locality. According to (Scott, 2009) inferential statistics pertains to making decisions, predictions, or generalization of a sample data set based on what information that sample contains. For this research, inferential statistics was used for hypothesis testing to test the null and alternative hypotheses listed in Table 5.1. The goal of hypothesis testing is to make conclusions about the value of one or more tested parameters which for this study these parameters are the business category against the question.

4.6.2. Statistical Analysis

The following questions were tested:

- i. Question 1: How familiar are you with the issues of climate change and its implications?
- ii. Question 2: How informed are you about coastal flooding (in your locality)?
- iii. Question 4: Were you aware about the risk of sea level rise and possible coastal flooding when you opened your current business?
- iv. Question 5: In recent years, have you experienced coastal flooding?
- v. Question 6: Have you ever envisaged that future sea level rise and coastal flooding could threaten your business?
- vi. Question 7: Do you think that sea level rise and flooding will affect your business?
- vii. Question 8: If you knew the risks that coastal flooding (due to sea level rise and storm surges) could have on your business, would you still have chosen a location along the coast?
- viii. Question 9: If such an event does happen in future, do you think that your business can recover from such a setback?

- ix. Question 15: Would it be possible to diversify your business operations, should current business operations not be possible anymore due to future impacts of coastal flooding?
- x. Question 16: How likely would you consider relocating your business?

Table 4.21 below illustrates the alternative and null hypothesis statements according to each tested question.

Table 4.21 – Business questions alternative and null hypothesis

Question	Accept Alternative Hypothesis (H1) P-value ≤ 0.05	Accept Null Hypothesis (H0) P-value >0.05
Question 1: How familiar are you with the issues of climate change and its implications?	The differences in familiarity level according to business category are statistically significant.	The differences in familiarity level according to business category are not statistically significant
Question 2: How informed are you about coastal flooding (in your locality)?	The differences in familiarity level according to business category are statistically significant.	The differences in familiarity level according to business category are not statistically significant.
Question 4: Were you aware about the risk of sea level rise and possible coastal flooding when you opened your current business?	The differences in risk awareness level according to business category are statistically significant.	The differences in risk awareness level according to business category are statistically not significant.
Question 5: In recent years, have you experienced coastal flooding?	The differences in recent coastal flooding episodes according to business category are statistically significant.	The differences in recent coastal flooding episodes according to business category are statistically not significant.
Question 6: Have you ever envisaged that future sea level rise and coastal flooding could threaten your business?	The differences in prediction level according to business category are statistically significant.	The differences in prediction level according to business category are not statistically significant.
Question 7: Do you think that sea level rise and flooding will affect your business?	The differences in opinion level according to business category are statistically significant.	The differences in opinion level according to business category are not statistically significant.
Question 8: If you knew the risks that coastal flooding (due to sea level rise and storm surges) could have on your business, would you still have chosen a location along the coast?	The differences in locality risk awareness level according to business category are statistically significant.	The differences in locality risk awareness level according to business category are not statistically significant.
Question 9: If such an event does happen in future do you think that your business can recover from such a setback?	The differences in business recovery level according to business category are statistically significant.	The differences in business recovery level according to business category are not statistically significant.
Question 15: Would it be possible to diversify your business operations, should current business operations not be possible anymore due to future impacts of coastal flooding?	The differences in business diversification level according to business category are statistically significant.	The differences in business diversification level according to business category are not statistically significant.

Question 16: How likely would you consider relocating your business?	The differences in relocation likelihood level according to business category are statistically significant.	The differences in relocation likelihood level according to business category are not statistically significant.
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Table 4.22 displays the resultant p-values for each tested question according to each locality. The blue cells show that there are differences in the answers of the owners according to the categories of businesses ($P \leq 0.05$, Accept H1) while those in white show that there are no statistical differences in the answers of business owners according to their category of business ($P > 0.05$, Accept H0). The complete SPSS Kruskal Wallis statistical outputs of these tests may be viewed in the Appendix 3 section 3.1.

Table 4.22 – Color coded p-values (Asymp. Sig.)

Question	Gżira	Sliema	St Julian's	Marsalforn	Xlendi
Question 1: How familiar are you with the issues of climate change and its implications?	0.430	0.765	0.005	0.520	0.269
Question 2: How informed are you about coastal flooding (in your locality)?	0.665	0.464	0.013	0.559	0.346
Question 4: Were you aware about the risk of sea level rise and possible coastal flooding when you opened your current business?	0.716	0.687	0.015	0.643	1.000
Question 5: In recent years, have you experienced coastal flooding?	0.463	0.520	0.694	0.875	0.189
Question 6: Have you ever envisaged that future sea level rise and coastal	0.752	0.665	0.035	0.668	0.978

flooding could threaten your business?					
Question 7: Do you think that sea level rise and flooding will affect your business?	0.199	0.607	0.505	0.801	0.978
Question 8: If you knew the risks that coastal flooding (due to sea level rise and storm surges) could have on your business, would you still have chosen a location along the coast?	0.273	0.162	0.943	0.052	0.153
Question 9: If such an event does happen in future do you think that your business can recover from such a setback?	0.532	0.431	0.514	0.264	0.153
Question 15: Would it be possible to diversify your business operations, should current business operations not be possible anymore due to future impacts of coastal flooding?	0.171	0.027	0.559	0.760	0.444
Question 16: How likely would you consider relocating your business?	0.789	0.916	0.214	0.616	0.053

As one can see from Table 4.22, almost all conducted tests resulted in a negative statistical variance meaning that there are no differences between the responses and the business

category. The fact that out of all the tests concluded, five tests showed that there are differences in the owners' answers by locality shows how lacking the business community is in term of their responses pertaining to perceptions, risk, measures and so on. In respect to coastal flooding, despite having most tests with a negative statistical p-value, the p-value itself does differ from one locality to another in the same question. For example, in question 8, St Julian's had a p-value of 0.943 while Marsalforn had a p-value of 0.153. These results mean that St Julian's has a strong negative statistical significance while Marsalforn had a weak statistical significance, with the strength of the negative significance depends on the number itself. In statistics a p-value of 1 is considered as having strong insignificance while a p-value of 0 is considered to have strong significance. Hence the reason why St Julian's has a strong statistical insignificance and Marsalforn has a weak statistical insignificance. On the other hand, question 1 had St Julian's with a positive statistical significance while the remaining localities had a negative statistical significance. This means that in St Julian's a different trend was identified as the locality resulted to have four out of five positive statistical tests, meaning that there is a correlation between the various business categories and the question it was tested against.

5. Chapter 5: Discussion

5.1. Introduction

This chapter discusses the business community, local councils, and experts' findings in relation to the literature reviews findings, however within the first section of this chapter only the businesses' findings will be discussed while the councils and experts' findings will be discussed later in the second section of this chapter. The following are the business community's major key findings: most businesses never envisaged that sea level rise and storm surge flooding could pose a legitimate threat to their business operations, none of the owners have any contingency plans in case coastal flooding bankrupts their business, due to the high demand most businesses would not consider relocation, and finally a heavily dependence on insurance.

5.2. Findings from the Businesses Community

5.2.1. Perception and Education

This study presented evidence that most of the local business communities in each locality ranked low in terms of awareness and perception on climate change, sea level rise and storm surge flooding on a global dimension. However, when they were asked about sea level rise and storm surge flooding within their respective locality, most owners ranked high in terms of awareness and perception along with the Kruskal Wallis Tests (see Table 4.22) that proved that apart from St Julian's, the business sector is irrelevant in relation to perception and education. Another factor that could have contributed to this lack of knowledge amongst the business community was the lack of meetings organized by governmental bodies that was documented in the business descriptive analysis section (see section 4.5.3) as well as the Chamber of SMEs expert interview.

These two findings correspond to the findings of the author's initial study (Spiteri, 2019) for the localities of Marsaskala, Marsaxlokk, Birżebbuġa, and Msida. This continues to confirm the extent to which business owners may not be knowledgeable enough on scientific issues related to climate change, sea level rise and storm surge flooding on a global scale but they

can easily relate to these phenomena when applied to their own locality due to their own personal experiences. This finding contrasts with that of (Clemo, 2008) in terms of perception and awareness who claimed that 70 percent of the businesses operating in high-risk areas were not even aware that flooding would affect them.

It is becoming clearer that the coastal business community experiences may be an important resource to assess and validate within any future risk assessment of coastal flooding. Similar to this study, (Akerlof et al., 2016) confirmed that living or operating within close proximity of flooding hazards significantly increased the participants' perceptions. This is in line with the Maltese findings, especially in Gozitan coastal localities, where owners reported that they are extremely familiar with sea level rise and storm surge flooding and knew about the risks along with the associated hazards before they established their businesses (see section 4.5.3). In addition, most of them have been living in their respective locality since childhood or inherited their business from their parents who also warned them about the risks involved (see section 4.5.3).

The results presented in Chapter 4 (section 4.5.3) showed evidence that the Gozitan and Maltese business community are not sufficiently informed about the potential risks associated with sea level rise and storm surge flooding by any government entity. In (Thake, 2016) study on perception of climate change amongst the Maltese public, he had observed that education (amongst individual's age, locality, gender, or work) was the only variable that had a meaningful effect in determining their knowledge, awareness, and ability level to act. Scientific education may enable the business community to better understand and become more knowledgeable and aware about climate-change related to coastal flooding.

Receiving information on floods and risk management may help to improve stakeholder involvement but should not be the only strategy to increase knowledge about the importance managing flood risks. In fact, (Lewis, 2012) had discovered that business operators who had received flood risk information from the British Environment Agency had lower knowledge on the importance of managing flood risks than those who had not.

5.2.2. Vulnerability/Risk

i. Elevation

In terms of vulnerability, the land use mapping exercise (see section 4.5.2) has spatially shown the establishment's elevation (i.e., height above sea level) and provides evidence of how many coastal businesses in all selected localities are located around 1-3m above sea level. This factor makes businesses highly susceptible to sea level rise and storm surge flooding and almost all Maltese and Gozitan owners reported that they have experienced sea level rise and storm surge flooding in the past. As a matter of fact, Question 5's Kruskal Wallis Test proved that there is no statistical significance between coastal flooding and the business sector (see Table 4.22). This corroborates with what was seen in the land use mapping exercise, as various business sectors are operating adjacent to one another resulting in all businesses suffering coastal flooding and business disruptions. This finding also agrees with the author's initial study (Spiteri, 2019) and those studies by (Stafford and Renaud, 2019) and (Song et al., 2016) who found that the businesses operating in low lying areas are deemed to be more susceptible to sea level rise and extreme storms. The land use maps also confirm that these coastal areas should be considered high risk areas not only by virtue of elevation above sea level but also by the dense concentration of business services within a very small stretch of the coastal zones, exposed also to some of the most prevalent storms coming from the NW and NE sextants. This was reiterated by (Song et al., 2016) claiming that that the highest deemed flood risk zones do not necessarily intersect with high-risk areas, as other factors apart from flooding, such as land use, road networks and infrastructural quality increase the coastal area's vulnerability.

ii. Business Disruptions

Those owners and local councils who reported that they had already experienced coastal flooding events agree that future flooding by sea level rise and storm surge, may produce more deleterious business disruptions, particularly in their operations. Business disruptions included flooding inside the establishment, small damages, on-going maintenance, temporary closures, decrease in sales, accessibility issues, closing off sections and so on (see Table 4.17). (Spiteri, 2019) had also collected similar information from business owners of other Maltese localities (see section 2.5.4) although for this research, bankruptcy was added as a new

additional disruption, as this latter disruption was not mentioned in this present study; on the contrary most owners believe that coastal flooding is a seasonal element (mostly occurring during winter when business in general is very low) and they will not go bankrupt.

Sea level rise was wrongly assumed by the owners as being a seasonal phenomenon. The wrong perception of seasonality was also documented in (Busuttil, 2011), where her interviewees mentioned that the effects of these two phenomena on the urban environment surrounding the bay is minimal as they are also seasonal (winter). This leads us to another issue - business communities are still thinking that these phenomena will remain seasonal, when on the contrary, it is predicted to happen throughout the year.

Accessibility issues and the reduction in business traffic were also mentioned by the local councils and business owners as two aspects of main concern during episodic flooding events. These issues were also documented by NVivo during the analysis of the Chamber of SMEs and The MCCEI interviews (see section 4.2.1 and 4.2.2). Rizzo (2019) study showed that Triq ix Xatt in Sliema and Xatt ta' San Ġorġ in St Julian's were deemed to be most at risk from flooding. These findings continue to confirm the views expressed in this present study by the business owners operating along these two roads: a significant number of businesses operating in these areas should be designated as high-risk areas from flooding threats.

The business owners' survey has also helped to expand another disruption issue highlighted by (Rizzo, 2019) i.e. the accessibility issues due to road flooding derived from episodic coastal storms. The high risk levels assigned to these roads by (Rizzo, 2019) cascade into high risks for the business operations located along these coastal roads. So, there is risk transference taking place, in view of the small scale of the infrastructure in which both road network and business establishments operate.

A substantial number of business owners in this present research complained about inaccessibility issues due to road flooding since customers are not able to access the establishment when roads are completely flooded. This risk cascading effect was also mentioned by (Song et al., 2016) who reiterated that as sea level rises, a substantial number of road networks, urban and industrial areas and businesses would be exposed to the highest

designated flood risk zones. Moreover, the authors also report that during flooding events, businesses experience a lack of sales during that day/s. This will be explained in further detail under the financial/economic section 5.2.3. The lack of sales derived from accessibility was also pointed out by NVivo during the analysis the Chamber of SMEs and The MCCEI (see section 4.2.1 and 4.2.2). Inaccessibility is a key concern that will inevitably aggravate the risk level, especially if establishments are already facing accessibility issues with present levels; let alone with future projected levels (as mentioned also by Hino et al., 2019). This finding is unique to the real estate industry. The (Union of Concerned Scientists, 2018) pointed out that as sea level rises, property value will decrease significantly in high risk coastal areas. This finding will significantly damage real estate revenue since these localities are extremely low lying.

Another factor that was reported by the Maltese and Gozitan business community is that they experience damages when coastal flooding occurs. Depending on the frequency period and the strength of the storm, owners reported minor to major damages such as broken glass and doors, shorted appliances, useless stock (thrown away), ruined furniture and so on. To see the full list of damages, please refer to Table 4.17. These findings confirm those by (Zhang et al., 2009). In this latter study, Zhang claimed that the damages suffered depended on the intensity of the disaster. Damages could significantly elevate the establishment's vulnerability risk and put pressure on insurance companies due to the number of claims made after every event. In this regard, (Craig et al., 2019) stated that lack of planning would significantly elevate the business's susceptibility level not only to risk but also to higher insurance costs in future.

iii. Relocation

The owners' refusal to relocate in the event of coastal flooding is another finding that significantly increases the establishments' vulnerability level to such coastal risk. Most of the owners interviewed in each locality were adamant that they will not consider relocating their business (see section 4.5.3). This is because the five localities, especially those in Malta, experience high economic profits and turnover throughout the year. Owners working in the catering industry also reported that a coastal location is a must for their sector's location for two reasons: first, walking trade generates a lot of profit along the coast and secondly people

look for establishments near the coast for leisure and dining. This refusal was also confirmed by the Kruskal Wallis Test in Q6 and Q18 as in each locality (see Table 4.22), where all p-values indicate that relocation refusal is not influenced by the business category. In addition, NVivo also documented that walking trade is a major disruption followed by hefty consequences indicating that these areas generate a lot of profit, hence the refusal. A similar argument was presented by (Stafford and Renaud, 2019) who investigated a high percentage of businesses that were at risk of relocation after episodic storm events and yet the communities refused to relocate due to economic turnover generated by the coast as a touristic service area.

5.2.3. Financial/Economic

From the responses of the Maltese and Gozitan business community, it became also evident that they are heavily reliant on insurance to cover the present financial impacts incurred by coastal flooding. When asked about the ability to recover from future coastal flooding setbacks, most of them were confident that they would, due to insurance and past experiences. According to most owners, their insurance plans cover both structural damages to the establishment as well as any loss of revenue incurred, especially if the establishment must temporarily shut down until repairs are concluded. This was verified by Table 4.22 in Q9 where its' results show that this heavy dependence on insurance to recover in the shortest possible time is not influenced by the business sectors in all localities. The current financial recovery of Maltese coastal businesses is similar to that reported in the literature such as by (Clemo, 2008) and (Wedawatta et al., 2014). Clemo (2008), showed that 90 percent of SMEs were underinsured and when asked what measures they have in place to protect themselves against flooding, around 59 percent answered that they were insured against business interruption or loss of earnings and 62 percent also claimed that they are also protected against "acts of god". According to (Clemo, 2008), the lack of awareness and preparedness about the consequences of climate change and flooding from the small-to-medium sized businesses, the insurance industry is extremely nervous due to the huge sums of financial reimbursements being handed out following such events. The authors concluded that due to the nature of small-scale businesses, owners tend to be ill-equipped and with limited resources to deal with flooding. In most cases, the accommodation and catering sector will cease to operate following a flooding event. It is therefore very likely that impacts of coastal

flooding will create a new level of financial vulnerability in which insurance premiums may eventually increase to cover the costs of hazards such as coastal flooding that may likely increase in frequency and severity in future decades.

Wedawatta et al., (2014) also found a strong interaction between post flooding insurance costs and direct physical flood impacts, with a considerable rise in excesses and property insurance costs after the flooding event. It is therefore important to assess better coastal flooding impacts on the Maltese Islands, to allocate more resources and investments to flood protection measures specifically in a post flood property reinstatement stage. With this heavy dependency on insurance, future sea level rise and storm surge flooding will add financial strain to both the businesses and their insurance companies. The insurance costs implications evidenced in this current research need to be examined to better inform decisions by policy makers and profession as insurances are not the only option available.

Dávila et al., (2014) findings on a business community insurance regarding flooding is to recover as soon as possible. The longer time taken to recover the more likely the loss of economic costs in the post-storm recovery plan. This recovery will not only depend on the recovery of damages done to a single property but to the whole territory's vulnerability. Given the high concentration of coastal business located in such a limited space along the Maltese urban coasts (See maps section 4.5.2), impacts of coastal flooding will impact the whole territory.

For instance, in France insurance companies are particularly interested in risk mapping to identify risk at a territorial level. To this end, insurance companies collaborate with the Ministry for Risk Prevention and estimate the number of people living in susceptible areas (Dávila et al., 2014). Micro-insurance programs are being setup to enable affected households to rebuild their properties and livelihoods to recover in the shortest possible time (Intergovernmental Panel on Climate Change, 2012). The role of insurances hence may acquire an important weight in future coastal territory's vulnerability to flooding. From the surveys carried out with the local councils and central government, no reference was made about the role of insurance in future pricing and recovery plans by NVivo.

In literature, micro-businesses (employing 50 people or less) were found to be more vulnerable due to their limited capital power (Davlasheridze and Geylani, 2017). As seen in the land use assessment (see Section 2.4.4) most of the businesses present on the selected coasts are micro-businesses, especially retail and catering services. Yet, no economic detailed assessment has ever been carried out to profile the characteristics of the business community along our coastal zones, as evidenced by feedback given contact from the Ministry of Economy (see Section 4.2.4). Davlasheridze and Geylani (2017) explained how subsidized disaster loans are crucial for micro-businesses and that according to their estimates, for every dollar spent on disaster loans on each establishment, four small businesses will survive. A national estimate of the required recovery costs from flooding will thus require a comprehensive inventory of coastal micro-businesses operating in Malta and Gozo.

5.2.4. Sales Disruptions

Most of the past business disruptions experienced by local stakeholders (Section ii business disruptions) were described as contributing to a reduction in sales, but during the analysis, three specific sales disruptions were identified. The first disruption is related to outdoor seating areas (often 'pavement restaurants/cafeterias' extending from a small interior within the actual building Figure 5.1). The physical dimensions of most establishments in the five studied localities were observed to be quite small and tend to have a large outside capacity but limited space inside. The type of physical setup is the main factor that leads to a reduction in sales when impacted by flooding in view of the cascading impact of road flooding. Road flooding significantly reduces their seating capacity and operations, and sales go down drastically as they cannot use the outside area. To make matters worse, their outside area sits on a platform on the road itself and during flooding the platform itself is completely flooded. In addition, the outer platform elevates the susceptibility level of the establishment. Song et al., (2016) mentioned that flooding or inundation of roads causes devastation to coastal businesses and their sales; likewise, the Maltese and Gozitan businesses experience similar decrease in sales especially the catering industry.



Figure 5.1 – This image illustrates a business establishment in Gzira with its outside seating platform sitting on the pavement (Source: Author, 2021)

The second factor was that these five areas are well renowned for coastal flooding, people avoid these areas during storms (regardless of whether they are flooded or not) and this in turn leads to a reduction in revenue. This is a very common pattern observed in other studies namely (Craig et al., 2019), (Clemo, 2008), (Stanford University, 2019), and (Hino et al., 2019). Craig et al., (2019) also identified that in Virginia Beach, Virginia USA, businesses experience a lack in daily sales during rainy days (see Figure 2.6).

The third and final factor is a new aspect, not mentioned in any literature, including by (Spiteri, 2019): the incidence of foul smell after the flooding event. Several businesses in the catering industry reported that they suffer a reduction in sales, when powerful storms damage the sewage systems, resulting in a pungent smell present while repairs are being done. All three factors were once again documented by NVivo during the The MCCEI and The Chamber of SMEs.

5.2.5. Policies

Similar to (Spiteri, 2019), none of the coastal business interviewed owners have any contingency plans or policies to protect themselves from coastal flooding. Some owners, despite not having any short or long-term plans, took the initiative to implement short term

mitigation measures for their inventory (see Table 4.19) to lessen the effects of sea level rise and storm surge flooding on his/her business. Wedawatta et al., (2014) and Hino et al., (2019) also had similar findings. These authors suggest that a higher understanding of flooding impacts is needed to enable policy makers and professional bodies, such as insurance companies, to provide better advice to small and medium sized businesses. Hino et al., (2019) suggest a more comprehensive inventory of the impacts of flooding on the local economic activity to pioneer efficient adaptation responses. Hino et al., (2019) suggestion is most relevant to Maltese policy makers and owners to develop efficient responses for local adaptations.

5.2.6. Crisis Management

Similar to (Coates et al., 2016) and (Masgrau and Palom, 2012), this current study has found that despite both SME's and the coast are considered an important economic engine, a research gap in business flooding disruptions still exists and which requires a multi-disciplinary approach to the assessment and implementation. The delineation and designation of measures requires multiple disciplines from both the physical and the socio-economic sciences including flooding modelling and simulation, economic modelling, behavioural science, and business continuity management (Coates et al., 2016). Only through such an approach can coastal businesses be given support to build and enhance their resilience against coastal flooding. Flooding assessments similar to those done such as by (Attard, 2017), (Rizzo, 2019), (Attard, 2015) and (Formosa, 2015) could assist the local and central government to visualize the spatial extent of sea level rise and coastal flooding and facilitate more comprehensive and inclusive vulnerability and risk assessments in all coastal urban localities.

Craig et al., (2019) found that most small business owners do not have a disaster plan in place and that around 40 to 60 percent ceased operations after they endured a natural disaster. Usher et al., (2020) found out that many participants did not feel highly vulnerable due to infrastructure mitigation and adaptations efforts taken by the city of Virginia, hence the lack of planning; however large-scale businesses did commence undertaking better strategic, recovery, and preparedness planning. As for disaster planning findings, all three studies do

corroborate each other as none of the interviewed Maltese and Gozitan owners reported that they have any plans. This again significantly elevates their susceptibility level as they are utterly defenseless and are at the mercy of these two phenomena. However, evidence of permanent closures and termination of operations due to coastal flooding were not encountered during this study. The interviewee claims that even though they have suffered from episodic coastal flooding in the past, they have always recovered and carried on with their operations.

5.3. Local Council and Experts Discussion

5.3.1. Introduction

This section will deal with the local councils and experts' findings in relation of the literature review. The major key findings for the local councils were: Sliema, Marsalforn, and Xlendi's councils do not think that with its current projections sea level rise is a threat to the town's economy and residents, while the other two councils believe it is a threat, Gżira, St Julian's, and Xlendi have plans to protect their town against sea level rise while Sliema and Marsalforn reported that no such plans exist. Finally, Gżira, Sliema, and Marsalforn reported that in recent years the council did implement mitigation measures to mitigate these two phenomena while the other two councils reported that no such measures were implemented. As for the experts, each expert has a set of legal responsibilities that allows them to operate within their remit. Within this section, the local council and expert's discussion is combined into one discussion as the local councils are responsible for local governance while the experts, most of whom work for central government, are responsible for national governance.

5.3.2. Perception

When all council members and experts were asked whether they are aware about flooding risks from sea level rise and storm surges, all interviewees agreed that they are extremely aware about these two phenomena. However, when the experts were asked what their role is in addressing these phenomena, only the ones responsible for the environment gave detailed and specific answers; the rest all reported that they rely on other environmental ministries and departments. The local council's perceptions were observed to be similar to those found by (Spiteri, 2019) as all four councils (Marsaskala, Birżebbuġa, Marsaxlokk, and

Msida) in his previous study acknowledged that they were aware of the risks pertaining to sea level rise and storm surge flooding.

Good governance is central to any successful management of hazards and threats driven by climate change. Those same agencies such as environment ones, are more proactive than others and it is expected that addressing this phenomenon will be more in line with their remit. However, given the multi-sectorial nature of the flooding phenomenon, challenges remain as to how to engage with other stakeholders in this effort. Lewis (2012) for example highlighted how the British Environment Agency has taken up a leading role in flood risk mitigation on the Humber Estuary within the governance process. The agency is trying to harmonize flood risk mitigation with sustainable economic development, but despite its efforts, the agency has suffered hefty challenges in engaging with regional and local businesses within the governance process. In this current study it was observed that such leading initiatives in mitigating flood risk and inform the local business community about the risks were sporadic and have not yet been concretely addressed.

Out of five local councils, only one reported that a government entity informed them about the impacts of sea level rise and storm surge flooding on their town. However, it is worth mentioning that three out of five local councils have organized meetings with their residents and business community to discuss these phenomena. For Malta and Gozo, The Chamber of SMEs and The MCCEI that were interviewed reported that they have never informed the business community about these impacts as they have limited resources, already fully occupied and that are forced to prioritize on issues which affect the wider business community (see Section 4.2.1 and 4.2.2). Without a good understanding of how businesses comprehend flood risk and how this affects the participation within a governance process, the full cooperation of the private sector within the flood risk mitigation governance remains highly unlikely, to the detriment of sustainable economic development.

5.3.3. Vulnerability/Risk

A vulnerability/risk assessment is crucial as it assists in prioritizing the most susceptible areas to coastal flooding by collecting data on the impacts of this phenomena. In terms of vulnerability, two (Gżira, and St Julian's) out of five councils reported that they do believe sea

level rise will pose a threat to their town's economy. As for hotspots, only Xlendi's council reported in the negative while, when assessing infrastructure risk susceptibility to sea level rise Gzira and St Julian's councils reported in the negative. This is quite perplexing as they both agreed that sea level rise and storm surge flooding will pose significant risks for their own localities and as already mentioned, when storm surge flooding occurs their infrastructure suffers considerable damages. Their responses also do not concur with real-world scenarios as they all contradict the council's feedback. Figure 5.2 shows the aftermath in St Julian's after a storm surge flooding event that caused significant damages to the town's infrastructure.



Figure 5.2 - Waves smashing into police vehicles along the St Julian's promenade (Source: Times of Malta, 2019)

Similar questions were asked to some experts to assess their responses: TM, PA, MRA, The Ministry for Transport, Infrastructure and Capital Projects, Ministry for Sustainable Development, Environment and Climate Change and the ERA. Experts reported that Sliema does have road networks and infrastructure that are at risk of sea level rise and storm surge flooding and this finding was also confirmed by Sliema's local council findings. Despite having similar geographic and topographic characteristics, none of the experts mentioned the neighboring Gzira and St Julian's. Also, NVivo identified the code of strategy building within The Ministry for Transport, Infrastructure and Capital Projects' analysis which plays a key role in vulnerability/risk assessments. This study's local councils' findings agree with the (Spiteri,

2019) research, however, as previously mentioned, the experts cannot be compared as they were not conducted during that study.

Main et al., (2018) finding was that international comparison for disaster risk intermittently classifies the Maltese Islands as being one of the least hazardous exposed country in the world while (Rizzo, 2019) listing identified roads most susceptible to sea level rise and storm surge flooding. Despite the local councils and experts not specifically listing those identified roads, Sliema has one major road that is highly susceptible to coastal flooding and that is Triq ix-Xatt while in St Julian's there are multiple coastal roads. Rizzo's findings coincide with this study's findings especially when considering that few roads were mentioned by the councils and experts

This current study confirms Rizzo's findings on the need to prioritize investment and plan climate change adaptation measures during the development of coastal roads, as it was found that roads have a strong connection with the success of coastal businesses and overall potential post-flooding recovery of the coastal territories. As elaborated also by (Stafford and Renaud, 2019), a territorial framework in which to identify the different and interconnected factors of risks and vulnerabilities is required in order to both respond and recover well from coastal flooding

5.3.4. Financial/Economic

Tourism attraction is the main economic sources of these coastal businesses. Briguglio (2000) was very clear in considering the tourism sector as at risk from sea level rise, and from extreme weather events, such as storms and flooding. Island tourism is very dependent on transport connectivity and impacting hazards can have a cascading effect on the national economy, from a local to a national level (Kennedy et al., 2020). Flooding may ultimately leave a negative impact on air and sea transport (cruise liners) and other activities /events related to tourism. Due to the small size of Malta, even inland urbanization would therefore be impacted in a cascading manner from coastal flooding, especially those areas surrounding the harbours.

Sierra (2019) Sierra showed that, the number of ports affected by overtopping will increase with sea level rise, along with its financial and economic impact and any financial savings, since implementing the most economic, feasible adaptation measures would allow a minimum level of damages instead of the unfeasible zero damages option. From a local council and Transport Malta Ports and Yachting Directorate perspective, overtopping was never identified, as according to the Directorate sea level rise is of only 1.6mm per year which, according to them, is negligible. Also throughout the experts' analysis, overtopping was never mentioned. This confirms (Sierra, 2019) findings and what was already known in the increase of affected ports as sea level rises, however, in terms of the economic costs that Sierra talked about, it is still unknown within this research, as this factor was overlooked by all local councils and experts interviews. On the contrary, adaptation as a code was identified by NVivo in all interviews apart from the MTA, MRA, and the MCCEI, meaning that adaptation to coastal flooding is given high importance, but overtopping was overlooked.

Dávila et al., (2014) contends that insurance against natural hazards, such as flooding are being integrated in coastal management policies for a few reasons (see section 2.4.4). Intergovernmental Panel on Climate Change (2012) states that financial mechanisms like Insurance, DRR (disaster risk reduction) and other risk transfer instruments aim to minimize the financial losses incurred following natural hazards in developing countries. Micro-insurance programs are being setup to enable affected households rebuild their properties and livelihoods to recover in the shortest possible time. Despite (Dávila et al., 2014) and (Intergovernmental Panel on Climate Change, 2012) findings regarding the role of insurance companies' importance in coastal management and disaster risk reductions, none of the interviewed local councils or experts mentioned insurance as a key component of their coastal management and/or disaster risk reductions policies. As a matter of fact, insurance was never mentioned throughout the interviews.

El Raey et al., (1999) concluded that if no action is taken, around 30 percent of the city of Alexandria will be completely submerged and lost. Around 2 million people will have to abandon their homes, and it is predicted that around 195,000 jobs will be lost together with an estimated \$3.5 billion (€3 billion) of economic losses by the next century. In Port Said, the results indicate that beaches would be acutely affected; this will first affect coastal tourism

and will eventually impact urban areas as well, with the least affected industry expected to be agriculture. Unfortunately, the Ministry for the Economy, Investment and Small Businesses does not collect data on sea level rise and storm surge flooding, meaning a discussion between the Ministry's findings and El Raey cannot take place.

5.3.5. Tourism

Coastal zones are of utmost importance to the tourism industry and the need to protect them is crucial as they are vital to the country's economy and for the many coastal localities and regions. Sagoe-Addy and Appeaning Addo (2013) predicted models for 2020, 2060 and 2100 based on A2 (enhanced regional economic growth) and B2 (more environmentally focused) IPCC scenarios and show that 13 tourism facilities are currently at risk of being flooded due to sea level rise and that 31 percent of all tourism facilities cannot physically endure sea level rise due to their proximity to the shorelines. Sanitation and salinization problems will further aggravate the negative effects on the tourism industry across the coast. When comparing (Sagoe-Addy and Appeaning Addo, 2013) findings with the MTA expert, the findings did not agree as the expert said that the only major impact of sea level rise would be the Island's beaches. The expert reported that thousands of tourists visit Malta in summer specifically for the Island's beautiful climate and beaches. If sea level rises to a point that sandy beaches and bathing areas are significantly reduced or degraded, its consequences will have a direct effect on tourism. Tourists would most likely opt to go to our competitors (Greece, Cyprus, Sardinia and so on) to enjoy their vast sandy coasts and beaches. However, The Seventh National Communication of Malta under the United Nations Framework Convention on Climate Change, reported that one of the likely impacts of sea level rise is loss of beaches which corroborates with what the MTA expert reported.

5.3.6. Policies

From the replies given by the three categories of stakeholders, it is evident that the level of risks involved need to be better understood by stakeholders and that there need to be advances in governance related to openness to policy changes, the latter also reiterated by (Poulter et al., 2009). This is also collaborated by (Mackinson and Middleton, 2018), however,

(Mackinson and Middleton, 2018) presented an interchangeable cooperation between industry research knowledge and the scientific community which was also reiterated by the PA and Environment, Climate Change and Development Planning Policy experts. It is hoped that this current study provided some initial work on the benefits that may emerge from stakeholders' consultation as an exercise of 'openness' to policy change.

5.3.7. Adaptation, Mitigation, Prevention, and Resilience Measures

Key findings by (Busuttil, 2011) were that interviewees agreed that the impacts of sea level rise and storm surge flooding in terms of frequency and intensity needs to be recorded. However according to (Busuttil, 2011) respondents, they said that the effect of these two phenomena on the urban environment and the bays is minimal, as these phenomena are seasonal; therefore infrequent. This seasonality issue was not identified while conducting the local council interviews especially with St Julian's council. As for the experts, again NVivo did not identify seasonality as a code throughout their analysis. Busuttil (2011) stated that precautions and hard and/ or soft engineering methods have to be applied and used sustainably to continuously safeguard the bay.

The PA and the ERA no longer promote the use of hard engineering methods but instead shifted to soft engineering methods, green, and blue infrastructure. Having said that, they also reported that in some scenarios the implementation of green and blue infrastructure is not possible, so they have to revert back to hard or soft engineering methods. Phillips and Jones (2006) both agree and disagree with the PA and the ERA. According to (Phillips and Jones, 2006) hard and soft engineering should be linked to the physical process while soft engineering methods such as beach nourishment, should be linked with the Integrated Coastal Zone Management. While the Ministry for The Environment, Climate Change and Planning reported that in accordance with the Adaptation Strategy, measures are already in place to protect coastlines, infrastructure and so on, they claimed that the implementation of such measures do not fall under their responsibility but with other relevant authorities.

A form of integrated coastal zone management approach needs to be adopted that would allow a reasonable balance between cost effectiveness and overall costs (El Raey et al., 1999;

Sung et al., 2018). Though this study has provided examples of unquantified costs (based on disruptions) related to coastal flooding events, these localities are still very far away from getting a proper management based on cost effectiveness and overall costs. As previously mentioned, the Ministry for the Economy, Investment and Small Businesses does not collect any data on climate change, so such financial costs are not available yet.

Yet, as (El Raey et al., 1999) pointed out, an effective integrated coastal zone management (ICZM) is considered to be a high-cost measure due to its expensive implementation. Land-use change, because of ICZM, is also considered as a very high-cost measure but in the case of the selected coastal localities (and nationwide), implementing land use change to reduce risks would be very complex in view of the already highly developed state of these coasts. Though none of the local councils mentioned the integrated coastal zone management approach, The Ministry for Sustainable Development, Environment and Climate Change, Ministry for Transport, Infrastructure and Capital Projects and PA mentioned a number of plans that all contribute to the integrated coastal zone management such as the Shoreline Management Plan, The National Risk Assessment, Strategic Plan for Environment and Development Plan which identified climate change as a key challenge for the Maltese Islands, and also present the policy framework for the Coastal Zone and Marine Areas.

However, in the (Malta Resources Authority, 2013) Preliminary Flood Risk Assessment Final Report, it is reported that flood events that happen in the Maltese Islands are brought by the reactivation of dry valley systems after rainfall events. Within this report an integrated coastal zone management plan was not mentioned. This is alarming, as floods are strongest in coastal areas and as we have already seen from the business and local councils' data, this causes devastation to the towns. Meanwhile (Aquilina et al., 2017) of The Seventh National Communication of Malta under the United Nations Framework Convention on Climate Change, reported that the regulation of a coastal zone management is critical for sea level rise and anti-flooding measures, even though this report stated that this falls under the infrastructure sector (Ministry for Transport, Infrastructure and Capital Projects). However, the two experts interviewed from the Ministry for Transport, Infrastructure and Capital Projects did not mention the idea of a coastal zone management. As a matter of fact, one of them claimed that they are waiting for the preparation of a Shoreline Management Plan.

Years of infrastructural and economic development advances can be easily undone by one single extreme weather event (Intergovernmental Panel on Climate Change, 2012). Due to their limited financial, skills and labor resources and underdeveloped infrastructure, it may take several years for these small island states, like the Maltese Islands, to recover. Natural disasters usually result in the loss of capital assets and obstruct the production and distribution of the flow of goods and services in the economy; further aggravating the financial burden on these islands (Kennedy et al., 2020). Both the short- and long-term effects of climate change on these islands will hamper the economic and infrastructural development of the affected countries. GDP, foreign trade and public finances will suffer leading to an increase in public debt and poverty. However, when it comes to the Ministry for Transport, Infrastructure and Capital Projects expert, it was documented that those large infrastructural projects, especially if EU funded, will have measures in place to protect them from climate change, natural disaster and so on, as these would have been a necessity.

This study has also shown how much a better connection is needed between (and within) society and the environment pertaining to climate change pressures. The findings point to lack of connection, communication and coordination between the coastal business sector and local/central government on issues related to coastal flooding. (Angus and Hansom, 2021) reiterated that this connection is fundamental and that a high community awareness and participation will translate into a higher success rate in resilience planning.

Resilience can be achieved and improved in susceptible areas via continuous engagement with local stakeholders, backed by research adhering to these policies. In their study about hazards of the Maltese Islands, the findings by (Kennedy et al., 2020) indicated that there is an increase in need for integrated stakeholder collaboration with drought, flooding and storms being the most prominent hazards to affect the Maltese Islands. The key outcome was that the authors also suggest that within the Islands, there is a dire need for training and the development of management strategies and their implementation that could benefit the country and its tourism sector to deal with natural hazards. From a local council perspective, Gżira, St Julian's and Xlendi reported that they organized meetings with their residents and business community to raise awareness on the issues of coastal flooding, however from the

businesses analysis these meetings did not have a higher success in resilience planning as was previously mentioned; businesses lack proper long-term planning and mitigation measures.

As for the experts in terms of protection, the PA and the ERA has shifted to soft engineering and blue and green infrastructure, where coastal dunes align with both authority's philosophy. In terms of priorities, The Ministry for Transport, Infrastructure and Capital Projects expert explicitly stated that priorities depend on the impacts that local communities and/or wider areas endure, however at present there is no comprehensive assessment of risks associated with coastal flooding and its impacts. In the absence of a priority list, the expert claimed that priorities are instigated after a large extreme storm event.

Within the findings of this research, it was identified that there is a lack of community resilience frameworks for disaster risk management in terms of the business community, the local and central government. This corroborates with what (Almutairi et al., 2020) found during their study. Their key findings indicate that around 22 percent of the framework's participants do consider future risks; leaving the remaining 78 percent ill-equipped for examining projected climate change risks. None of the frameworks consulted all stakeholders which are expert bodies, the public and the government. During the development stage which includes applicability, acceptability, and effectiveness, 56 percent within this framework only account for one single hazard instead of a multidimensional hazard approach that is required for a community resilience. This was also corroborated by (Marfai and King, 2008) who claimed that the lack of implemented measures created a significant lack of resilience amongst the communities, despite the fact that improvements have been made on a wide range of coastal inductation issues and that are yet to be addressed.

5.3.8. Management/ Planning

Spiteri (2019), the author's own initial study in his undergrad study's, local councils' finding was that none of the local councils (Marsaskala, Marsaxlokk, Birżebbuġa, and Imsida) had any plans to combat sea level rise and storm surge flooding even though all localities have already experienced storm surge flooding and sea level rise. Recent flooding events have pushed local councils to start evaluating the vulnerability of their locality to coastal flooding and are in the process of drawing up plans to protect their towns from future sea level rise and storm

derived flooding. For this study Sliema, St Julian's, and Marsalforn's councils reported that they have plans in place to protect their towns from sea level rise and storm surge flooding while Gżira and Xlendi reported that no such plans exist. However, Gżira's council reported that their plan is still in the planning phase as it is part of a larger project called "The Gżira Gardens". Furthermore, Gżira, Sliema, and Marsalforn's council reported that they have also implemented measures to protect their town from sea level rise and storm surge flooding.

Yusuf et al., (2018) key finding was that events aided participants to individually broaden their understanding and perspective towards sea level rise and flooding. Those participants who were already exposed to the subject have already established their opinion that the region's willingness to take action was weak. Similarly Gżira, St Julian's and Xlendi did organize meetings with its town's residents and business communities to discuss the impacts of sea level rise and storm surge flooding. However, according to the business descriptive analysis (see section 4.5.3), none of the businesses in these localities have any long term plans to mitigate and manage sea level rise; indicating that (Yusuf et al., 2018) finding could be found in these localities especially when considering that most business owners think that sea level rise and storm surge flooding is seasonal (winter). This finding could shed doubts on how effective these talks were. As for the experts interviews, The Chamber of SMEs reported that they did not set up any meetings with the business community while The MCCEI did. However, The MCCEI did not specify which localities the owners that attended came from.

5.4. Conclusion

This chapter looked at the business communities, local councils, and experts' findings found in the literature review and discussed how these findings corroborate or contradict this study's findings. In all three targeted audiences there were numerous instances of corroboration or contradictions with the literature review which prompted a detailed discussion on why this study corroborated or contradicted the literature review. For instance, the business community accessibility issues were corroborated as it was discovered both in this study and in the literature review. However, when it comes to infrastructure risk assessments, some councils agreed that infrastructure is at risk to sea level rise and storm surge flooding while others did not, which contradicts the literature review's findings and real-life scenarios when these phenomena occur.

6. Chapter 6: Conclusion

6.1. Introduction

A summary of the findings is presented, together with any recommendations for future studies, the constraints that were encountered while conducting this research and new skills gained throughout the process.

6.2. Summary of Findings

i. Local Councils

All five councils reported to be aware about climate change, sea level rise and storm surge flooding along with their implications. However, not all councils agree that with its current projections, sea level rise is a threat to the town's economy and local population. Sliema, Marsalforn and Xlendi do not classify this phenomenon as a threat, while Gżira and St Julian's consider it as a threat. Despite that, all councils except Xlendi identified sea level rise hotspots within their locality. From an infrastructure perspective, Gżira and St Julian's reported that they do not have any infrastructure at risk to sea level rise and storm surge flooding while the remaining localities reported that they do.

All councils except Marsalforn reported that no government entity has ever informed them about the impacts of sea level rise and storm surge flooding; indicating that these councils are not well informed on these phenomena. From a mitigation and planning standpoint, Gżira, Sliema, and Marsalforn reported that they did implement measures to minimize the effects of sea level rise and storm surge flooding while St Julian's and Xlendi reported that no such measures have been implemented. As for future planning, Gżira, St Julian's and Xlendi reported that they do possess such plans while Sliema and Marsalforn reported that to date, no such plans exist. Finally, Gżira, St Julian's and Xlendi reported that they have organized meetings with the town's residents and business community to discuss the most likely effects of sea level rise and storm surge flooding while no such meetings took place in Sliema and Marsalforn.

ii. Business Community

In each locality, more than half of the interviewed business owners claimed to be knowledgeable on sea level rise and storm surge flooding in their respective locality. Most of the business community in all three localities (Gżira, Sliema, and St Julian's) reported that they were not aware of the risks of sea level rise and storm surge flooding before they established their business and that they did not, or rarely thought that sea level rise and storm surge flooding could pose a threat to their business and that it will eventually affect their operations. To make matters worse, none of the interviewed businesses in all three localities have any contingency plans in place in case the worst possible scenario comes to light, where coastal flooding would drive these businesses to bankruptcy. Most of the interviewed owners in each locality were adamant that even if they knew about the risks associated with sea level rise and storm surge flooding, they would have still opted for these localities as according to them, these areas are good for business with high demand for goods and services from locals, tourists, and foreigners alike. This economic factor is the main driving force why these owners also refuse to consider business relocation. In all localities, owners believe that to resolve the recurring issue of coastal flooding, the government needs to invest and plan in building the necessary infrastructure and carry out the necessary maintenance and management of such infrastructure within their respective areas. However, some owners in Sliema and St Julian's do not know what can be done and believe that this issue is practically impossible to solve.

For both localities in Gozo, many of the businesses ranked within the knowledgeable part of the spectrum. It was discovered that both business communities seem to be more familiar with the issues of sea level rise and storm surge flooding than their Maltese counterparts. Many of both communities did not consider the fact that one day, sea level rise and storm surge flooding could pose a threat to their business and disrupt their operations. Just like their Maltese counterparts, none of the businesses in both localities possess any contingency plans in case coastal flooding drives them out of business. Similarly, many owners would have still chosen these localities for their business operations even if they knew about the risks associated with sea level rise and storm surge flooding beforehand as, according to them, they are prime areas for business. Again, the majority also refuse to consider business relocation and firmly believe that to solve coastal flooding, the government needs to build

the infrastructure that will serve as preventive measures. Also, several businesses do not know what can be done and that coastal flooding is practically impossible to solve.

iii. Experts

Amongst all the experts interviewed, two main findings were identified. The first one was that all government and private organizations, entities, departments, ministries interviewed are severely tied to operate within a defined legal framework and that they can only operate and act within their own jurisdiction. The positive side of this was that the issues of climate change are spread out within government entities, as every expert reported that they have a role in climate change aligned with their respective legal obligations. On the other hand, this could lead to a situation where steps need to be taken but no-one will act as it is beyond their remit, creating a “vacuum of responsibilities”. The second key finding is associated with the Ministry for the Economy, Investment and Small Businesses which reported that the Ministry does not collect data on the economic effects of climate change, particularly in relation to sea level rise and storm surge flooding. This is quite perplexing as the localities chosen for this research are vital to this country’s economy.

6.3. Recommendations

6.3.1. Local and Central Government

It is recommended that local councils increase their efforts in raising awareness and educating their residents and business communities on climate change, particularly in sea level rise and storm surge flooding, both of which are consequences of climate change and are of most relevance to the business communities. Central government should also organize meetings with the local council to look at their current set-up and identify future requirements for them to effectively manage coastal flooding by sea level rise and storm surge within their locality.

Presently, local councils lack the necessary resources (capital and technical investment) to carry out this task. If the necessary resources and funds are made available to the local councils, they could be in a better position to carry out studies to investigate what the predicted impacts will be and implement the necessary measures and policies such as: coastal management, land use management, transport management, disaster risk management and

infrastructure management accordingly. In addition, central government should also allocate the necessary funds and resources to develop or upgrade the current infrastructure to withstand these two phenomena so that these towns will be adequately protected and prepared.

The local councils should undertake a risk assessment to assess their vulnerability level not just as a town, but also on specific areas with the town that might be more susceptible than others. A revision of each government's Ministry is also encouraged to make sure that no climate-change related vacuums are created amongst its Ministries due to their legal obligations. It is also important that the Ministry for the Economy, Investment and Small Businesses kicks off the process of collecting data to look at the financial cost of coastal flooding on a national scale.

To address the issues of sea level rise and storm surge flooding on coastal towns and their businesses communities more effectively, high-level planning and management of the area should be at the forefront of anything that pertains to the town itself. This could ensure that less damages and chaos is created when these two phenomena occur simultaneously which would prove invaluable as the situation worsens. What was already suggested by the business communities, was those stakeholders (central and local government and the business community), collaborate more with each other to create a more triangulated and coordinated plan of action to combat the effects of coastal flooding on businesses. This triangulation, if executed in a proper manner, could also prove invaluable as the central and local government have the necessary resources (financial, and experts) to develop and implement mitigation and adaptation measures, while the business community is at the forefront of these impacts thus, know precisely what issues present themselves based on real life scenarios.

6.3.2. Business Community

The business sector should initiate the process of formulating and implementing strategies to ensure business continuity. It is also recommended that all members within this sector are more pro-active in becoming aware and knowledgeable about this issue, so they will be better prepared and informed to make the necessary decisions when implementing mitigation and adaptation measures for their establishment. Finally, those owners that have not yet

implemented any mitigation and adaptation strategies, should start investing in them as they will be needed in the future. The business owners themselves recommended the development and implementation of an early warning system as a mitigation measure by warning the owners to brace their establishment for the upcoming event/s. In addition, a system of this caliber would not only prove useful for the businesses but also for the town's residents to reinforce any weak spots in their houses (where water might seep into their residences) and warn the public to avoid the area. They believe that such a system should be funded and implemented by the central and local government.

6.4. Limitations

Since this study was a continuation of Spiteri (2019) research, the initial experience helped the author to overcome certain challenges during this second study. However, new challenges presented themselves. The preparation of the mixed method questionnaires for the business community and local councils was more time-consuming, as the right mix of closed and open-ended questions needed to be laid out. The same applies for the formulation of the expert interviews: these had to be short, concise, to-the-point, relevant to their field of expertise and designed in such a way to ask the right questions. All three questionnaires were created to be answered in a reasonable time frame for the three targeted audiences to answer effectively. Due to time constraints on their behalf, some open-ended questions were not answered, or the respondents did not provide the level of detail that was hoped to be collected.

Unfortunately, the timing of this study coincided with the Covid-19 global pandemic which made the data collection phase (March 2020- July 2020) a difficult task. The closure of businesses enforced by the health authorities to limit the spread of Covid-19 cases, delayed this process by three months. Data collection started around June-July 2020 and as mentioned in the methodology, was conducted on site (i.e. physically going to the localities to interview owners). Furthermore, these businesses lost three months' worth of revenue and they needed to recover it in the shortest time possible. Most of them were too busy or declined to participate which prompted me to go on multiple occasions on different days and times in the hope of collecting this data. In addition, a significant number of businesses in

each locality (Gżira, Sliema, and St Julian's) were closed during every data collection attempt. It is important to mention that many of the businesses found in the localities are tourism-related, predominantly in the accommodation, catering, and entertainment industry. These were the hardest hit when government ordered the closure of all bars and restaurants. Hotels found it not viable to open as airports closed and tourists were barred from entering the country. This directive coupled with the closure of other businesses significantly impacted on the access to participants in this study.

In St Julian's, the target of collecting 70 questionnaires (50 percent) was not reached and after numerous attempts, 50 questionnaires were the best that could be achieved given the situation. Since data collection was done on site, I came across other challenges which were beyond my control and made data collection rather strenuous. These included social distancing and communication problems due to the wearing of masks, the maximum number of persons at once per establishment and so on. In Gozo, I met the same issues, but overall, when compared to Malta, data collection was less problematic and managed to complete data collection for both localities within the same day. One should note that the sample size for the sister island was relatively smaller (Marsalforn 13, and Xlendi 7) which made data collection much easier. Local councils and experts' questionnaires were distributed via Google forms for which multiple reminders were sent to the invited parties to participate due to their demanding work schedule. Despite all the challenges and obstacles encountered, this task was carried out to the best of the author's ability.

The final limitation is specifically related to the business questionnaire. Since the scope of this study was from a stakeholder management perspective, other important perceptions and demographic questions were left out due to two main reasons. The first reason was that although these questions are important, they were beyond the scope of this study therefore it was not feasible to include them. The second was due to time constraints as this questionnaire needed to be short and conducted in a time-efficient manner. Therefore, other questions more aligned with the scope of this study took precedence. However, some questions particularly asking regarding length of ownership and inheritance of establishment together with their results could have strengthened the results particularly in question 6 and 8 that ask about risks and decision making.

6.5. Research Skills

Although this study was riddled with challenges and obstacles, there were numerous situations outside the author's comfort zone that added new skills to his portfolio. The first one was the use of QGIS to create the maps displayed in the Chapter 4. Another skill developed was in SPSS to conduct the Kruskal Wallis Tests. At the beginning of this MA course, a three-part SPSS course (beginner, intermediate, and advanced) was attended at the University of Malta. Learning of NVIVO to analyse qualitative data was also undertaken.

Furthermore, a considerable experience was gained while carrying out this study that will serve well when carrying out other future research projects. The key factor is the scientific process that any research must rely on. Interviews test out one's ability to get the most scientific feedback in the shortest time possible. In addition, this research demanded time-management, focus and discipline to complete the tasks throughout. It also proved fruitful to learn how to approach and engage with various people coming from all walks of life such as the business communities and others occupying high-level, senior positions in their respective authorities.

6.6. Future Studies

To date, the topic of coastal flooding significantly lacks scientific studies and assessments especially when compared to other areas studying sea level rise and storm surge flooding. In addition, coastal businesses need to be included when studying the impacts of these two phenomena on the country's economy. The two key areas for this research are that it is important to keep on assessing the impacts of these two phenomena, while also assessing what measures are best suited to deal with these two phenomena, and to encourage the business community to account for sea level rise and storm surge flooding in their operational planning, while simultaneously investing in mitigation and adaptation measures. If such businesses are to continue operating, they must keep in mind that both phenomena are expected to increase and worsen in the future.

A suggestion for future researchers is to carry out this same study in other localities until all coastal towns across Malta and Gozo have been covered, as this will present a full picture and a better understanding of the situation. Another suggestion is to look at the future financial and economic impacts that sea level rise and storm surge flooding may have on small coastal businesses. Ideally this should cover both micro and macro economies (local and national economy) as some localities contribute more to the national GDP than others.

Another suggestion could be carrying out a study on coastal business owners to assess in greater detail their perceptions and demographics and identify and assess any similarities or differences between the owners. Another suggestion could be to study the impacts of sea level rise and storm surge flooding on the real estate business as these two phenomena tend to leave a negative effect on property value if located in high-risk areas. Another study could focus on the loss of land brought by sea level rise in these areas. The main scope of this study would be to accurately examine the lost submerged land due to sea level rise. Another two recommendations took inspiration from Craig et al., (2019): one study could carry out a strength, weaknesses, opportunities, and threats (SWOT) analysis on the climatic variability and shifting weather patterns that results in extreme weather events and natural disasters and their associated risks on Maltese coastal businesses; the other recommendation is assessing the daily sales of an establishment against current seasonal flooding to calculate to what extent the loss of revenue incurred by the business community will amount to. The final suggestion would be in identifying the total number of businesses, categorized by segments/sectors found in each coastal town and compare this count against the national aggregate for each business segment. In this way, preventive measures can be taken and applied to the specific business sectors as a priority programme.

It is hoped that this dissertation would help current and future business owners in making informed decisions as well as answering any pertinent questions related to the risk of sea level rise and storm surge flooding. It is also hoped that this dissertation will assist current policy makers and relevant governmental authorities to better manage coastal flooding effects.

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1 Appendix 1

1.1 Global Sea level trends

The (Intergovernmental Panel on Climate Change, 2013), discussed past, present, and future sea level change (see 2.3.3). According to the IPCC, past sea level change is divided into two categories: The Geological Record and The Instrumental Record. The Geological Record is further divided into 4 subcategories, namely:

- The Middle Pliocene
- Marine Isotope Stage 11
- The Last Interglacial Period
- The Late Holocene

1.1.1 The Middle Pliocene

At medium confidence, during the warm period of the Middle Pliocene (around 3.3 to 3 million years ago), records show that global mean surface temperatures were approximately 2°C to 3.5°C warmer when compared with pre-industrial revolution climate. Promising evidence came from proximal sedimentary records that suggested the periodic deglaciation of the East and West Antarctic Ice Sheet along with other models that indicated an almost complete deglaciation of Greenland's ice sheet. During this warm interval, the 0.1 to 0.25% anomalies recorded in the LR04 benthic $\delta^{18}O$ stack (Lisiecki and Raymo, 2005) would translate into ~12 to 31 m higher than present GMSL, if they reflected only ice volume.

1.1.2 Marine Isotope Stage 11

The Marine Isotope Stage 11 occurred between 424,000 and 374,000 years ago. During this period, Antarctic ice and tropical Pacific paleo temperature was around 1.5°C to 2.0°C warmer than pre-industrial times (Masson-Delmotte et al., 2010). Since the AR 4 was published, other studies have included GIA (Glacial Isostatic adjustment) effects (Raymond and Mitrovika, 2012) or reported elevations from sites where the GIA effects are small. The IPCC's assessment is that during the Marine Isotope Stage Period (MIS 11), Global Mean Sea Level (GMSL) was around 6 to 15 meters higher than it is today at medium confidence. To achieve this rise it required all or most of Greenland's ice, West Antarctica Ice Sheet, and a significant

deglaciation in the East Antarctica Ice Sheet of up to 5 meters equivalent of sea level if rise in sea level was already at the higher end.

1.1.3 The Last Interglacial Period

New data and models since the release of AR4 indicate that during the Last Interglacial Period (LIG), which occurred between 129 to 116 thousand years ago, the global mean annual temperature was 1°C to 2°C warmer than preindustrial times at medium confidence with the climax of global annual sea surface temperatures was in the region of 0.7°C ± 0.6°C warmer at medium confidence. The analysis took into consideration the GIA (Glacial Isostatic Adjustment) and its uncertainties along with the uncertainties in the geochronology, regional tectonic uplift, and the interpretation of sea level indicators. Kopp et al., (2013) analysis indicated that the Global Mean Sea Level (GMSL) was 6.4 meters at 95 percent probability and 7.7 meters at 65 percent probability higher than present and with a 33 percent probability that it surpassed 8.8 meters. Another approach taken by Dutton and Lambeck (2012) was to collect data from far field sites that sit on tectonically stable areas. Their assessment was around 5.5 to 9 meters Last Interglacial Period (LIG) global mean sea level (GMSL) and is compatible with the probabilistic projections made by Kopp et al. (2009, 2013).

1.1.4 The Late Holocene

There has been significant progress dealing with the history of sea level over the last 7,000 years since the AR4 has been released. Sea level rise records indicate that from 7,000 to 3,000 years ago, global mean sea level probably rose between 2 to 3 meters to near present-day level. According to local sea level spanning from the last 2,000 years, there is medium confidence that variations in the global mean sea level during this time frame have not exceeded ~ ±0.25 meters on a time scale of a few hundred years. The image below shows sea levels during the Late Holocene Period. Figure Appendix 1.1 shows sea level changes in the last couple of hundred years.

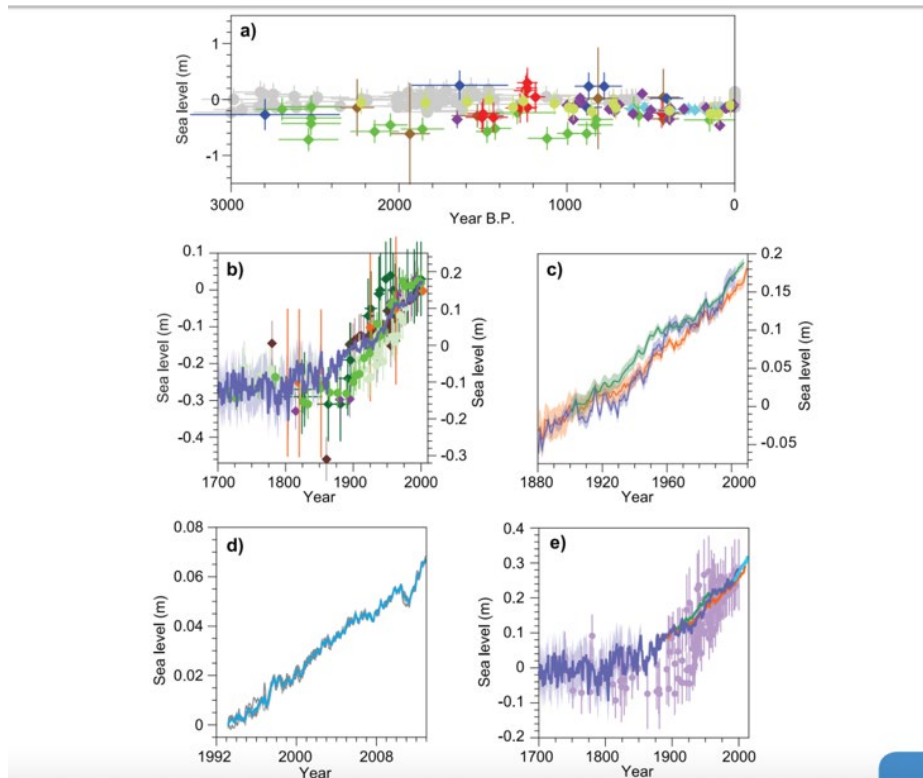


Figure Appendix 1.1 - These graphs show sea level changes in the last couple of hundred years (Source: Intergovernmental Panel on Climate Change, 2013)

1.2 The Instrumental Record

The second part of this section tackles instrumental record of sea level change. The instrumental record is split up into two further categories: tide gauge record and satellite altimeter record. The tide gauge record is basically a compound of tidal measurement over the past two to three centuries (1700-2012) - 2012 was at the time of writing this report). The second measurement is the satellite radar altimeter which was setup in the early 1990s.

The main purpose of a tide gauge record is to record and measure tides. Tide gauges were installed in some northern European ports in the 18th century followed by the Southern Hemisphere in the 19th century. By time, more gauges were set up across European ports and an influx of data was starting to be collected. From the data collected from the last three centuries, scientists can know how sea level changed. According to this data, sea level is highly likely to rise between 1.5 to 1.9mm annually which adds up to an increase of about 0.17 to 0.21 meters between 1901 and 2010.

Satellite Altimeter Record provides an almost global $\pm 66^\circ$ sea level measurement at a 10-day interval. In the altimeter, a slight difference occurs at interannual time scales in the global mean sea level across the globe due to data processing groups situated in different time zones. Despite that, there is a strong agreement on the 20-yearlong global mean sea level flow. After taking into consideration the ~ -0.3 mm per year correction due to the expanding size of the world's ocean basins from the glacial isostatic adjustment, a mean sea level rate around 2.8 to 3.6mm annually over a 19-year time span (1993-2012) is consistent with the different altimetry data processing groups.

Figure Appendix 1.2 shows the changing rates of sea level in sea surface height from tide stations and satellite.

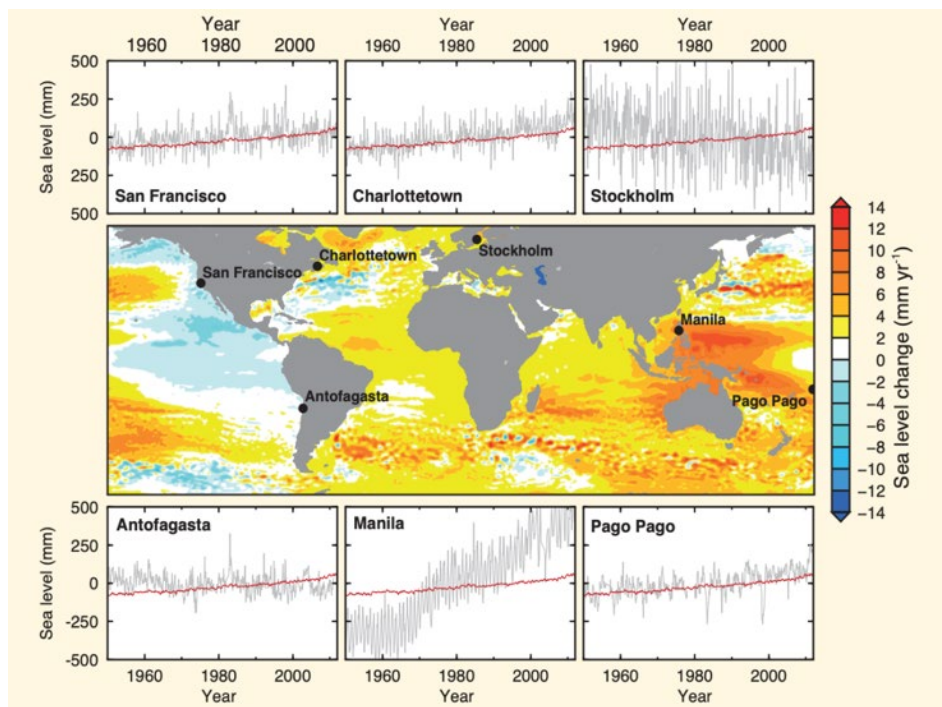


Figure Appendix 1.2 - This image shows the changing rate in sea surface height from 1993-2012 from the satellite altimetry. Whilst the grey represents relative sea level change from specific tide stations from 1950-2012. (Source: Intergovernmental Panel on Climate Change, 2013)

1.3 Ice2sea Studies

Table Appendix 1.1 – Ice2sea Studies (Source: Ice2sea, 2014)

Antarctica	
Observations	Modelling
A 40-year accumulation dataset for Adelie Land, Antarctica and its application for model validation (Agosta et al. 2011)	Computing the volume response of the Antarctic Peninsula ice sheet to warming scenarios to 2200 (Barrand et al. 2013)
Present weather sensors tests for measuring drifting snow (Bellot et al. 2011)	Impact of Basal Melting on a Coupled Dynamic 3d-SIA-SSA_Ocean Model (Determann et al. 2011)
Antarctic ice-shelf thickness from satellite radar altimetry (Griggs et al. 2011)	Antarctic precipitation and climate change predictions: Horizontal resolution and margin vs plateau issues (Genthon et al. 2009)
Greenland	
Observation	Modelling
Seasonal velocities of eight major marine-terminating outlet glaciers of the Greenland ice sheet from continuous in situ GPS instruments (Ahlstrøm et al. 2013)	Effect of uncertainty in surface mass balance-elevation feedback on projections of the future sea level contribution of the Greenland ice sheet (Edwards et al. 2014)
Mass loss of Greenland's glaciers and ice caps 2003-2008 revealed from ICESat laser altimetry data (Bolch et al. 2013)	Estimate of the Sea Level Rise by 2100 Resulting from Changes in the Surface Mass Balance of the Greenland Ice Sheet in Climate Change – Geophysical Foundations and Ecological Effects (Kheradmand et al. 2011)
Historical glacier length changes in West Greenland (Leclercq et al. 2012)	Estimating Greenland ice sheet surface mass balance contribution to future sea level rise using the regional atmospheric climate model MAR (Fettweis et al. 2013)
Glacial	
Observations	Modelling
Investigating changes in basal conditions of Variegated Glacier prior and during its 1982-1983 surge (Allemand et al. 2011)	Permanent fast flow versus cyclic surge behavior numerical simulations of the Austfonna ice cap Svalbard (Dunse et al. 2011)
Sharply increased mass loss from glaciers and ice caps in the Canadian Arctic Archipelago (Gardner et al. 2011)	Climate-model induced differences in the 12th century global and regional contributions to sea-level rise (Giesen et al. 2013)
Fluctuations of tidewater glaciers in Homsund Fiord (Southern Svalbard) since the beginning of the 20 th century (Błaszczuk et al. 2013)	Calibration of a surface mass balance model for global-scale applications (Giesen et al. 2012)
Global	
Observations	Modelling
Squeezing more information out of time variable gravity data with a temporal decomposition approach (Barletta et al. 2012)	Hindcasting to measure ice sheet model sensitivity to initial states (Aschwanded et al. 2013)

Multi-decadal sea level trends and land movements in the Mediterranean Sea with estimates of factors perturbing tide gauge data and cumulative uncertainties (Tsimplis et al. 2011)	Representing Grounding Line Dynamics in Numerical Ice Sheet Models: Recent Advances and Outlook (Docquier et al. 2011)
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2 Appendix 2

2.1 Cloud Isle and Coordinates Sampling

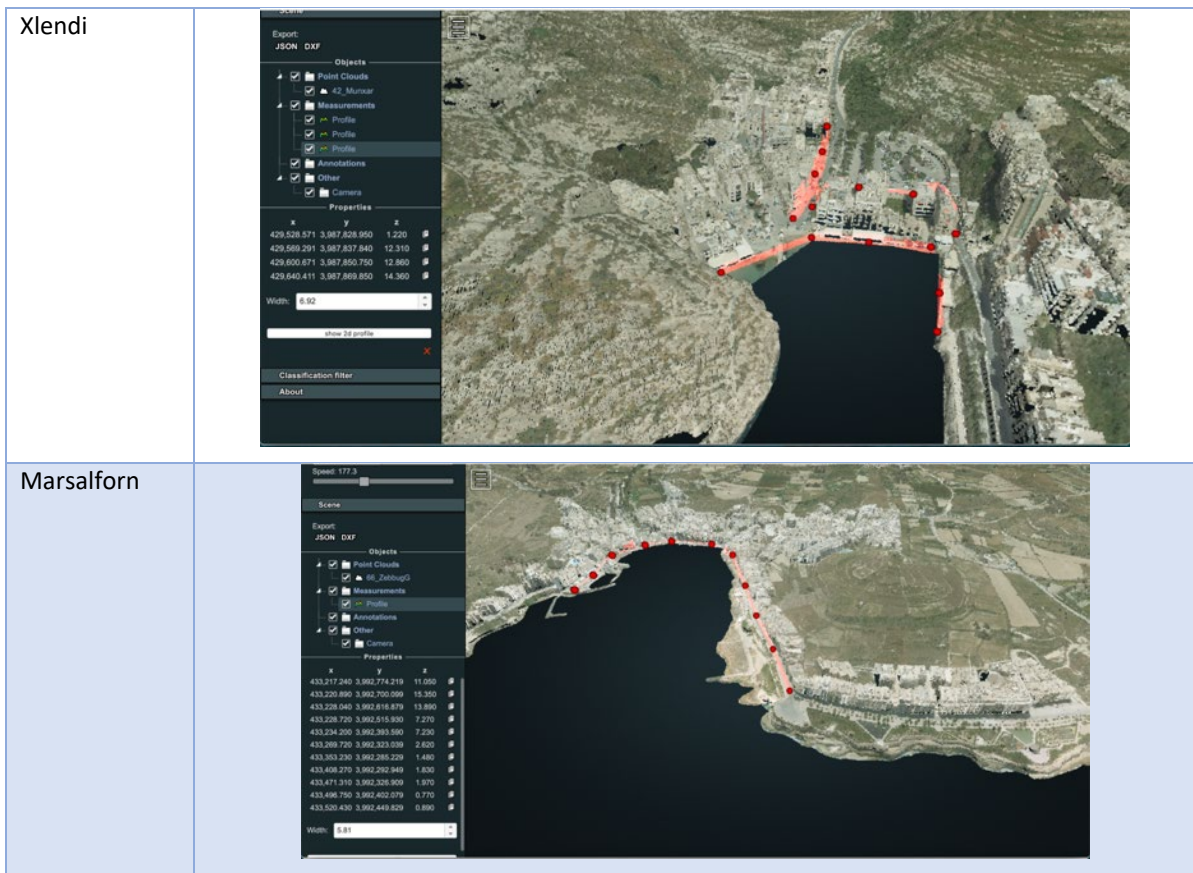
The table below depicts screenshots taken from cloud isle for the construct of the above height profiles (see section 3.4.2).

Table Appendix 2.1 – Cloud Isle Locality Profile Height Images

Locality	Cloud Isle																																				
Gżira	<table border="1"> <thead> <tr> <th>x</th> <th>y</th> <th>z</th> </tr> </thead> <tbody> <tr><td>454,367,950</td><td>3,973,377,329</td><td>2,140</td></tr> <tr><td>454,409,750</td><td>3,973,424,530</td><td>2,250</td></tr> <tr><td>454,448,340</td><td>3,973,465,890</td><td>2,620</td></tr> <tr><td>454,494,870</td><td>3,973,545,310</td><td>2,450</td></tr> <tr><td>454,534,180</td><td>3,973,621,940</td><td>1,900</td></tr> <tr><td>454,583,001</td><td>3,973,678,830</td><td>1,190</td></tr> <tr><td>454,604,861</td><td>3,973,735,999</td><td>2,050</td></tr> <tr><td>454,649,971</td><td>3,973,795,199</td><td>3,580</td></tr> <tr><td>454,700,470</td><td>3,973,861,080</td><td>3,910</td></tr> <tr><td>454,747,840</td><td>3,973,916,530</td><td>2,160</td></tr> <tr><td>454,830,570</td><td>3,974,007,390</td><td>1,030</td></tr> </tbody> </table>	x	y	z	454,367,950	3,973,377,329	2,140	454,409,750	3,973,424,530	2,250	454,448,340	3,973,465,890	2,620	454,494,870	3,973,545,310	2,450	454,534,180	3,973,621,940	1,900	454,583,001	3,973,678,830	1,190	454,604,861	3,973,735,999	2,050	454,649,971	3,973,795,199	3,580	454,700,470	3,973,861,080	3,910	454,747,840	3,973,916,530	2,160	454,830,570	3,974,007,390	1,030
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St Julian's





The table below depicts screenshots consisting of a few sample coordinates used for the construction of the business distribution maps (see section 3.4.3)

Table Appendix 2.2 – Business Sectors Sample Coordinates

Locality	Sample Coordinates			Business Sector
Gżira	A	B	C	Restaurants
	ID	Easting	Northing	
	1	14.493887	35.901934	
	2	14.494278	35.902301	
Sliema	A	B	C	Boat Tours
	ID	Easting	Northing	
	1	14.501008	35.907983	
	2	14.501669	35.90818	
St Julian's	A	B	C	Retail
	ID	Easting	Northing	
	1	14.487543	35.923607	
	2	14.487565	35.923642	
	3	14.487585	35.923656	

Marsalforn	A	B	C	Dive Centres
	ID	Easting	Northing	
	1	14.257951	36.071385	
	2	14.257858	36.071418	
	3	14.258694	36.071246	
Xlendi	A	B	C	Accommodation
	ID	Easting	Northing	
	1	14.217099	36.031007	
	2	14.217423	36.031278	
	3	14.218037	36.03119	

2.2 Expert Questionnaires Samples

2.2.1 The Ministry for Transport, Infrastructure and Capital Projects Expert Interview Sample

The Ministry for Transport, Infrastructure and Capital Projects expert questionnaire consisting of 9 questions (see section 3.8).

Table Appendix 2.3 – Infrastructure Expert Interview.

Question	Justification
1. Can you provide a brief overview on the agency's work related to the risks of climate change, especially in relation to sea-level rise and coastal flooding?	The expert is asked to provide a brief overview regarding the agency's work on risks related to climate change, with special reference to sea level rise and coastal flooding.
2. Has the agency identified road networks and public structures that are at risk of sea-level rise/flooding? If yes, can you give me some more details of the areas that are more likely to be prone to sea level rise?	The expert is asked if the agency identified any coastal infrastructures that are at risk of sea level rise and coastal flooding. If yes, then more details would be asked to be provided about these infrastructures and the areas.
3. What are the agency's priorities on issues that will seek measures to mitigate the effects of sea-level rise and coastal flooding on Maltese coastal urban areas? If so, are the results of these works available for public viewing? If Yes, can you provide more details? If no, why?	The expert is asked about the agency's priorities to seek mitigation measures to mitigate the effects of sea level rise and coastal flooding. If the agency does have such priorities, then the expert will be asked if the results are available for public viewing. The second part of this question is that if the agency does have such works for public viewing, then the expert will be asked for more details to be provided. If the agency does not have then, then the expert is asked to provide reasons why not.
4. In its yearly budget, has the agency allocated funds for further studies to be carried out on the impacts of such a phenomenon on coastal infrastructure, especially in high touristic areas? If yes, can you provide more details?	The expert is asked if the agency allocates funds in its yearly budget for further studies to be carried out on impacts on coastal infrastructures especially in high touristic areas. If the agency does allocate such funds, then the researcher would ask the expert to provide more details. If no funds are allocated, then the researcher would ask for reasons to be provided.

If no, why?	
5. In your opinion, what other resources should be allocated to this agency to enable it to come up with effective measures?	The expert is asked to provide his/her expert's opinion on what resources should be allocated to this agency to enable it to come up with effective measures.
6. Before embarking on any new coastal infrastructural development projects, is the agency taking into consideration sea-level rise and the prospect of more frequent and violent storms resulting and more flooding days and flooded areas? If yes, how? If no, why?	Information on whether the agency is considering sea level rise and storm surge flooding and their prospect of more frequent and violent storms on new coastal development. If the agency is considering such event, the expert is asked to provide details on how the agency is doing it. If no consideration is taken, then the agency would ask the expert to provide reasons why not.
7. Recently, Malta has seen an upgrade on its coastal infrastructure. Where there any measures that may have been put in place to protect these new upgrades / investments from sea-level rise or coastal flooding? If yes, can you provide more details? If no, why haven't any measures been put into place?	Any information as to what protective measures are put in place to protect current and upgraded coastal infrastructure from sea level rise and storm surge flooding. If yes, then the author wants to know what measures are put in place and if no, the reasons why not.
8. Are there any plans to protect coastal infrastructure and investments (such as roads, businesses, buildings and so on.) which are deemed to be at risk of being partly submerged? Likewise, are there any plans to protect those localities with a high incidence of floods? If no, why?	The author wants to know if the agency has any plans to protect coastal infrastructure and investment from sea level rise and coastal flooding. Likewise, the author wants to know the plans, if any exist, to protect coastal towns from such a phenomenon. If there are no plans, the author wants to know the reasons why.
9. If the answer to question 7 was yes, are there any future plans to upgrade the coastal infrastructure to align with the current sea level rise projections and impacts of coastal flooding? If yes, can you provide me with some examples? If no, why	If answered yes in question 7, then the author seeks information on future plans to upgrade existing coastal infrastructure to align with sea level rise projections. If the agency has such information, then the author asks the expert to provide some examples and if the agency does not have such data, then the expert is asked to provide reasons why they do not have.

2.2.2 Environmental Resource Authority (ERA), Malta Resource Authority (MRA), Ministry for the Environment, Sustainable Development and Climate Change, and Planning Authority Expert Interview

Environmental Resource Authority (ERA), the Malta Resource Authority (MRA), and the Ministry for the Environment, Sustainable Development and Climate Change, and to the Planning Authority (PA). All entities have overlapping responsibilities; hence the common questionnaire.

Table Appendix 2.4 – Environmental Resource Authority (ERA), the Malta Resource Authority (MRA), the Ministry for the Environment, Sustainable Development and Climate Change, and the Planning Authority (PA) expert interview.

Question	Justification
<p>1. What is the authority's current role on issues of climate change and especially on sea level rise and coastal flooding?</p>	<p>The author wants to know the authority's current role in relation to climate change issues.</p>
<p>2. To what extent does the agency's work relate to the risks of climate change and sea-level rise? Can you elaborate?</p>	<p>The author wants to have information on the agency's work on risks pertaining to climate change and sea level rise.</p>
<p>3. Has the authority identified any road networks and public structures that are at risk of sea-level rise / coastal flooding?</p> <p>If yes, can you give me some details about them especially those that are more likely to be impacted by sea level rise and coastal flooding than others?</p>	<p>The author wants to know the authority's current knowledge and assessment level on the vulnerability of sea level rise and storm surge flooding. If these road networks and infrastructures have been identified, then the author seeks more detailed information about them.</p>
<p>4. In view of the 2020 targets that were not reached by Malta, what is the future direction being taken to reduce the footprint of carbon dioxide (CO₂)?</p>	<p>Considering that the 2020 EU climate change targets were not reached, the author wants to know what the future direction is to reach the other EU targets.</p>
<p>5. Has the authority identified those areas (localities) that will most likely be affected by sea-level rise and coastal flooding?</p> <p>If yes, can you name a few of those areas?</p> <p>If no, why hasn't the authority identified them yet?</p>	<p>The author is seeking information about the authority's identification of the most likely areas to be affected by sea level rise and coastal flooding.</p> <p>If the authority has identified those areas, then the author would want to know some of those areas. If the authority hasn't yet identified them, then the author would want to know the reasons why.</p>
<p>6. Has the authority conducted any recent studies on the impacts of sea level rise and coastal flooding on coastal towns across the Maltese Islands?</p> <p>If yes, are the studies publicly accessible and what did they entail?</p> <p>If no, why have there not been any studies?</p>	<p>The author is after any information on whether the authority has conducted any recent studies on the impacts of sea level rise and storm surge flooding on coastal towns.</p> <p>If the authority has conducted such studies the author would like to know what the findings were and what did it entail. If no, then he would like to know the reasons why.</p>
<p>7. What is authority's current assessment level and knowledge on the vulnerability of sea level rise and coastal flooding by storms on the Maltese Islands?</p>	<p>The author wants to know the authority's position on protecting coastal towns across the Maltese Islands.</p>
<p>8. What is the authority's position on protection with hard and soft engineering structure of coastal towns across the Maltese Islands?</p>	<p>The author wants to know if the authority foresees any future regulations linked with coastal development especially in low-lying area.</p> <p>If yes, the author would like to know what kind of regulations have been put in place. If no, then he would like to know why the authority does not foresee any future regulations.</p>

<p>9. Do you foresee any future regulations in relation to coastal development of low-lying areas that are highly prone to coastal flooding and sea level rise?</p> <p>If yes, what kind of regulations? If no, why?</p>	<p>The author investigates if the expert foresees any future regulations that needs to come in force in relation to future coastal development, especially in low-lying areas. If the expert foresees regulations, then the author asks what kind of regulations he/she foresees. If no regulations are envisaged, then the author would ask why this is the case.</p>
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2.2.3 Ministry for the Economy, Investment and Small Businesses Expert Interview Sample

The Ministry for the Economy, Investment and Small Businesses expert questionnaire consisting of 10 questions.

Table Appendix 2.5 – Economy expert interview.

Question	Justification
<p>1. What are your views on sea level rise and coastal flooding and its impacts on the Maltese economy?</p>	<p>Information is sought on the expert's thoughts re climate change and its impacts on the Maltese economy.</p>
<p>2. Which sectors of the economy will be most likely affected when sea level rise and coastal flooding occurs?</p>	<p>Information is sought to know which economic sectors will be most likely affected by climate change.</p>
<p>3. For the sectors mentioned in question 2, are the sectors mentioned crucial to the Maltese economy?</p> <p>If yes, why? If no, why?</p>	<p>This question is a follow up question to question 2, where expert is asked on his/her opinion on whether those sectors mentioned in question 2 are of utmost importance to the Maltese economy and the reason/s why.</p>
<p>4. Are Maltese economic advisers taking into account sea level rise and coastal flooding costs in their yearly plan?</p> <p>If no, why?</p>	<p>Information is sought on whether Maltese economists are accounting for climate change costs in their yearly plan. If not, then the expert is asked to for reason/s why.</p>
<p>5. Are there any studies that detail the specific contribution of coastal businesses to Malta's economic revenue?</p> <p>If yes, can you give more details about these studies (reports, figures and so on.) for the sole purpose of this study?</p>	<p>The author wants to assess if the ministry of economics conducted any studies that assessed the contribution of coastal businesses to Malta's economic revenue. If such studies have been conducted, then the expert is asked for more details pertaining this study.</p>
<p>6. What are the government plans to counter the future effects of sea level rise and coastal flooding due to climate change in respect of the Maltese economy?</p>	<p>To investigate whether any governmental plans are implemented to counter the effects of storm surge flooding and sea level rise in coastal areas from an economic perspective.</p>
<p>7. Do you think that sea level rise and coastal flooding will hurt Malta's economy if low-lying touristic places like Sliema, Gzira and St Julian's and so on (business hubs) will get flooded?</p> <p>If yes, how? If no, why?</p>	<p>The expert's opinion is sought whether sea level rise and storm surge flooding will hurt the Maltese economy if low-lying touristic hubs across the island get flooded. Furthermore, the expert is asked to provide reason/s for his/her opinions.</p>

8. If answered yes in question 7, do you think that the Maltese economy can recover from such as loss of revenue? If yes, why? If no, why?	If answered in the affirmative in question 7 then the expert is asked to give an insight on his/her thoughts on whether the Maltese economy can recover from such a revenue loss. Irrespective of the answer the expert is asked to back up his/her thoughts with a reason/s.
9. Do you think that Malta should diversify its economic dependence from the coastal sector to other non-coastal sectors? If yes, why and to what? If no, why?	The author seeks the expert's opinion whether Malta should diversify its economic dependence from one sector to another. Irrespective of the answer the expert is asked to back up his/her answer with reason/s.
10. What is percentage of the GDP allocated by the government to carry out studies and infrastructural changes to mitigate the effect of sea level rise and coastal flooding due to climate change?	The expert is asked to provide an insight on the GDP's gross domestic product) annual percentage that is allocated by the government to conduct studies and infrastructural changes to mitigate the effects of storm surge flooding and sea level rise.

2.2.4 Malta Chambers of Commerce and The Chamber of Small, and Medium Enterprises Expert Interview Sample

This expert questionnaire consists of 9 questions distributed to The Chamber of Small, and Medium Enterprises. The only difference between both questionnaires is by replacing the Chamber title (i.e., The Malta Chamber of Commerce, Enterprise, and Industry was replaced by Chamber of Small and Medium Enterprises).

Table Appendix 2.6 - The Malta Chamber of Commerce, Enterprise, and Industry Chamber of Small and Medium Enterprises expert interview.

Question	Justification
1. What is the role of the Malta Chamber of Commerce?	Understand the functions and roles of the Chamber of Commerce.
2. Is the Chamber aware of the risks of coastal flooding and sea-level rise due to climate change? If yes, what industries have been identified that will suffer from such a phenomenon?	To investigate whether the Chamber of Commerce is aware of the risk of sea level rise and storm surge flooding because of climate change. If answered yes, then the expert is asked for more details about the industries that have been identified and that are expected to suffer from such a phenomenon.
3. In your opinion, how high is such a risk to Malta's commercial activity? What type of disruptions would the Maltese business community expect to experience due to sea level rise and coastal flooding?	The researcher is seeking for the expert's opinion on the level of risk sea level rise and coastal flooding are to Malta's commercial activity. Then the researcher would ask the expert to provide reasons on their opinion. In the second part of this question the researcher asks the expert on the type of disruptions that the Maltese business community is expected to face.
4. Does the chamber have any data that shows the expected loss to revenue, jobs and coastal business establishments due to sea-level rise and coastal flooding?	To investigate if the chamber has any data that shows the expected revenue loss, jobs, and business establishments on the Maltese economy and its labour force due to sea level rise and storm surge flooding.

<p>If yes, can the chamber provide more detail about this data for the purpose of this study?</p> <p>If no, why?</p>	<p>If answered yes, then the expert is asked to elaborate in more detail. If answered no, then the expert is asked for reason/s why the chamber does not have any data.</p>
<p>5. Has the Chamber ever discussed with potential stakeholders the threats which may arise to the business community from sea level rise and coastal flooding?</p> <p>If yes, why?</p> <p>If no, why?</p>	<p>The assess whether the Chamber has ever organized any meetings with any potential stakeholders, discussing sea level rise and storm surge flooding threats that may emerge to the business community.</p> <p>Irrespective of the answer he/she would be asked the backup his/her answer with reason/s.</p>
<p>6. Has the Chamber ever been approached by any of its members requesting information and/or advice on sea-level rise and coastal flooding due to climate change and its effects?</p> <p>If yes, can you provide more details on the reasons why you were contacted by the members?</p>	<p>To assess whether the chamber has ever been approached by any its members requesting information and/or advice regarding sea level rise and storm surge flooding to know their effects.</p> <p>If answered yes, the expert is asked to provide details on the reasons why the Chamber has been contacted.</p>
<p>7. Has the Chamber ever been consulted or been part of discussions initiated by local government on the impact of sea level rise or climate change on local coastal businesses?</p> <p>If yes, what form of discussions took place?</p>	<p>To investigate if the chamber has ever been consulted or been invited to participate in discussions by the government.</p> <p>If answered yes, then the expert is asked to provide more details on what the discussions discussed.</p>
<p>8. Do you think that the Chamber of Commerce should have a role in building a national strategy to address the impacts of coastal flooding and sea level rise on coastal businesses?</p> <p>If no, why?</p>	<p>The expert's opinion on whether the Chamber of Commerce should have a role on in building a national strategy to address the impacts of storm surge flooding and sea level rise on coastal businesses.</p> <p>If answered no, then the expert is asked to elaborate more.</p>
<p>9. If answered yes in question 8, can you provide any details on how the chamber can contribute on its future strategy?</p>	<p>This is a a follow up question to question 8. If answered yes, then the expert is asked to elaborate on how the chamber can contribute on its future strategy.</p>

2.2.5 Civil Protection Department Expert Interview Sample

This expert questionnaire consists of 13 questions distributed to Civil Protection Department.

Table Appendix 2.7 - Civil Protection Department expert interview.

Question	Justification
<p>1. What is the role of the Civil Protection Department pertaining to the risk of climate change, especially in relation to sea-level rise and coastal flooding?</p>	<p>To assess the CPD's role pertaining to the risk of climate change, particularly in sea level rise and storm surge flooding.</p>
<p>2. Which coastal areas in Malta and Gozo does the CPD classify as high risk to sea level rise and coastal flooding?</p>	<p>To investigate which areas, the CPD classify as high risk to sea level rise and storm surge flooding.</p>
<p>3. A. Has the CPD implemented mitigation measures in the above coastal localities?</p> <p>B If answered yes, what type of measures have been implemented?</p>	<p>To investigate whether the CPD implemented any mitigation measures in the localities listed in question 2. If answered yes, the expert is asked to provide the type of measures implemented. If answered no, the expert is asked why any measures haven't been implemented.</p>

C. If answered no, why have no measures been implemented to date?	
4. What type of training and machinery does the CPD have to effectively deal with coastal flooding emergencies?	To investigate what type of training and machinery CPD personnel could employ to effectively deal with coastal flooding emergencies.
5. From which coastal areas does the CPD receive the most emergency calls during flooding events and how are these situations approached?	To look at which localities ask most assistance from CPD during these events and to classify those localities deemed to be at most risk.
6. What type of preventive measures does the CPD implement to reduce the number of coastal flooding related calls before a flooding event?	To assess what is being done from a proactive standpoint to limit the number of emergency calls pertaining to flooding.
7. If there are no measures implemented, what measures do you think should be implemented and how?	To assess the expert's opinion on what measures he/she thinks that should be implemented and their implementation approach.
8. My research is related to the coastal sites of Gżira, Sliema, and St Julian's, Xlendi and Marsalforn (Gozo). What are your views about the flooding risks of these localities based on your professional experience?	To acquire an insight on the expert's opinion on coastal flooding issues in this study's localities.
9. What specific mitigation measures do you think should be implemented in these sites to minimize flooding risks and related hazards in the area?	What are the expert's suggestions on the measures he/she thinks should be implemented in this study's research localities to minimize the risks and any related hazards in the area.
10. How does the CPD effectively intervene in flooding events for Gżira, Sliema, St Julian's, and Xlendi and Marsalforn (Gozo)?	To examine the CDP's approach to effectively intervene in flooding events within this study research areas.
11. Does the CPD liaise with other authorities for these flooding risks interventions and how?	To investigate whether the CDP liaises with any other authority or emergency services when responding to flooding emergencies. Furthermore, investigating the CPD's liaison approach.
12. With future projections of rising sea levels and increase in storm surges, how do you think these projections may impact on the future strategy of the CPD as an intervening authority related to risks and hazards?	Given that future predictions for rising sea levels are expected to rise and storm surges are expected to be more powerful and frequent, the researcher is after the CPD expert's opinion on CPD's future strategies, as an intervening authority, in relation to these risks and hazards.
13. In your opinion, what other resources should be allocated to the CPD to enable it to come up with effective measures to mitigate the effect of sea level rise and coastal flooding?	After the expert's views on what other resources he/she thinks should be allocated to the CPD to enable it to develop effective mitigation measures for sea level rise and storm surge flooding.

2.2.6 Transport Malta Expert Interview Sample

This expert questionnaire consists of 9 questions distributed to Transport Malta.

Table Appendix 2.8 - Transport Malta expert interview

Question	Justification
<p>1. Can you provide a brief overview on the authority's work related to the risks of climate change, especially in relation to sea-level rise and coastal flooding?</p>	<p>To assess what is the authority's work related to climate change risks particularly those related to sea level rise and storm surge flooding.</p>
<p>2. A. Has the authority identified road networks and public structures that are at risk of sea-level rise / flooding?</p> <p>B. If yes, can you provide some more details of the areas that are more likely to be prone to sea level rise?</p> <p>C. If no, why the authority has not yet conducted such an assessment?</p>	<p>To investigate whether the authority has identified any road networks and public structures that are at risk of sea level rise/ storm surge flooding. The second and third part of the question depends on the answer provided. If answered yes, then the expert is asked to elaborate more on those areas that are more susceptible to this phenomenon. If answered no, the expert is asked to elaborate why the authority has not yet conducted such assessment.</p>
<p>3. A. Are coastal flooding and projected sea-level rise taken into account when designing new roads especially along the coast?</p> <p>B. If yes, how are the works planned out in relation to these phenomena?</p> <p>C. If no, why this type of assessment is not taken into account in the project works?</p>	<p>To investigate whether projected sea level rise and storm surge flooding predications are taken into account when designing new roads especially along the coast. If answered yes, the expert is asked to provide additional details on how the works are planned out in relation to them. If answered no, the expert is asked to provide a reason why this type of assessment is not taken into account.</p>
<p>4. A. Flooding of coastal roads leads to heavy traffic congestions or disruptions. Does the authority have any management strategies in place to minimize these disruptions when these phenomena occur?</p> <p>B. If yes, what type of strategies are currently being implemented?</p> <p>C. If no, give reasons to explain why the authority does not have such management strategies.</p>	<p>To assess whether the authority has implemented any management strategies to reduce disruptions on Maltese roads when these phenomena occur. If yes, the expert is asked to elaborate on the type of implemented strategies. If answered no, then the expert is asked to provide reasons why such management strategies do not exist.</p>
<p>5. A. When new coastal infrastructural development projects are proposed, does the agency give advice (or is asked for advice) on the likely impacts of sea-level rise and violent storms which may result in more flooding days and flooded areas?</p> <p>B. If yes, how are such assessment done?</p> <p>C. If no, why?</p>	<p>To investigate whether the authority is called upon by other authorities for consultation on the impacts of sea level rise and storm surge flooding on any forthcoming development projects.</p>
<p>6. A. Recently, Malta has seen an upgrade on its coastal roads. Have any measures been put in place to protect these new upgrades/investments from sea-level rise or coastal flooding?</p> <p>B. If yes, how?</p>	<p>To assess whether any measures have been implemented to protect Malta's newly upgraded coastal roads from sea level rise and/or storm surge flooding. If answered yes, the expert is asked to elaborate on the implementation approach for such measures. If answered no, the expert is asked to elaborate on why no measures been implemented.</p>

	C. If no, why?	
7.	A. Are there any plans to protect coastal infrastructure and investments (such as roads) which are deemed to be at risk of being partly submerged? B. If yes, can you provide more details? C. If no, can you provide one reason or more for your answer?	To assess whether there are any plans in the pipeline to protect current coastal infrastructure (such as roads) that are deemed to become at risk of being partially or fully submerged. If answered yes, then the expert is asked to provide more details. If answered no, the expert is asked to provide reasons why no plans exist.
8.	B. If the answer to question 7 was yes, are there any future plans to upgrade the coastal roads to align with the current sea level rise projections and impacts of coastal flooding? C. If yes, can you provide some examples? D. If no, why?	To assess whether there are any future plans to upgrade coastal roads to align them with current and future sea level rise projections. If answered yes, the expert is asked to provide some examples if possible. If answered no, the expert is asked for reason/s why no future plans exist.
9.	In your opinion, what other resources should be allocated to this authority to enable it to come up with effective measures to mitigate the effect of sea level rise and coastal flooding?	To acquire an insight on his/her opinion regarding the necessary resources this authority should have to enable it in the development of effective mitigation measures to mitigate the impacts of sea level rise and storm surge flooding.

2.2.7 Transport Malta Ports and Yachting Directorate Expert Interview Sample

This expert questionnaire consists of 10 questions distributed to the Transport Malta Ports and Yachting Directorate

Table Appendix 2.9 - Transport Malta Ports and Yachting Directorate expert interview

Question	Justification
1. Can you provide a brief overview on the Ports and Yachting Directorate work pertaining to the risks of climate change, especially in relation to sea-level rise and coastal flooding?	To assess the Directorate's role pertaining to the risks of climate change particularly with sea level rise and storm surge flooding.
2. In your opinion, to what extent do you think that current coastal infrastructures are currently equipped to deal with risk and hazards related to sea level rise and coastal flooding?	To examine the expert's confidence level regarding the tolerance capability of current coastal infrastructure to withstand the risks and hazards associated with this phenomenon.
3. In your opinion, which do you think are the foreseen impacts of coastal flooding and sea level rise on the maritime services of the Maltese Islands?	Does the expert think that the maritime services currently offered will be negatively affected in the event of sea level rise and storm surge flooding?
4. A. Are the services mentioned in question 3 imperative for the Maltese economy and the maritime industry? B. If yes, how? C. If no, why?	The assess whether the services mentioned in question 3 are vital for the Maltese economy and the maritime industry. If answered yes, the expert is asked to elaborate. If answered no, then the expert is asked to provide reason/s to back up their answer.
5. A. Have the Ports and Yachting Directorate considered any mitigation measures to protect coastal infrastructure and towns from sea level rise and coastal flooding? B. If yes, what type of measures have been implemented?	Examining whether the Directorate considered any mitigation measures to protect coastal towns and infrastructures from sea level rise and storm surge flooding. If answered yes, the expert is asked to elaborate on these measures. If answered no, the expert is asked to provide reason/s why no mitigation measures have been considered. Furthermore, if answered no, the expert is

<p>C. If answered no, why are not any mitigation measures being considered?</p> <p>D. If answered no, what types of mitigation measures do you think should be implemented by the Port and Yachting Directorate?</p>	<p>asked for his/her opinion on what mitigation measures should be implemented.</p>
<p>6. A. My research is related to the coastal sites of Gżira, Sliema, and St Julian's, Xlendi and Marsalforn (Gozo). Do you think coastal flooding events and sea level rise may disrupt seaborne transport in these coastal localities?</p> <p>B. If yes, can you please provide more details?</p> <p>C. If no, could you provide details to substantiate your answers?</p>	<p>Examining the expert's opinion on any disruptions brought by this phenomenon on sea transport within this study's localities. If answered yes, the expert is asked to provide more details. If answered no, the expert is asked provide reasons to substantiate the answer/s</p>
<p>7. In your opinion what are the likely impacts of coastal flooding and sea level rise on private and commercial berthing sites along these coastal sites mentioned in Question 6?</p>	<p>To investigate the expert's opinion on the likely impacts of sea level rise and coastal flooding on private and commercial berthing sites in the localities mentioned in question 6.</p>
<p>8. A. Given the planned increase in seaborne transport (ferry services) especially in the area of Sliema and St. Julian's, is sea level rise and coastal flooding taken into consideration when constructing new berthing facilities?</p> <p>B. If answered yes, what type of measures are implemented to protect these platforms?</p> <p>C. If answered no, why no mitigation measures are considered</p>	<p>Assessing whether sea level rise and storm surge flooding is taken into account when constructing new berthing sites. If answered yes, the expert is asked to elaborate on the type of measures. If answered no, the expert is asked to elaborate why such measures were neglected.</p>
<p>9. In your opinion, what other resources should be allocated to the Ports and Yachting Directorate to enable it to come up with effective measures to mitigate the effect of sea level rise and coastal flooding in these areas?</p>	<p>Assessing the expert's opinion on what other resources should be allocated to this directorate.</p>
<p>10. With future projections of rising sea levels and increase in storm surges, how do you think these projections may impact on the future strategies of the Ports and Yachting Directorate as the competent authority related to maritime affairs?</p>	<p>Assessing the expert's thoughts and predictions of future sea level rise and storm surges flooding impacts on the directorate's future strategies.</p>

3 Appendix 3

3.1 Individual Locality Kruskal Wallis Tests

i. Question 1: How familiar are you with the issues of climate change and its implications

This question statistically assessed whether there is a correlation between the various business sectors and the owner’s familiarity with the issues and implications of climate change.

Kruskal–Wallis Test

Ranks			
	BusinessType	N	Mean Rank
Familiarity	Accommodation	2	11.00
	Catering	16	19.94
	Retail	22	21.77
	Total	40	

Test Statistics^{a,b}

Familiarity	
Kruskal–Wallis H	1.689
df	2
Asymp. Sig.	.430

- a. Kruskal Wallis Test
b. Grouping Variable: BusinessType

Figure Appendix 3.1- Gżira Question 1

Kruskal–Wallis Test

Ranks			
	BusinessType	N	Mean Rank
Familiarity	Catering	23	24.85
	Retail	27	26.06
	Total	50	

Test Statistics^{a,b}

Familiarity	
Kruskal–Wallis H	.089
df	1
Asymp. Sig.	.765

- a. Kruskal Wallis Test
b. Grouping Variable: BusinessType

Figure Appendix 3.2 – Sliema Question 1

Kruskal–Wallis Test

Ranks			
	BusinessType	N	Mean Rank
Familiarity	Accommodation	6	8.25
	Catering	27	26.59
	Retail	17	29.85
	Total	50	

Test Statistics^{a,b}

Familiarity	
Kruskal–Wallis H	10.571
df	2
Asymp. Sig.	.005

- a. Kruskal Wallis Test
b. Grouping Variable: BusinessType

Figure Appendix 3.3 – St Julian’s Question 1

Kruskal–Wallis Test

Ranks			
	BusinessType	N	Mean Rank
Familiarity	Accommodation	1	3.50
	Catering	9	6.94
	Retail	3	8.33
	Total	13	

Test Statistics^{a,b}

Familiarity	
Kruskal–Wallis H	1.309
df	2
Asymp. Sig.	.520

- a. Kruskal Wallis Test
b. Grouping Variable: BusinessType

Figure Appendix 3.4 – Marsalforn Question 1

Kruskal–Wallis Test

Ranks			
	BusinessType	N	Mean Rank
Familiarity	Accommodation	1	2.50
	Catering	2	2.50
	Retail	4	5.13
	Total	7	

Test Statistics^{a,b}

Familiarity	
Kruskal–Wallis H	2.625
df	2
Asymp. Sig.	.269

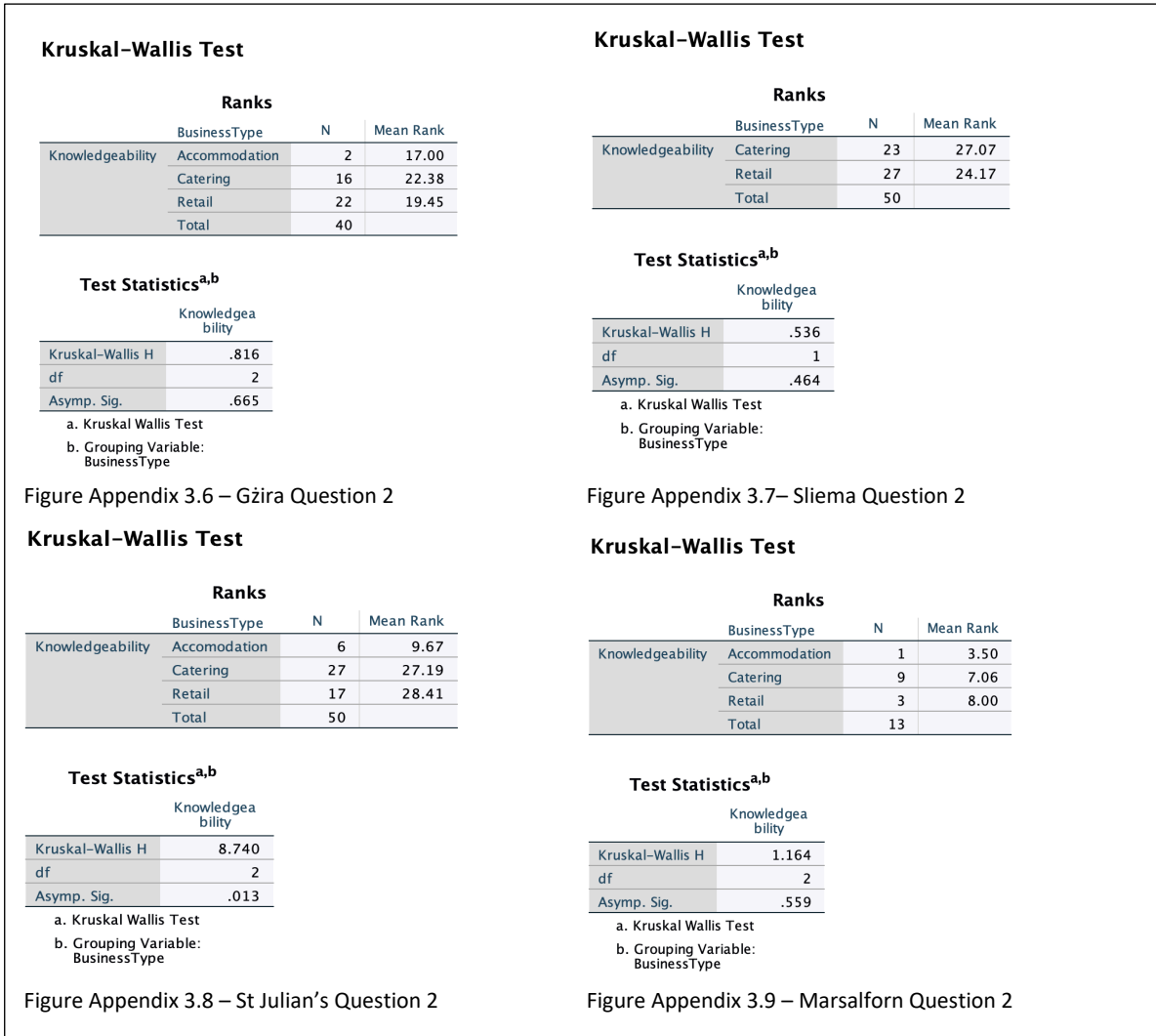
- a. Kruskal Wallis Test
b. Grouping Variable: BusinessType

Figure Appendix 3.5 – Xlendi Question 1

Table 4.22 exhibits that St Julian’s is the only locality that retained the alternative hypothesis (H1) while the rest retained the null hypothesis listed in Table 4.21.

ii. Question 2: How informed are you about coastal flooding (in your locality)?

This test was conducted to statistically assess whether there is a correlation between the various business sectors and the owner’s familiarity with coastal flooding within their locality.



Kruskal–Wallis Test

		Ranks	
	BusinessType	N	Mean Rank
Knowledgeability	Accommodation	1	2.50
	Catering	2	2.75
	Retail	4	5.00
	Total	7	

Test Statistics^{a,b}

		Knowledgeability
Kruskal–Wallis H		2.123
df		2
Asymp. Sig.		.346

a. Kruskal Wallis Test

b. Grouping Variable:
BusinessType

Figure Appendix 3.10– Xlendi Question 2

Table 4.22 exhibits that St Julian’s was the only locality that retained the alternative hypothesis while the remaining localities retained the null hypothesis listed in Table 4.21.

iii. Question 4: Were you aware about the risk of sea level rise and possible coastal flooding when you opened your current business?

A statistical test was carried out to investigate whether there is a correlation between the various business sectors and the owner’s awareness pertaining to the risk of sea level rise and storm surge flooding before he/she established their business.

Kruskal-Wallis Test

Ranks			
	BusinessType	N	Mean Rank
Familiarity	Accommodation	2	21.75
	Catering	16	18.75
	Retail	22	21.66
	Total	40	

Test Statistics^{a,b}

Familiarity	
Kruskal-Wallis H	.669
df	2
Asymp. Sig.	.716

- a. Kruskal Wallis Test
b. Grouping Variable:
BusinessType

Figure Appendix 3.11 – Gzira Question 4

Kruskal-Wallis Test

Ranks			
	BusinessType	N	Mean Rank
Awareness	Catering	23	26.33
	Retail	27	24.80
	Total	50	

Test Statistics^{a,b}

Awareness	
Kruskal-Wallis H	.162
df	1
Asymp. Sig.	.687

- a. Kruskal Wallis Test
b. Grouping Variable:
BusinessType

Figure Appendix 3.12 – Sliema Question 4

Kruskal-Wallis Test

Ranks			
	BusinessType	N	Mean Rank
Awareness	Accommodation	6	12.67
	Catering	27	24.81
	Retail	17	31.12
	Total	50	

Test Statistics^{a,b}

Awareness	
Kruskal-Wallis H	8.454
df	2
Asymp. Sig.	.015

- a. Kruskal Wallis Test
b. Grouping Variable:
BusinessType

Figure Appendix 3.13 - St Julian's Question 4

Kruskal-Wallis Test

Ranks			
	BusinessType	N	Mean Rank
Awareness	Accommodation	1	7.50
	Catering	9	6.39
	Retail	3	8.67
	Total	13	

Test Statistics^{a,b}

Awareness	
Kruskal-Wallis H	.885
df	2
Asymp. Sig.	.643

- a. Kruskal Wallis Test
b. Grouping Variable:
BusinessType

Figure Appendix 3.14 - Marsalforn Question 4

Kruskal-Wallis Test

Ranks			
	BusinessType	N	Mean Rank
Awareness	Accommodation	1	4.00
	Catering	2	4.00
	Retail	4	4.00
	Total	7	

Test Statistics^{a,b}

Awareness	
Kruskal-Wallis H	.000
df	2
Asymp. Sig.	1.000

- a. Kruskal Wallis Test
b. Grouping Variable:
BusinessType

Figure Appendix 3.15 – Xlendi Question 4

Table 4.22 indicates that St Julian's was the only locality that retained the alternative hypothesis while the rest retained the null hypothesis listed in Table 4.21.

iv. Question 5: in recent years, have you experienced coastal flooding?

A statistical analysis was conducted to test whether there is a correlation between the various business sectors and any recent coastal flooding experience.

Kruskal-Wallis Test

Ranks			
	BusinessType	N	Mean Rank
Familiarity	Accommodation	2	24.75
	Catering	16	18.06
	Retail	22	21.89
	Total	40	

Test Statistics^{a,b}

Familiarity	
Kruskal-Wallis H	1.539
df	2
Asymp. Sig.	.463

- a. Kruskal Wallis Test
- b. Grouping Variable: BusinessType

Figure Appendix 3.16– Gżira Question 5

Kruskal-Wallis Test

Ranks			
	BusinessType	N	Mean Rank
Frequency	Catering	23	26.87
	Retail	27	24.33
	Total	50	

Test Statistics^{a,b}

Frequency	
Kruskal-Wallis H	.414
df	1
Asymp. Sig.	.520

- a. Kruskal Wallis Test
- b. Grouping Variable: BusinessType

Figure Appendix 3.17– Sliema Question 5

Kruskal-Wallis Test

Ranks			
	BusinessType	N	Mean Rank
Frequency	Accommodation	6	21.08
	Catering	27	26.52
	Retail	17	25.44
	Total	50	

Test Statistics^{a,b}

Frequency	
Kruskal-Wallis H	.731
df	2
Asymp. Sig.	.694

- a. Kruskal Wallis Test
- b. Grouping Variable: BusinessType

Figure Appendix 3.18 – St Julian’s Question 5

Kruskal-Wallis Test

Ranks			
	BusinessType	N	Mean Rank
Frequency	Accommodation	1	5.50
	Catering	9	7.00
	Retail	3	7.50
	Total	13	

Test Statistics^{a,b}

Frequency	
Kruskal-Wallis H	.267
df	2
Asymp. Sig.	.875

- a. Kruskal Wallis Test
- b. Grouping Variable: BusinessType

Figure Appendix 3.19 - Marsalforn Question 5

Kruskal-Wallis Test

Ranks			
	BusinessType	N	Mean Rank
Frequency	Accommodation	1	6.00
	Catering	2	5.00
	Retail	4	3.00
	Total	7	

Test Statistics^{a,b}

Frequency	
Kruskal-Wallis H	3.333
df	2
Asymp. Sig.	.189

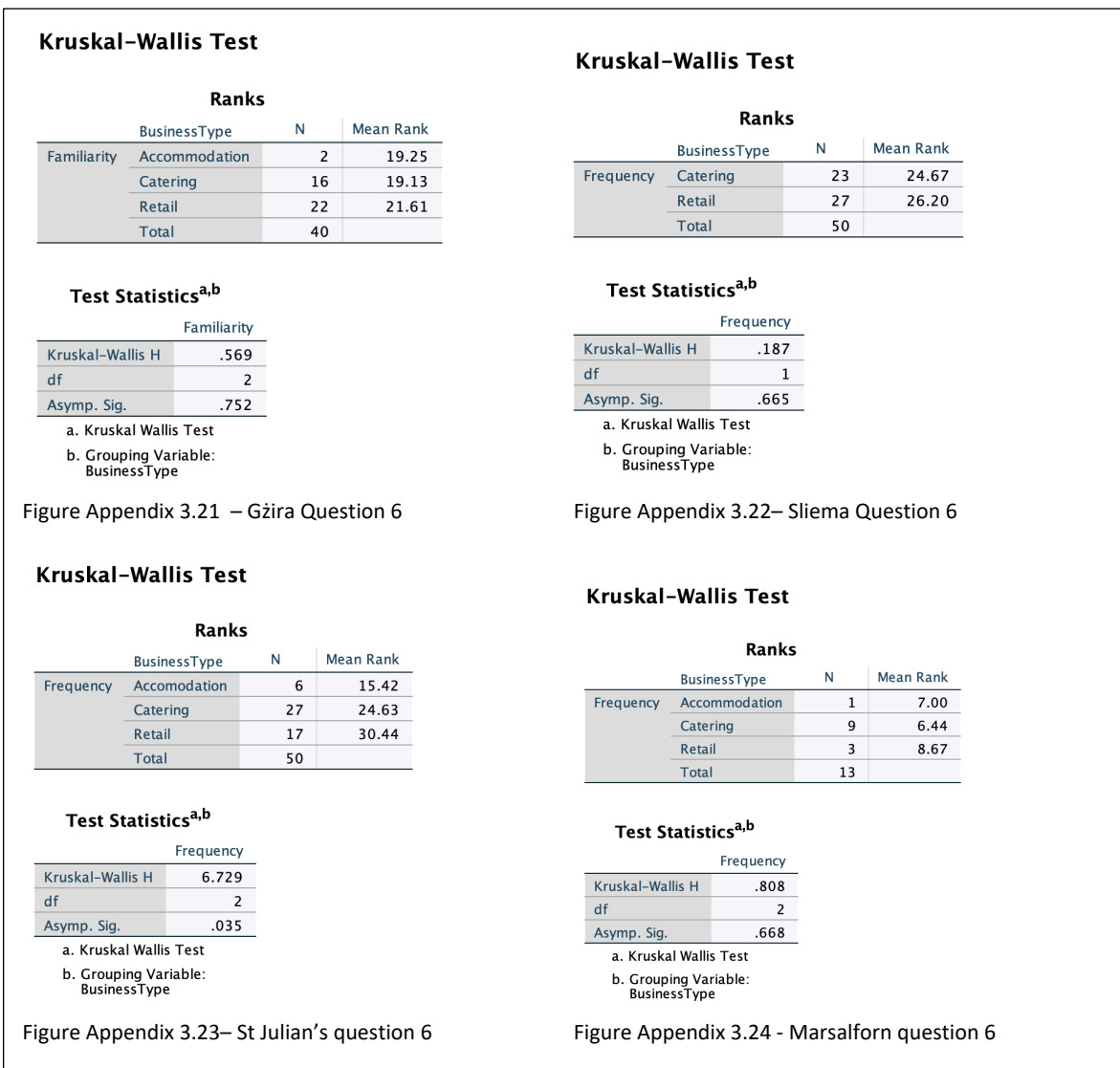
- a. Kruskal Wallis Test
- b. Grouping Variable: BusinessType

Figure Appendix 3.20 - Xlendi Question 5

Table 4.22 all localities retained the null hypothesis mentioned in Table 4.21.

v. Question 6: Have you ever envisaged that future sea level rise and coastal flooding could threaten your business?

To assess whether there is a relationship between the various business sectors and the owner’s prediction regarding the effects future sea level rise and storm surge flooding could have on their business.



Kruskal–Wallis Test

Ranks			
	BusinessType	N	Mean Rank
Frequency	Accommodation	1	4.00
	Catering	2	4.25
	Retail	4	3.88
	Total	7	

Test Statistics^{a,b}

	Frequency
Kruskal–Wallis H	.044
df	2
Asymp. Sig.	.978

a. Kruskal Wallis Test

b. Grouping Variable:
BusinessType

Figure Appendix 3.25 – Xlendi Question 6

According to Table 4.22 St Julian’s was the only locality that retained the alternative hypothesis while the rest retained the null hypothesis listed in Table 4.21.

vi. Question 7: Do you think that sea level rise and flooding will affect your business?

A Kruskal Wallis test was conducted to examine whether there is a statistical relationship between the various business sectors and the owners’ opinion pertaining to the possible effects that sea level rise and storm surge flooding could have on his/her business.

<h4 style="text-align: center;">Kruskal–Wallis Test</h4> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th colspan="4">Ranks</th> </tr> <tr> <th></th> <th>BusinessType</th> <th>N</th> <th>Mean Rank</th> </tr> </thead> <tbody> <tr> <td rowspan="4">Likelihood</td> <td>Accommodation</td> <td>2</td> <td>19.75</td> </tr> <tr> <td>Catering</td> <td>16</td> <td>16.81</td> </tr> <tr> <td>Retail</td> <td>22</td> <td>23.25</td> </tr> <tr> <td>Total</td> <td>40</td> <td></td> </tr> </tbody> </table> <h4 style="text-align: center;">Test Statistics^{a,b}</h4> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th></th> <th>Likelihood</th> </tr> </thead> <tbody> <tr> <td>Kruskal–Wallis H</td> <td>3.225</td> </tr> <tr> <td>df</td> <td>2</td> </tr> <tr> <td>Asymp. Sig.</td> <td>.199</td> </tr> </tbody> </table> <p>a. Kruskal Wallis Test b. Grouping Variable: BusinessType</p> <p>Figure Appendix 3.26– Gżira Question 7</p>	Ranks					BusinessType	N	Mean Rank	Likelihood	Accommodation	2	19.75	Catering	16	16.81	Retail	22	23.25	Total	40			Likelihood	Kruskal–Wallis H	3.225	df	2	Asymp. Sig.	.199	<h4 style="text-align: center;">Kruskal–Wallis Test</h4> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th colspan="4">Ranks</th> </tr> <tr> <th></th> <th>BusinessType</th> <th>N</th> <th>Mean Rank</th> </tr> </thead> <tbody> <tr> <td rowspan="3">Likeliness</td> <td>Catering</td> <td>23</td> <td>26.57</td> </tr> <tr> <td>Retail</td> <td>27</td> <td>24.59</td> </tr> <tr> <td>Total</td> <td>50</td> <td></td> </tr> </tbody> </table> <h4 style="text-align: center;">Test Statistics^{a,b}</h4> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th></th> <th>Likeliness</th> </tr> </thead> <tbody> <tr> <td>Kruskal–Wallis H</td> <td>.264</td> </tr> <tr> <td>df</td> <td>1</td> </tr> <tr> <td>Asymp. Sig.</td> <td>.607</td> </tr> </tbody> </table> <p>a. Kruskal Wallis Test b. Grouping Variable: BusinessType</p> <p>Figure Appendix 3.27 – Sliema Question 7</p>	Ranks					BusinessType	N	Mean Rank	Likeliness	Catering	23	26.57	Retail	27	24.59	Total	50			Likeliness	Kruskal–Wallis H	.264	df	1	Asymp. Sig.	.607
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Asymp. Sig.	.607																																																							

Kruskal-Wallis Test

Ranks			
	BusinessType	N	Mean Rank
Likeliness	Accomodation	6	20.33
	Catering	27	25.19
	Retail	17	27.82
	Total	50	

Test Statistics^{a,b}

Likeliness	
Kruskal-Wallis H	1.366
df	2
Asymp. Sig.	.505

- a. Kruskal Wallis Test
b. Grouping Variable:
BusinessType

Figure Appendix 3.28 – St Julian’s Question 7

Kruskal-Wallis Test

Ranks			
	BusinessType	N	Mean Rank
Likeliness	Accommodation	1	9.00
	Catering	9	7.00
	Retail	3	6.33
	Total	13	

Test Statistics^{a,b}

Likeliness	
Kruskal-Wallis H	.444
df	2
Asymp. Sig.	.801

- a. Kruskal Wallis Test
b. Grouping Variable:
BusinessType

Figure Appendix 3.29 – Marsalforn Question 7

Kruskal-Wallis Test

Ranks			
	BusinessType	N	Mean Rank
Likeliness	Accommodation	1	4.00
	Catering	2	4.25
	Retail	4	3.88
	Total	7	

Test Statistics^{a,b}

Likeliness	
Kruskal-Wallis H	.044
df	2
Asymp. Sig.	.978

- a. Kruskal Wallis Test
b. Grouping Variable:
BusinessType

Figure Appendix 3.30 – Xlendi Question 7

According to Table 4.22 all localities had a p-value bigger than the 0.05 threshold, therefore the null hypothesis mentioned in Table 4.21 is retained for all localities.

- vii. **Question 8: If you knew the risks that coastal flooding (due to sea level rise and storm surges) could have on your business, would you still have chosen a location along the coast?**

This assessed whether there is a relationship between the various business sectors business sector and the owners’ locality decision making.

Kruskal–Wallis Test

Ranks			
	BusinessType	N	Mean Rank
Likelihood	Accommodation	2	25.00
	Catering	16	17.47
	Retail	22	22.30
	Total	40	

Test Statistics^{a,b}

Likelihood	
Kruskal–Wallis H	2.593
df	2
Asymp. Sig.	.273

- a. Kruskal Wallis Test
 b. Grouping Variable:
 BusinessType

Figure Appendix 3.31 – Gżira Question 8

Kruskal–Wallis Test

Ranks			
	BusinessType	N	Mean Rank
Likeliness	Catering	23	22.70
	Retail	27	27.89
	Total	50	

Test Statistics^{a,b}

Likeliness	
Kruskal–Wallis H	1.959
df	1
Asymp. Sig.	.162

- a. Kruskal Wallis Test
 b. Grouping Variable:
 BusinessType

Figure Appendix 3.32 – Sliema Question 8

Kruskal–Wallis Test

Ranks			
	BusinessType	N	Mean Rank
Likeliness	Accommodation	6	25.42
	Catering	27	24.96
	Retail	17	26.38
	Total	50	

Test Statistics^{a,b}

Likeliness	
Kruskal–Wallis H	.118
df	2
Asymp. Sig.	.943

- a. Kruskal Wallis Test
 b. Grouping Variable:
 BusinessType

Figure Appendix 3.33 – St Julian’s Question 8

Kruskal–Wallis Test

Ranks			
	BusinessType	N	Mean Rank
Likeliness	Accommodation	1	3.00
	Catering	9	6.06
	Retail	3	11.17
	Total	13	

Test Statistics^{a,b}

Likeliness	
Kruskal–Wallis H	5.931
df	2
Asymp. Sig.	.052

- a. Kruskal Wallis Test
 b. Grouping Variable:
 BusinessType

Figure Appendix 3.34 – Marsalforn Question 8

Kruskal–Wallis Test

Ranks			
	BusinessType	N	Mean Rank
Likeliness	Accommodation	1	7.00
	Catering	2	3.00
	Retail	4	3.75
	Total	7	

Test Statistics^{a,b}

Likeliness	
Kruskal–Wallis H	3.750
df	2
Asymp. Sig.	.153

- a. Kruskal Wallis Test
 b. Grouping Variable:
 BusinessType

Figure Appendix 3.35 – Xlendi Question 8

According to Table 4.22, all localities retained the null hypothesis mentioned in Table 4.21. However, it is important to note that in Marsalforn the p-value is 0.052, meaning that it is marginally insignificant.

viii. **Question 9: If such an event does happen in future do you think that your business can recover from such a setback?**

This test assessed whether there is a relationship between the various business sectors and business recovery related to coastal flooding setbacks.

Kruskal–Wallis Test

Ranks			
	BusinessType	N	Mean Rank
Likelihood	Accommodation	2	15.00
	Catering	16	22.50
	Retail	22	19.55
	Total	40	

Test Statistics^{a,b}

Likelihood	
Kruskal–Wallis H	1.261
df	2
Asymp. Sig.	.532

- a. Kruskal Wallis Test
- b. Grouping Variable: BusinessType

Figure Appendix 3.36 – Gżira Question 9

Kruskal–Wallis Test

Ranks			
	BusinessType	N	Mean Rank
Likeliness	Catering	23	23.93
	Retail	27	26.83
	Total	50	

Test Statistics^{a,b}

Likeliness	
Kruskal–Wallis H	.621
df	1
Asymp. Sig.	.431

- a. Kruskal Wallis Test
- b. Grouping Variable: BusinessType

Figure Appendix 3.37 – Sliema Question 9

Kruskal–Wallis Test

Ranks			
	BusinessType	N	Mean Rank
Likeliness	Accommodation	6	29.58
	Catering	27	26.22
	Retail	17	22.91
	Total	50	

Test Statistics^{a,b}

Likeliness	
Kruskal–Wallis H	1.333
df	2
Asymp. Sig.	.514

- a. Kruskal Wallis Test
- b. Grouping Variable: BusinessType

Figure Appendix 3.38 – St Julian’s Question 9

Kruskal–Wallis Test

Ranks			
	BusinessType	N	Mean Rank
Likeliness	Accommodation	1	7.00
	Catering	9	6.33
	Retail	3	9.00
	Total	13	

Test Statistics^{a,b}

Likeliness	
Kruskal–Wallis H	2.667
df	2
Asymp. Sig.	.264

- a. Kruskal Wallis Test
- b. Grouping Variable: BusinessType

Figure Appendix 3.39 – Marsalforn Question 9

Ranks

	BusinessType	N	Mean Rank
Likeliness	Accommodation	1	7.00
	Catering	2	3.00
	Retail	4	3.75
	Total	7	

Test Statistics^{a,b}

Likeliness	
Kruskal–Wallis H	3.750
df	2
Asymp. Sig.	.153

- a. Kruskal Wallis Test
- b. Grouping Variable: BusinessType

Figure Appendix 3.40 – Xlendi Question 9

According to Table 4.22 all localities retained the null hypothesis mentioned in Table 4.21.

ix. Question 15: Would it be possible to diversify your business operations, should current business operations not be possible anymore due to future impacts of coastal flooding?

To assess whether there is a relationship between the various business sectors and the possibility of business diversification in case future sea level rise and storm surge flooding ceases current business operations.

Kruskal-Wallis Test

Ranks			
	BusinessType	N	Mean Rank
Likelihood	Accommodation	2	34.00
	Catering	16	19.53
	Retail	22	19.98
	Total	40	

Test Statistics^{a,b}

Likelihood	
Kruskal-Wallis H	3.532
df	2
Asymp. Sig.	.171

- a. Kruskal Wallis Test
- b. Grouping Variable: BusinessType

Figure Appendix 3.41 – Gżira Question 15

Kruskal-Wallis Test

Ranks			
	BusinessType	N	Mean Rank
Likeliness	Catering	23	21.13
	Retail	27	29.22
	Total	50	

Test Statistics^{a,b}

Likeliness	
Kruskal-Wallis H	4.865
df	1
Asymp. Sig.	.027

- a. Kruskal Wallis Test
- b. Grouping Variable: BusinessType

Figure Appendix 3.42 – Sliema Question 15

Kruskal-Wallis Test

Ranks			
	BusinessType	N	Mean Rank
Likeliness	Accommodation	6	29.75
	Catering	27	25.96
	Retail	17	23.26
	Total	50	

Test Statistics^{a,b}

Likeliness	
Kruskal-Wallis H	1.165
df	2
Asymp. Sig.	.559

- a. Kruskal Wallis Test
- b. Grouping Variable: BusinessType

Figure Appendix 3.43 – St Julian’s Question 15

Kruskal-Wallis Test

Ranks			
	BusinessType	N	Mean Rank
Likeliness	Accommodation	1	4.50
	Catering	9	7.22
	Retail	3	7.17
	Total	13	

Test Statistics^{a,b}

Likeliness	
Kruskal-Wallis H	.548
df	2
Asymp. Sig.	.760

- a. Kruskal Wallis Test
- b. Grouping Variable: BusinessType

Figure Appendix 3.44 – Marsalforn Question 15

Kruskal–Wallis Test

Ranks			
	BusinessType	N	Mean Rank
Likeliness	Accommodation	1	2.00
	Catering	2	3.75
	Retail	4	4.63
	Total	7	

Test Statistics^{a,b}

Likeliness	
Kruskal–Wallis H	1.625
df	2
Asymp. Sig.	.444

a. Kruskal Wallis Test

b. Grouping Variable:
BusinessType

Figure Appendix 3.45 -Xlendi Question 15

According to Table 4.22 Sliema was the only locality that retained the alternative hypotheses while the remaining localities retained the null hypothesis mentioned in Table 4.21.

x. Question 16: How likely would you consider relocating your business?

This test assessed whether there is a relationship between the various business sectors and the owner's consideration for business relocation.

Kruskal-Wallis Test

Ranks			
	BusinessType	N	Mean Rank
Likelihood	Accommodation	2	24.25
	Catering	16	19.38
	Retail	22	20.98
	Total	40	

Test Statistics^{a,b}

Likelihood	
Kruskal-Wallis H	.475
df	2
Asymp. Sig.	.789

- a. Kruskal Wallis Test
 b. Grouping Variable:
 BusinessType

Figure Appendix 3.46 – Gżira Question 16

Kruskal-Wallis Test

Ranks			
	BusinessType	N	Mean Rank
Likeliness	Catering	23	25.72
	Retail	27	25.31
	Total	50	

Test Statistics^{a,b}

Likeliness	
Kruskal-Wallis H	.011
df	1
Asymp. Sig.	.916

- a. Kruskal Wallis Test
 b. Grouping Variable:
 BusinessType

Figure Appendix 3.47 – Sliema Question 16

Kruskal-Wallis Test

Ranks			
	BusinessType	N	Mean Rank
Likeliness	Accommodation	6	34.42
	Catering	27	24.17
	Retail	17	24.47
	Total	50	

Test Statistics^{a,b}

Likeliness	
Kruskal-Wallis H	3.085
df	2
Asymp. Sig.	.214

- a. Kruskal Wallis Test
 b. Grouping Variable:
 BusinessType

Figure Appendix 3.48 – St Julian's Question 16

Kruskal-Wallis Test

Ranks			
	BusinessType	N	Mean Rank
Likeliness	Accommodation	1	8.00
	Catering	9	7.28
	Retail	3	5.83
	Total	13	

Test Statistics^{a,b}

Likeliness	
Kruskal-Wallis H	.970
df	2
Asymp. Sig.	.616

- a. Kruskal Wallis Test
 b. Grouping Variable:
 BusinessType

Figure Appendix 3.49 – Marsalforn Question 16

Kruskal-Wallis Test

Ranks			
	BusinessType	N	Mean Rank
Likeliness	Accommodation	1	3.00
	Catering	2	1.50
	Retail	4	5.50
	Total	7	

Test Statistics^{a,b}

Likeliness	
Kruskal-Wallis H	5.870
df	2
Asymp. Sig.	.053

- a. Kruskal Wallis Test
 b. Grouping Variable:
 BusinessType

Figure Appendix 3.50 - Xlendi Question 16

According to Table 4.22, all localities retained the null hypothesis mentioned in Table 4.21. However, it is important to note that for Xlendi, the p-value is 0.053 meaning that it is marginally insignificant.

3.2 Entire Businesses Kruskal Wallis Test

All the tests conducted in the section are for the entire dataset meaning all five localities are compiled and analyzed in one test.

i. Question 1: How familiar are you with the issues of climate change and its implications?

This question statistically assessed whether there is a correlation between the various business sectors and the owners' familiarity with the issues and implications of climate change.

Kruskal–Wallis Test

Ranks			
	BusinessType	N	Mean Rank
Familiarity	Accommodation	10	31.15
	Catering	77	79.26
	Retail	73	88.57
	Total	160	

Test Statistics^{a,b}

Familiarity	
Kruskal–Wallis H	14.246
df	2
Asymp. Sig.	.001

a. Kruskal Wallis Test

b. Grouping Variable:
BusinessType

Figure Appendix 3.51– All Localities Question 1

According to the 0.001 p-value, it suggests that there is a strong correlation between the two variables, therefore, the alternative hypothesis in Table 4.21. is retained.

ii. Question 2: How informed are you about coastal flooding (in your locality)?

This question examined if a correlation between the various business sectors and the owners' familiarity with coastal flooding within their respective locality is present.

Kruskal-Wallis Test

Ranks			
	BusinessType	N	Mean Rank
Knowledgeability	Accommodation	10	45.90
	Catering	77	85.32
	Retail	73	80.16
	Total	160	

Test Statistics^{a,b}

	Knowledgeability
Kruskal-Wallis H	6.896
df	2
Asymp. Sig.	.032

a. Kruskal Wallis Test
 b. Grouping Variable: BusinessType

Figure Appendix 3.52- All Businesses Localities Question 2

A 0.032 p-value suggests that there is a correlation between the two variables, therefore, the alternative hypothesis in Table 4.21.is retained.

iii. Question 4: Were you aware about the risk of sea level rise and possible coastal flooding when you opened your current business?

The test was carried out to investigate whether there is a correlation between the various business sectors and the owners' awareness related to the risk of sea level rise and storm surge flooding before he/she established their business.

Kruskal–Wallis Test

Ranks			
	BusinessType	N	Mean Rank
Awareness	Accommodation	10	52.90
	Catering	77	78.46
	Retail	73	86.43
	Total	160	

Test Statistics^{a,b}

Awareness	
Kruskal–Wallis H	5.573
df	2
Asymp. Sig.	.062

a. Kruskal Wallis Test

b. Grouping Variable:
BusinessType

Figure Appendix 3.53- All Localities Question 4

A 0.062 p-value suggests that there is a negative correlation between the two variables therefore, the null hypothesis in Table 4.21. is retained.

iv. Question 5: in recent years, have you experienced coastal flooding?

The analysis was conducted to test whether there is a correlation between the various business sectors and any recent coastal flooding experience.

Kruskal–Wallis Test

Ranks			
	BusinessType	N	Mean Rank
Fequency	Accommodation	10	81.90
	Catering	77	82.93
	Retail	73	77.75
	Total	160	

Test Statistics^{a,b}

Fequency	
Kruskal–Wallis H	.535
df	2
Asymp. Sig.	.765

a. Kruskal Wallis Test

b. Grouping Variable:
BusinessType

Figure Appendix 3.54- All Localities Question 5

Due to an insignificant p-value, no correlation was identified between the two variables. Therefore, the null hypothesis in Table 4.21 is retained.

v. Question 6: Have you ever envisaged that future sea level rise and coastal flooding could threaten your business?

To assess whether there is a relationship between the various business sectors and the owner’s prediction regarding the possible effects that future sea level rise and storm surge flooding could have on his/her business.

Kruskal–Wallis Test

Ranks			
	BusinessType	N	Mean Rank
Fequency	Accommodation	10	54.95
	Catering	77	76.60
	Retail	73	88.11
	Total	160	

Test Statistics^{a,b}

	Fequency
Kruskal–Wallis H	7.038
df	2
Asymp. Sig.	.030

a. Kruskal Wallis Test

b. Grouping Variable: BusinessType

Figure Appendix 3.55- All Localities Question 6

A correlation was identified between the two variables due to a significant statistical p-value of 0.030. Therefore, the alternative hypothesis in Table 4.21 is retained.

vi. Question 7: Do you think that sea level rise and flooding will affect your business?

To assess whether there is a relationship between the various business sectors and owners’ opinion pertaining to the possible effects that sea level rise and storm surge flooding could have on his/her business

Kruskal-Wallis Test

Ranks			
	BusinessType	N	Mean Rank
Likeliness	Accommodation	10	72.05
	Catering	77	77.00
	Retail	73	85.35
	Total	160	

Test Statistics^{a,b}

Likeliness	
Kruskal-Wallis H	1.808
df	2
Asymp. Sig.	.405

a. Kruskal Wallis Test

b. Grouping Variable:
BusinessType

Figure Appendix 3.56- All Localities Question 7

A negative correlation was discovered between the two variables due to an insignificant p-value, therefore the null hypothesis in Table 4.21 is retained.

- vii. **Question 8: If you knew the risks that coastal flooding (due to sea level rise and storm surges) could have on your business, would you still have chosen a location along the coast?**

This assessed whether there is a relationship between the various business sectors business sector and the owners' locality decision making process.

Kruskal-Wallis Test

Ranks			
	BusinessType	N	Mean Rank
Likeliness	Accommodation	10	81.90
	Catering	77	72.38
	Retail	73	88.88
	Total	160	

Test Statistics^{a,b}

Likeliness	
Kruskal-Wallis H	5.768
df	2
Asymp. Sig.	.056

a. Kruskal Wallis Test

b. Grouping Variable:
BusinessType

Figure Appendix 3.57 - All Localities Question 8

A p-value of 0.056 suggests an insignificant statistical value, therefore the null hypothesis mentioned in Table 4.21 is retained.

viii. Question 9: If such an event does happen in future do you think that your business can recover from such a setback?

This test assessed whether there is a relationship between the various business sectors and business recovery related to coastal flooding setbacks.

Kruskal-Wallis Test

Ranks			
	BusinessType	N	Mean Rank
Likeliness	Accommodation	10	84.95
	Catering	77	78.13
	Retail	73	82.39
	Total	160	

Test Statistics^{a,b}

Likeliness	
Kruskal-Wallis H	.523
df	2
Asymp. Sig.	.770

a. Kruskal Wallis Test

b. Grouping Variable: BusinessType

Figure Appendix 3.58- All Localities Question 9

A statistically insignificant p-value suggests a negative correlation between the two variables thus the null hypothesis in Table 4.21 is retained.

ix. Question 15: Would it be possible to diversify your business operations, should current business operations not be possible anymore due to future impacts of coastal flooding?

To assess whether there is a relationship between the various business sectors and the possibility of business diversification.

Kruskal-Wallis Test

Ranks			
	BusinessType	N	Mean Rank
Likeliness	Accommodation	10	97.50
	Catering	77	76.97
	Retail	73	81.90
	Total	160	

Test Statistics^{a,b}

Likeliness	
Kruskal-Wallis H	2.291
df	2
Asymp. Sig.	.318

a. Kruskal Wallis Test

b. Grouping Variable:
BusinessType

Figure Appendix 3.59- All Localities Question 15

The p-value is statistically insignificant suggesting a negative correlation between both variables thus the null hypothesis in Table 4.21 is retained.

x. Question 16A: How likely would you consider relocating your business?

This test assessed whether there is a relationship between the various business sectors and the owner's consideration for business relocation.

Kruskal-Wallis Test

Ranks			
	BusinessType	N	Mean Rank
Likeliness	Accommodation	10	102.95
	Catering	77	78.81
	Retail	73	79.21
	Total	160	

Test Statistics^{a,b}

Likeliness	
Kruskal-Wallis H	2.986
df	2
Asymp. Sig.	.225

a. Kruskal Wallis Test

b. Grouping Variable:
BusinessType

Figure Appendix 3.60 - All Localities Question 16

The p-value is statistically insignificant foreshadowing a negative correlation between the various business sectors and business relocation. Thus, the null hypothesis in Table 5.1 is retained.

4 Appendix 4

4.1 Expert Interviews Transcripts

4.1.1 The MCCEI and The Chamber of SMEs Transcripts

Appendix 4 Table 4.1 - The Malta Chamber of SMEs and The MCCEI Interview Transcripts

Question	Answers	
	The MCCEI	The SMEs
1. What is your role	The Malta Chamber of Commerce, Enterprise and Industry is the independent voice of the private sector in Malta. Its principal mission is to actively represent companies from all economic sectors and ensure that entrepreneurs enjoy the best competitive environment and regulatory conditions possible for the conduct of business.	The Malta Chamber of SMEs represents the interests of Employers mainly the Small and Micro Enterprises. Through its representation, the SME Chamber seeks to ensure a level playing field and ensuring that businesses can operate freely.
2. Is the Chamber aware of the risks of coastal flooding and sea- level rise due to climate change? If yes, what industries have been identified that will suffer from such a phenomenon?	Yes, All but mainly retail and real estate.	No, N/A.
3. In your opinion, how high is such a risk to Malta's commercial activity and why? What type of disruptions would the Maltese business community expect to experience due to sea level rise and coastal flooding?	Medium. Health and Safety, Maintenance, Reduced business traffic, Reduced value of prime real estate, Cleanliness.	There is obviously a very high risk to economic activity in the vicinity. Accessibility issues, issues with outside seating, walking trade.
4. Does the chamber have any data that shows the expected loss to revenue, jobs, and coastal business establishments due to sea-level rise and coastal flooding? If yes, can the Chamber provide more details about this data for the purpose of this study?	No, needs to be modelled No, needs to be modelled	No, given the limited resources available at our disposal, the Malta Chamber of SMEs is limited and forced to prioritize its resources on issues which affect the wider business community. Having said that, this is still a very important and relevant subject to research. No, given the limited resources available at our disposal, the Malta Chamber of SMEs is limited and forced to prioritize its resources on issues which affect the wider business community. Having said that, this is still a very important and relevant subject to research.

<p>If no, why?</p> <p>Does the chamber have any data that shows the expected losses that would affect the Maltese economy and labor force?</p> <p>If yes, can the chamber provide more details about this data for the purpose of this study?</p> <p>If no, why?</p>		
<p>5. Has the Chamber ever discussed with potential stakeholders the threats which may impact the coastal business community from sea level rise and coastal flooding?</p> <p>If yes, why?</p> <p>If no, why?</p>	<p>Yes, the Chamber is mindful of climate change realities.</p>	<p>No, to date this topic was not on the SME Chambers' agenda.</p>
<p>6. Has the Chamber ever been approached by any of its members requesting information and/or advice on sea-level rise and coastal flooding due to climate change and its effects?</p> <p>If yes, can you provide more details on the reasons why you were contacted by the members?</p>	<p>No</p>	<p>No</p>
<p>7. Has the Chamber ever been consulted or been part of discussions initiated by local government on the impact of sea level rise or climate change on local coastal businesses?</p> <p>If yes, what form of discussions took place?</p>	<p>Yes, Climate Action Board</p>	<p>No</p>

<p>8. Do you think that the Chamber should have a role in building a national strategy to address the impacts of coastal flooding and sea level rise on coastal businesses?</p> <p>If no, why?</p>	<p>Yes</p>	<p>Yes</p>
<p>9. If answered yes in question 8, can you provide any details on how the Chamber can contribute on its future strategy?</p>	<p>The country needs an economic vision that is built around sustainability and actions against climate change. This is good for business and good for supporting stability of sea levels. COVID may help us achieve these objectives. Please see our Chamber economic visions – Smart Sustainable Island.</p>	<p>The Chamber of SMEs can enter consultation and discussions with members to analyze the concerns raised within its members and propose ways and measures on how these concerns can be mitigated and addressed effectively. Additionally, the Malta Chamber of SMEs can effectively prioritize issues and present them to the government.</p>

4.1.2 Civil Protection Department Expert Interview Transcript

Appendix 4 Table 4.2 – Civil Protection Department Transcript

Question	Answer
<p>1. What is the role of the Civil Protection Department pertaining to the risk of climate change, especially in relation to sea-level rise and coastal flooding?</p>	<p>The Civil Protection Department is legally obliged to respond to any emergency within Malta’s territory. The same applied to prevention and preparedness. Concerning this risk, CPD is only responsible to respond only if lives are in peril if not if/when coastal flooding happens the CPD will not be involved.</p>
<p>2. Which coastal areas in Malta and Gozo does the CPD classify as high risk to sea level rise and coastal flooding?</p>	<p>As per above, CPD is int involved in sea level rise or coastal flooding. Where Tsunamis are concerned CPD classified all northern and eastern beaches in Malta’s territory as high risk. This includes Marsaxlokk to Marsalforn.</p>
<p>3. A. Has the CPD implemented mitigation measures in the above coastal localities? B If answered yes, what type of measures have been implemented? C. If answered no, why have no measures been implemented to date?</p>	<p>Yes, CPD has a tsunami plan for Malta and each locality will start receiving its own tsunami plan.</p>
<p>4. What type of training and machinery does the CPD have to effectively deal with coastal flooding emergencies?</p>	<p>CPD is involved in response only and since coastal flooding is a slow onset disaster Malta will have time to react to a slow onset problem such as coastal flooding. Nonetheless CPD has acquired some machinery to be able to tackle such emergencies and should the need arise, it can call in third party contractors, with machinery operators in a national emergency. Legislation exists for such instances.</p>
<p>5. From which coastal areas does the CPD receive the most emergency calls during flooding events and how are these situations approached?</p>	<p>None. Calls are received from within households which are flooded, because of buildings located close to valleys not coastal areas. There have been however calls from establishments such as hotels or establishments that are located by the coastline. In most instances CPD can only reinforce doors and apertures and pump out water if firefighters are able to access the structure from a safe entrance.</p>

6. What type of preventive measures does the CPD implement to reduce the number of coastal flooding related calls before a flooding event?	None
7. If there are no measures implemented, what measures do you think should be implemented and how?	The infrastructure built by Government should be designed to mitigate flash flood. In most instances coastal infrastructure is being built this way.
8. My research is related to the coastal sites of Gżira, Sliema, and St Julian's, Xlendi and Marsalforn (Gozo). What are your views about the flooding risks of these localities based on your professional experience?	These areas are exposed to flash floods, not floods. Flash floods consist of fast-moving water. The area will not remain flooded a few hours after the storm, however the real risks lie in the fast-moving water which can kill or maim civilians trying to navigate in the water whether on foot or in a vehicle.
9. What specific mitigation measures do you think should be implemented in these sites to minimize flooding risks and related hazards in the area?	Any infrastructure or alteration must consider flash floods.
10. How does the CPD effectively intervene in flooding events for Gzira, Sliema, St Julian's, and Xlendi and Marsalforn (Gozo)?	Due to the number of calls that are received over a short time frame, CDP will be responding to emergency calls all over Malta and Gozo and will therefore not intervene directly unless lives are in peril. It must be noted that since the introduction of flood relief projects, the interventions required have declined considerably and CPD is analyzing trends that are emerging from this project.
11. Does the CPD liaise with other authorities for these flooding risks interventions and how?	Yes. During interventions CPD liaises and directs other entities such as Transport Malta, Malta Police Force and may request the intervention of AFM if required.
12. With future projections of rising sea levels and increase in storm surges, how do you think these projections may impact on the future strategy of the CPD as an intervening authority related to risks and hazards?	This is a tricky question since business owners that are affected by storm surges tend to implement their own measures to mitigate such impacts and, in most instances, do not require any second intervention. Same applied to government infrastructure which is either built to withstand such events or else is fixed in such a way that it will cater for future storms. The tricky part is that storms are not constant and vary in intensity, direction, duration, and strength and therefore it is difficult to consider anything as storm proof.
13. In your opinion, what other resources should be allocated to the CPD to enable it to come up with effective measures to mitigate the effect of sea level rise and coastal flooding?	CPD has already been given the necessary tools to cater for storm surges.

4.1.3 Environmental Resource Authority (ERA), Malta Resource Authority (MRA), Ministry for the Environment, Sustainable Development and Climate Change, and Planning Authority Expert Interview Transcripts

Appendix 4 Table 4.3 – Transcripts of the environmental related experts

Question	Answers			
	Environmental Resource Authority	Malta Resource Authority	Ministry for the Environment, Sustainable Development and Climate Change	Planning Authority
<p>1. What is the authority's current role on issues of climate change and especially on sea level rise and coastal flooding?</p>	<p>The Authority's role is mostly linked with issues pertaining to environment protection, as outlined by the Environment Protection Act (EPA, Cap.549) of the Laws of Malta. Climate change is not directly addressed by ERA, but we address these indirectly through the implementation of the Act and related policy.</p>	<p>MRA is designated as the Greenhouse Gases Inventory Agency.</p>	<p>As a party to the Paris Agreement, Malta must do its part in the implementation of the global goal on adaptation – of enhancing adaptive capacity, strengthening resilience, and reducing vulnerability to climate change in the context of the temperature goal of the Agreement. The role of the Ministry as the policy maker is to identify sectors of society and the natural environment, which are susceptible to climate change impacts and as stated in the Climate Action Act (CH 543) draw up and implement policies and measures that significantly strengthen national adaptation efforts.</p>	<p>The Planning Authority's work is guided by the strategic policy framework of the Strategic Plan for Environment and Development – SPED (2015) which identifies Climate Change as a key challenge for the Maltese Islands and presents the policy framework for the Coastal Zone and marine Area. The PA's work is also guided by other national documents specifically addressing climate change and related issues. As the focal point for the ICZM Protocol within the Mediterranean, the Authority is working to improve Malta's capacity to address various aspects on coastal zone management – in this case article 23 of the Protocol addresses risks.</p>

<p>2. To what extent does the agency's work relate to the risks of climate change and sea-level rise? Can you elaborate?</p>	<p>Most issues are linked with adaptation and mitigation measures, including issues with site management, environmental aspects linked with biodiversity management, desertification, nature protection, waste, water, and air quality monitoring as well as other issues linked with permitting and compliance. Our work is complementary to that of other entities, including the Malta Resources Authority (MRA); the Directorate for Environment and Climate Change (DECC) within the Ministry for the Environment, Climate Change and Planning (MECP); Ambient Malta (AM); and the Energy and Water Agency (EWA) amongst others.</p>	<p>Not part of MRA's remit.</p>	<p>The Ministry has the role of elaborating and implementing the national Climate Change Adaptation Strategy. Currently, the Ministry is in the process of updating the 2012 Adaptation Strategy for the Maltese Islands identifying areas of action which call for strengthened resilience and increase preparedness for climate change impacts. It is also within the Ministry's remit to improve its understanding on the degree of vulnerability to which society, our economic sectors, and our natural environment are exposed to, being it from sea level rise or otherwise related to climate change. This would enable better targeted and prioritised action where it is needed the most. To this effect, Malta is also planning to conduct a comprehensive review of the latest Vulnerability Risk Assessment.</p>	<p>The Development Planning Act of 2016 states that spatial planning policy is hierarchical. Therefore, any policy changes (e.g. partial review of Local Plans) that are carried out are assessed to determine whether coastal issues such as climate change and sea level rise may need to be addressed. The level of work that the PA can carry out depends on the data and information that is available at national level by relevant authorities responsible for developing national climate change policy. In the absence of such information, effort is made to incorporate precautionary measures in policy changes. For the functions related to evaluation of development proposals, these are tackled on a case-by-case situation and in many instances such matters are addressed through EIAs and detailed studied whose TORs are prepared by ERA.</p>
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<p>3. Has the authority identified any road networks and public structures that are at risk of sea-level rise/coastal flooding?</p> <p>If yes, can you give me some details about them especially those that are more likely to be impacted by sea level rise and coastal flooding than others?</p>	<p>Some areas which were identified are those within Natura 2000 sites, such as marshlands. Coastal erosion is a major issue in this case – which leads to removal of embankments and seawater flooding (rather than freshwater one); actions are planned for sites as Il-Ballut l/o Marsaxlokk, through MT-EU LIFE co-funding. Other actions are linked with coastal erosion and ERA has carried out a study on this and related desertification processes and modelling. In this case, climate change may exacerbate such erosion and desertification issues due to the more violent and sporadic nature of storms.</p>	<p>Such an issue falls outside the remit of MRA.</p>	<p>Yes. Indeed, road network and public structure were identified at risk of sea-level rise and/or coastal flooding not surprisingly so, noting that our urban development extends close to our shores. In view of this, several policies and measures are included in the current and upcoming Adaptation Strategy, to increasingly address such impacts. Examples which have been identified include reviewing the Storm Water Master Plan; and ensuring better long-term planning on existing and planned coastal infrastructure considering projections for the next 50-100 years of significant sea level rise. Within the Malta Adaptation Strategy, several actions have been identified to preserve valleys and roads from floods (e.g., actions 31 and 38) and to provide an early warning in this regard (e.g., action 63). Implementation of such measures fall under the remit of a separate Ministry being the latter being responsible for infrastructure and capital projects.</p>	<p>No.</p>
<p>4. In view of the 2020 targets that were not reached by Malta, what is the future direction being taken to reduce</p>	<p>This is being addressed through different strategies being drafted and adopted in line with existing legal requirements and commitments. In this respect, it is best to refer to such matter to DECC and MECP. From ERA's end, the actions are driven by the</p>	<p>Malta has met its target using the flexible mechanism.</p>	<p>With the lowest emissions per capita, Malta has achieved further emissions reductions in terms of its total greenhouse gas emission after overhauling its energy</p>	<p>It is not the PA's direct responsibility to address this. You may wish to look at Malta's reporting to the</p>

<p>the footprint of carbon dioxide (CO₂)?</p>	<p>various implementation processes linked with site management and thematic areas (see reply to Q2) and relevant policies and strategies in line with Article 51 of the EPA. The latter are driven by the current gap analysis and reviews established through the State of the Environment Report process (which also addresses climate change) and the review of the implementation of national targets – such as the ongoing review of the National Biodiversity Strategy and Action Plan 2012-2020 (NBSAP). New policies are being developed.</p>		<p>generation sector, shifting from heavy fuel oil to natural gas. Recently, Malta has committed to the EU-wide climate neutrality target by 2050. The compilation of its Long-Term Strategy towards decarbonisation shall enable us to identify the mitigation potential of the various contributing sectors and the action required to address such, noting the resultant socio-economic impacts. Considering that our economic structure is not carbon intensive, and heavy industry is very limited, mitigation action will target the energy and transport sectors amongst others.</p>	<p>EU prepared by the relevant entity.</p>
<p>5. Has the authority identified those areas (localities) that will most likely be affected by sea-level rise and coastal flooding?</p> <p>If yes, can you name a few of those areas?</p> <p>If no, why hasn't the authority identified them yet?</p>	<p>No. Climate Change issues are main coordinated through DECC and MECP with MRA, rather than ERA. Notwithstanding this, ERA assists in relation to selected thematic areas within its legal commitments and responsibilities.</p>	<p>No. Falls outside of the remit of MRA</p>	<p>Yes. Research conducted locally by research institutions identified several areas at risk of flooding and affected by sea level rise, based on the extent of sea level rise. Some of the identified areas are: Msida, Gżira, Mellieha, Marsaxlokk.</p>	<p>No. This is an exercise that requires a national effort and involves different entities both at government level and research level. In the absence of clear data on the national vulnerability and future trends related to climate change any one-off exercise that is carried out will be only indicative.</p>
<p>6. Has the authority conducted any recent studies on the impacts of sea level rise and coastal flooding on coastal</p>	<p>No. Climate Change issues are mainly coordinated through DECC and MECP with MRA, rather than ERA. Notwithstanding this, ERA assists in relation to selected thematic areas within its legal commitments and responsibilities.</p>	<p>No. Such studies fall outside the remit of MRA.</p>	<p>Yes. To date such studied were conducted by research institution, however as part of the comprehensive review of the Vulnerability Risk Assessment, which is planned for 2021-22, the</p>	<p>Yes. No as this is an internal administrative exercise serving the purpose of raising the importance of the issues of coastal vulnerability</p>

<p>towns across the Maltese Islands?</p> <p>If yes, are the studies publicly accessible and what did they entail?</p> <p>If no, why have there not been any studies?</p>			<p>impacts of climate change will be modelled to enable targeted actions</p>	<p>within the authority. Hopefully it will be the basis for more action on the subject.</p>
<p>7. What is the authority's current assessment level and knowledge on the vulnerability of sea level rise and coastal flooding by storms on the Maltese Islands?</p>	<p>You may wish to refer to the State of the Environment Report 2018.</p>	<p>High individual knowledge</p>	<p>The ministry bases its assessment on the research conducted both globally/EU wide, regionally, particularly that focused on the Mediterranean basin and nationally.</p>	<p>It is based on existing published knowledge (National reporting to UNFCCC).</p>
<p>8. What is the authority's position on protection with hard and soft engineering structure of coastal towns across the Maltese Islands?</p>	<p>Green and blue infrastructure are duly promoted.</p>	<p>Falls outside of the remit of MRA</p>	<p>In the current Adaptation Strategy, measures are in place to protect the coastline, roads and infrastructure from sea level rise and floods. Noting that climate change is mainstreamed across all Ministries, the implementation of such measures rests with the relevant authorities. Our Ministry collaborates and monitors the status of the measures to ensure that the implementation is successful and timely.</p>	<p>The PA has led the process since 1992 to shift away from hard engineering solutions. However, not every case can be resolved by soft engineering technology. The PA is trying to keep abreast with technology and expects that with time practitioners (engineers/architects) are trained and able to deliver new options more linked to nature-based solutions.</p>
<p>9. Do you foresee any future regulations in relation to coastal development of low-</p>	<p>There is already a considerable legal and policy regime addressing selected issues linked with environmental protection under the EPA. Other aspects linked with land use are also addressed via</p>	<p>No. Adaptation measures will need to take place without the need for regulations</p>	<p>Currently, we are in the process of updating the Adaptation strategy, which will inform us as policy makers and other authorities</p>	<p>No. In the absence of clear evidence it is not possible to discuss.</p>

<p>lying areas that are highly prone to coastal flooding and sea level rise?</p> <p>If yes, what kind of regulations?</p> <p>If no, why?</p>	<p>the Development Planning Act (DPA, CAP. 552), which is administered by the Planning Authority. As to 'regulations', ERA is undergoing a better regulation process, which implies updated legislation (including subsidiary regulations under the EPA) and new policy (including subsidiary plan under the EPA, which include national strategies, plans, guidelines and other policy) which address different aspects within our legal portfolio. In terms of legislation, these are often updated based on experience in implementation; scientific and administrative progress; ongoing monitoring and review; and discussions in relevant national and international fora, as applicable. Moreover, ERA is responsible for monitoring the state of the environment in Malta in regular cycles. Such report identifies the status of various aspects, including climate change, and is used to redirect policy to address emerging issues and gaps. Indeed, ERA is currently revising various policies in line with the results of the latest assessment. Updates both environmental legislation and policy are regularly posted in public consultations section on our website, where one can access current and past public consultation processes on both legislation and policy.</p>		<p>which are implementing vehicles on how regulations should be better strengthened to increase our resilience to climate change impacts. As such we are not able to confirm or otherwise whether development planning regulations on coastal development will be revised.</p>	
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4.1.4 The Ministry for Transport, Infrastructure and Capital Projects Expert Interview Transcripts

Appendix 4 Table 4.4 – Interview transcript of the Ministry for Transport, Infrastructure and Capital Projects Experts.

Questions	Answers	
	Expert 1	Expert 2
<p>1. Can you provide a brief overview on the agency’s work related to the risks of climate change, especially in relation to sea-level rise and coastal flooding?</p>	<p>The Public Works Department has several Directorates and Units with specialised functions, with the Marine and Storm Water Unit (MSWU) being responsible for marine works, coastal protection works, and storm water management.</p>	<p>The Public Works Department is currently building up its capacity to be able to monitor and implement projects aimed to address issues of coastal erosion and flooding.</p>
<p>2. Has the agency identified road networks and public structures that are at risk of sea-level rise/ flooding?</p> <p>If yes, can you give me some more details of the areas that are more likely to be prone to sea level rise?</p>	<p>Yes. Marsaskala, Sliema, Birżebbuġa, Marsaxlokk, St Paul’s Bay, most pocket/sandy beaches.</p>	<p>No.</p>
<p>3. What are the agency’s priorities on issues that will seek measures to mitigate the effects of sea-level rise and coastal flooding on Maltese coastal urban areas?</p> <p>If so, are the results of these works available for public viewing?</p> <p>If Yes, can you provide more details?</p> <p>If no, why?</p>	<p>Priorities depend on the impacts on the local community or wider areas, whereby specific projects may be instigated by the aftermath of large storm events. At present, there is no comprehensive assessment of the risks associated with coastal flooding and its impact on coastal communities and businesses. Thus, the Department does not have a structured list of priorities. Actions and works are carried out depending on the budget allocated on an annual basis, and this varies from one year to the next. The National Risk Assessment can provide guidance and direction for the CPD in extreme events, and this may be used for more strategic actions. This may be addressed in good part by studies and plans for coastal erosion risk assessment, which when undertaken holistically it will also serve as wider coastal vulnerability assessment.</p> <p>Very limited - see below. (The answer here is more of a NO than a YES).</p> <p>Information in terms of a national coastal vulnerability assessment is unavailable. The PA has carried out a</p>	<p>The priorities will be defined once a Shoreline Management Plan is prepared.</p> <p>No. Once the shoreline management plan will be in hand public consultation will be carried out.</p>

	<p>preliminary study and some research has been carried out on a NE coastal sector of the island of Gozo. Information emanating from the National Risk Assessment is held by the CPD and is published only in outline form for security purposes. On this, you may contact CPD directly or search what is available on the internet and their website.</p>	
<p>4. In its yearly budget, has the agency allocated funds for further studies to be carried out on the impacts of such a phenomenon on coastal infrastructure, especially in high touristic areas?</p> <p>If yes, can you provide more details?</p> <p>If no, why?</p>	<p>No. Although there is no direct budget allocation for such studies, the Department does submit proposals, when there is an opportunity for EU Funding to cover such studies. The budget allocated to the Department, and more specifically to the MSWU, is not dedicated to the management of risks from this phenomenon, and it is commonly used for many other things as well.</p>	<p>No. The location and interventions that are required are to-date not defined.</p>
<p>5. In your opinion, what other resources should be allocated to this agency to enable it to come up with effective measures?</p>	<p>Adequate resources are required for rigorous and regular research, including a steady monitoring programme. Funds are also required to draw up a coastal risk assessment that is holistic, evaluating impact not only from this phenomenon but also from other hazards/processes that are exacerbated by climate change, and which impact the coast. Well-trained professional and technical HR is also required, with adequate training for research, planning, and monitoring. Significant funds will then also be required to implement project interventions that will provide the identified mitigation measures (and these are likely to be costly).</p>	<p>More professionals and technical personnel are required as well as training to collect data, modelling of different scenarios, environmental design, and civil engineering works.</p>
<p>6. Before embarking on any new coastal infrastructural development projects, is the agency taking into consideration sea-level rise and the prospect of more frequent and violent storms resulting and more flooding days and flooded areas?</p> <p>If yes, how?</p> <p>If no, why?</p>	<p>Yes. By incorporating the requirement for considering these scenarios as part of the preparatory studies during the planning and feasibility stages.</p>	<p>Yes. Using mathematical modelling using foreign consultants.</p>
<p>7. Recently, Malta has seen an upgrade on its coastal</p>	<p>Yes. Most probably yes, especially in large infrastructural projects that</p>	<p>No.</p>

<p>infrastructure. Were there any measures that may have been put in place to protect these new upgrades/investments from sea-level rise or coastal flooding?</p> <p>If yes, can you provide more details?</p> <p>If no, why haven't any measures been put into place?</p>	<p>were EU Funded, as these would have, by necessity, required thorough preparatory and project appraisal studies that would bring this point home.</p>	
<p>8. Are there any plans to protect coastal infrastructure and investments (such as roads, businesses, buildings and so on.) which are deemed to be at risk of being partly submerged? Likewise, are there any plans to protect those localities with a high incidence of floods? If no, why?</p>	<p>Yes.</p>	<p>No.</p>
<p>9. If the answer to question 7 was yes, are there any future plans to upgrade the coastal infrastructure to align with the current sea level rise projections and impacts of coastal flooding?</p> <p>If yes, can you provide me with some examples?</p> <p>If no, why?</p>	<p>One would have to look at the specific coastal infrastructures on a case-by-case basis and research deeper as to what has been catered for in long-term planning and detail design (if at all).</p>	

4.1.5 Transport Malta Expert Interview Transcript

Appendix 4 Table 4.5 – Transport Malta Interview Transcript

Question	Answer
<p>1. Can you provide a brief overview on the authority's work related to the risks of climate change, especially in relation to sea-level rise and coastal flooding?</p>	<p>The Authority is aware of such problems and of the future consequences. As such new projects are designed whenever possible to cater for future sea level rise.</p>
<p>2. A. Has the authority identified road networks and public structures that are at risk of sea-level rise/flooding?</p> <p>B. If yes, can you provide some more details of the areas that are more likely to be prone to sea level rise?</p> <p>C. If no, why has the authority not yet conducted such an assessment?</p>	<p>Yes. We are aware that areas such Sliema, Marsaskala and Birżebbuġa are already experiencing problems with sea level rise.</p>
<p>3. A. Are coastal flooding and projected sea-level rise taken into account when</p>	<p>Yes. Whenever possible proposed structures are constructed at higher levels to cater for the</p>

<p>designing new roads especially along the coast?</p> <p>B. If yes, how are the works planned out in relation to these phenomena?</p> <p>C. If no, why is this type of assessment not taken into account in the project works?</p>	<p>phenomena. However, one has to keep in mind that these low-lying areas are heavily populated with buildings very close to the water's edge.</p>
<p>4. A. Flooding of coastal roads leads to heavy traffic congestions or disruptions. Does the authority have any management strategies in place to minimize these disruptions when these phenomena occur?</p> <p>B. If yes, what type of strategies are currently being implemented?</p> <p>C. If no, give reasons to explain why the authority does not have such management strategies.</p>	<p>No.</p>
<p>5. A. When new coastal infrastructural development projects are proposed, does the agency give advice (or is asked for advice) on the likely impacts of sea-level rise and violent storms which may result in more flooding days and flooded areas?</p> <p>B. If yes, how are such assessments done?</p> <p>C. If no, why?</p>	<p>Most of the time we are involved. Usually, a mathematical study would be asked for. Based on the results and recommendations further assessment may need to be requested or else project is approved.</p>
<p>6. A. Recently, Malta has seen an upgrade on its coastal roads. Have any measures been put in place to protect these new upgrades /investments from sea-level rise or coastal flooding?</p> <p>B. If yes, how?</p> <p>C. If no, why?</p>	<p>Yes.</p>
<p>7. A. Are there any plans to protect coastal infrastructure and investments (such as roads) which are deemed to be at risk of being partly submerged?</p> <p>B. If yes, can you provide more details?</p> <p>C. If no, can you provide one reason or more for your answer?</p>	<p>Yes. Currently we are looking into repairing the original flood valves at Sliema Ferries. In the long run other areas will also need to be tackled.</p>
<p>8. B. If the answer to question 7 was yes, are there any future plans to upgrade the coastal roads to align with the current sea level rise projections and impacts of coastal flooding?</p> <p>C. If yes, can you provide some examples?</p>	

D. If no, why?	
9. In your opinion, what other resources should be allocated to this authority to enable it to come up with effective measures to mitigate the effect of sea level rise and coastal flooding?	This problem is not a simple one. To tackle one would need to engage in a holistic study to see how such problems can be solved. In the future we should be looking at studying various coastal areas and coming up with solutions on how best to mitigate such a problem. This will have to be done in collaboration with other entities and Units.

4.1.6 Transport Malta Ports and Yachting Directorate Expert Interview Transcript

Appendix 4 Table 4.6 – Transport Malta Ports and Yachting Directorate Expert Interview Transcript

Question	Answer
1. Can you provide a brief overview on the Ports and Yachting Directorate work pertaining to the risks of climate change, especially in relation to sea-level rise and coastal flooding?	Our role is to monitor sea level, and this is with regards to safety of Navigation.
2. In your opinion, to what extent do you think that current coastal infrastructures are currently equipped to deal with risks and hazards related to sea level rise and coastal flooding?	From our records it transpires that sea level rise in our area is of 1.6 millimetre per year. That is 1.6cm per 10 years. 16cm in 100 years. I do not believe that the coastal infrastructure is equipped for coastal flooding.
3. In your opinion, which do you think are the foreseen impacts of coastal flooding and sea level rise on the maritime services of the Maltese Islands?	In my opinion the Freeport operations may be affected due to the air draft required to operate the cranes.
4. A. Are the services mentioned in question 3 imperative for the Maltese economy and the maritime industry? B. If yes, how? C. If no, why?	No. This is a long-term problem the cranes would anyhow need to be changed due to wear and tear.
5. A. Have the Ports and Yachting Directorate considered any mitigation measures to protect coastal infrastructure and towns from sea level rise and coastal flooding? B. If yes, what type of measures have been implemented? C. If answered no, why are not any mitigation measures being considered? D. If answered no, what types of mitigation measures do you think should be implemented by the Port and Yachting Directorate?	No. Ports and Yachting are responsible for safety of Navigation and the operation of vessels in Maltese territorial water. At the moment there is not a significant rise of sea level that is worrying (unlike other countries in the Atlantic). The flooding of other low lying coastal areas such as Msida, Sliema, Marsaxlokk and any other area is not the responsibility of Ports and Yachting Directorate.
6. A. My research is related to the coastal sites of Gżira, Sliema, and St Julian's, Xlendi and Marsalforn (Gozo). Do you think coastal flooding events and sea level rise may disrupt seaborne transport in these coastal localities?	No. There is no significant sea level rise to disrupt seaborne transport however if there is a significant coastal flooding (storm surge) then probably yes - local cruise and ferry operations in the ports may be suspended.

<p>B. If yes, can you please provide more details?</p> <p>C. If no, could you provide details to substantiate your answers?</p>	
<p>7. In your opinion what are the likely impacts of coastal flooding and sea level rise on private and commercial berthing sites along these coastal sites mentioned in Question 6?</p>	<p>No. There is no significant sea level rise to disrupt seaborne transport however if there is a significant coastal flooding (storm surge) then probably yes - local cruise and ferry operations in the ports may be suspended.</p>
<p>8. A. Given the planned increase in seaborne transport (ferry services) especially in the area of Sliema and St Julian's, is sea level rise and coastal flooding taken into consideration when constructing new berthing facilities?</p> <p>B. If answered yes, what type of measures are implemented to protect these platforms?</p> <p>C. If answered no, why are no mitigation measures are considered?</p>	<p>No. From our record it transpires that sea level rise in our area is of 1.6 millimetre per year. That is 1.6cm per 10 years. 16cm in 100 years. I do not believe that the coastal infrastructure are equipped for coastal flooding.</p>
<p>9. In your opinion, what other resources should be allocated to the Ports and Yachting Directorate to enable it to come up with effective measures to mitigate the effect of sea level rise and coastal flooding in these areas?</p>	<p>16cm in 100 years is not an issue however if sea level rise will change significantly (change of pattern) then there may be a need to raise the quay level hence more funds would be required.</p>
<p>10. With future projections of rising sea levels and increase in storm surges, how do you think these projections may impact on the future strategies of the Ports and Yachting Directorate as the competent authority related to maritime affairs?</p>	<p>From records there is not a significant sea level rise. Port operations may be disrupted during storm surges, but I believe there are no strategies for this.</p>

4.1.7 Malta Tourism Authority Expert Interview Transcript

Appendix 4 Table 4.7 – Malta Tourism Authority Interview Transcript

Question	Answer
<p>1. Is the Malta Tourism Authority aware of climate change and its implications, especially in relation to impacts of sea level rise and coastal flooding on the Maltese Islands?</p> <p>If yes, how do you think climate change (and especially sea level rise and coastal flooding) will affect Malta's tourism industry?</p>	<p>Yes. Thousands of tourists visit Malta in summer specifically for the beaches. If the weather impacts the beaches in a way that sand and bathing areas are reduced or degraded, it will have a direct effect on tourism.</p>
<p>2. Has the authority ever conducted studies on how climate change would impact Malta's tourism industry?</p>	<p>No. The MTA does not deal directly with specific environmental issues.</p>

<p>If yes, what did such studies entail and what were the key results?</p> <p>If no, why have there not been any studies on this issue?</p>	
<p>3. Are there any studies that detail the contribution of coastal businesses (related to the tourism industry) to Malta's economic revenue?</p> <p>If yes, can you give more details above these types of studies study (accessibility, figure and so on.) for the sole purpose of this research?</p>	<p>Yes. Tourism coastal businesses are various, and every entity does its own contribution to various sources. These include, but not only, hotels, restaurants, dive centres, concessions, souvenir shops, event organisers, property negotiators, water sports, and much more.</p>
<p>4. Given the importance of the tourism industry to Malta and that most of the tourism activities are found along the Maltese coastline (which is threatened by sea level rise and coastal flooding), has the authority ever carried out an impact assessment as to the loss of any business activity, accommodation spaces, job losses, revenue and other type of tourism related facilities?</p> <p>If yes, what did these types of studies reveal and what is the estimated revenue loss? Any other key results worth sharing?</p> <p>If no, do you envisage the authority undertaking these types of studies in future?</p> <p>If yes, how?</p> <p>If no, why?</p>	<p>No. As discussed earlier, the MTA relies on entities that have resources focused on Environmental subjects like Mepa, ERA, Ministry for the Environment and so on.</p>
<p>5. What is the authority's position about applications for new development for touristic and business purposes situated very close to the shoreline?</p>	<p>The MTA evaluated every development on its own and submits recommendation to Mepa according to the impacts/benefits that the development has to offer.</p>
<p>6. In 2016, it was revealed that 9 out of 12 victims of drownings were foreigners. Is Malta being considered as a high-risk destination by foreign tour operators in terms of coastal safety?</p> <p>Give a reason for your answer.</p>	<p>No. Life savers and first aiders are placed on the most popular beaches on the Islands, and they manage to save scores of lives every summer. Their priority is prevention rather than cure.</p>
<p>7. Do you think that the authority should align its future policies and marketing to reflect climate change impacts on coastal tourism, especially in relation to sea level rise and coastal flooding?</p>	<p>No. Marketing can attract high quality and environmental tourists in a positive manner and not by highlighting issues whose impacts are not clear enough on the Islands.</p>

If yes, why? If no, why?	
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