Coastal land use in the Maltese islands: a description and appraisal

John Andrew Schembri

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Abstract

The area of the Maltese Islands is 316 km^2, and with an official coastal length of 180 km possess a high ratio of coastal length to area. The physical properties of the coast include a highly indented and largely accessible coastline having a low sloping profile, on the north, east and south-east littoral of Malta, presenting inlets, bays and deep harbours. Most of the recreational, industrial and coastal residential areas are situated around these areas together with a wide range of fortifications and military defensive structures built as part of the coastal defensive network of Malta over the last five centuries. In contrast, the other parts of the coast, including Gozo, consists of a largely inaccessible coastline made up of cliffs and boulder scree slopes with the few indentations marking sandy beaches. These areas have a high aesthetic quality.

The rapid pace of development over last half-century has witnessed an economic transformation from an economy based on British military spending to one based on the development of coastal areas for marine-related services, tourism and residential and second-home development. Coastal land use conflicts have intensified with economic development and as people have sought to make a more use of the coast. This thesis is concerned with the evaluation of the coastal land use in the Maltese Islands.

A historical overview of the coast is first presented, then a methodology for the mapping, surveying and estimation of the land uses along the coastal zone of the Maltese Islands is developed. This is based on a number of coastal field surveys that the author participated in between 1989 and 1998. The coastal zone was divided into sixteen segments and mapping is covered by sixteen land uses. The main results were that coastal development was centred in areas where a high natural coastal indentation and good physical accessibility of the coast were present, these, in turn, gave rise to land use conflict. In addition, civil engineering works and modifications such as rock-cutting, jetties, breakwaters and, in densely populated areas, promenades, intensified land use conflict. A notable difference in the type of coastal development processes to the north (tourism) and south (industry) of the Great Fault is evident.

The thesis also includes the part played by the Malta Environment and Planning Authority in influencing coastal land uses, the main land use modifications proposed in the European Union accession talks and a brief assessment of the land use situation in selected localities in 2003.

Preface and acknowledgments

This thesis is intended to provide an overall view of the coast of the Maltese Islands with land use being the key term used throughout. The coast is a dynamic environment, susceptible to change from physical conditions such as meteorological circumstances, ocean processes and physical factors of geology and geomorphology prevailing at the land/sea interface. Human-induced situations arising from high population densities include also the need to accommodate housing, recreational sites, economic development and communications and maintain the extant agricultural fabric. In addition, the existence of archaeological and historical sites and the presence of a number of fragile ecosystems such as salt marshes, sand dunes and sand beaches, present a challenge to all coastal managers and planners. The mosaic of land uses along the Maltese littoral calls for a detailed appraisal.

This thesis is the result of the author's interest and participation in a number of coastal surveys in the Maltese Islands, together with the experience gained in conducting coastal field sessions for university students from Malta, Durham, Keele, Cardiff and Canterbury.

My work on the coast started with the encouragement I received from Professor Gerald H. Blake and Professor Ewan W. Anderson and Dr. Peter J. Atkins of the University of Durham who advised me to take on the coast as a theme for research. Practical experience soon followed with a number of coastal surveys and field exercises for students plus the production of a number of papers mainly for conferences and local publications.

The thesis is organized into three main parts. Chapters I to V provide the general setting to the Maltese coast, giving a historical overview, the necessary epistemological support and methodological backing of the field mapping exercise. Chapters VI and VII provide the descriptive element of the coast, based on the land uses mapped. Chapter VIII and IX contain the appraisal aspect of the thesis where through the application of a statistical method the evaluation of the coastal land uses with respect to the overall topographical pattern of the coast is examined.

As illustrative material accompanying the text, maps, diagrams and plates are used throughout. A progression from the general overall image of the Maltese Islands as presented in Chapters I and II by means of small scale maps to figures showing details at larger scales as the description and analysis unfolded in Chapters VI to VIII. The selection of the maps and photographs was dictated by two facets: the first one was to satisfy the need to show as wide a range as possible of coastal environments and secondly to illustrate a number of coastal land use issues. The result was that most of the coastal segments are represented. Most of the plates presented were photographed by the author in May 2001 during the final compilation of the thesis document. Further illustrative material was taken from reproducing old photographs of coastal sites. Mainly taken during the last part of the 19^{th} century and placed within the context of Chapter IV they help the reader to assess the extent of coastal development over a century.

A fairly large number of tables accompany the text, with most of the tables being the result of field and cartometric measurements. All the tables are derived from Appendix 1 that gives a comprehensive view of the distribution of the 16 land uses along the coast of the Maltese Islands. Subdivided into 16 coastal segments and these in turn are further subdivided into 136 coastal units, they provide a quantifiable data as to the properties of the Maltese coastline. All tables, maps and plates are placed in the main section of the thesis and generally follow in the page immediately where they are first mentioned.

The sources of information for the thesis were derived from journals and books and technical publications whose main theme was coastal management, the libraries at the Planning Authority, the Malta Maritime Authority, the Tourism Authority and the Statistics Authority stocked valuable information where technical documents pertaining t coastal issues were concerned. The National Library of Malta at Valletta, the Melitensia Reading Room of the University of Malta and the British Library Lending Division at Boston Spa stocked excellent secondary source information. Secondary literature included newspaper articles, Local Councils' and Parish Church Publications. To all the librarians concerned a special word of thanks is due.

The research and writing for this thesis was done cocurrently with lecturing full-time and helping to set up the Geography Programme at the University of Malta. As a result my grateful thanks go to a number of students who helped me at various stages in the realization of this work, especially in drawing a number of maps and in formatting tables: Maria Attard, Mariella Busuttil, Kurt Bonnici, Odette Magri and Josianne Vassallo. Academics at the university who encouraged me throughout were my mentor, former Rector and Chairman of the Mediterranean Institute Rev. Professor Peter Serracino-Inglott, the present Rector Professor Roger Ellul-Micallef, the pro-Rector Professor Charles J. Farrugia and Professor Patrick J. Schembri (no relation) of the Department of Biology and Professor Dominic Fenech of the Department of History. Thanks are also due to Professor Anton Buhagiar and Mr. Sandro Lanfranco for assistance with the statistics. However this thesis would never have got off the ground were it not for the efforts put in during my earlier education by my parents Maria and the late Salvino Schembri, the patience endured by my wife, Marlene and our son Peter Paul, for being around while I selfishly followed the academic paths.

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Chapter 1: *Introduction and background*

1.1 Introduction

The start of research for this thesis coincided with the requirement by the Government of Malta for a coastal survey as a key element in the Structure Plan for Malta. This Plan formed part of the Government's wish to rationalize the use and administration of the country's physical resources with the 1989 Coastal Survey being the first of its kind for Malta, and to distinguish the coast as a separate entity from the rest of the Island. The author was involved in the organization of this survey. Figure 1.1 gives the names and the main functions of the people involved in the survey. The survey was a joint collaboration between the Town Planning Department of the Ministry of Works of the Government of Malta, the University of Durham and the University of Malta. Professor E. W. Anderson from Durham University was the person commissioned by the Government of Malta to lead the team of thirty people. He had extensive experience in conducting similar surveys in the Middle East and Mediterranean and his leadership, technical and academic background were crucial in the successful completion of the project.

The outputs included a detailed report (Coastal Zone Survey of the Maltese Islands, Anderson and Schembri, 1989), one hundred land use maps (scale - 1:2500) and four other maps identifying sites of ecological importance. The land use maps remain the basis for the Planning Authority's decision-making process in the coastal area. This thesis also presents an analysis of the land uses in the coastal zone, and particularly illuminates those locations where conflicts occur. The study was divided into a number of stages.

In the initial stage a pilot survey was carried out by Professor Anderson and the present author in April 1989 to identify two sets of criteria upon which the coastal survey was to be based. These criteria were: the identification of the land use categories that were most representative of the coast - essentially these were the land uses that occurred most frequently along the littoral; and, the location of the landward boundary of the coastal zone - essentially drawing a line, largely parallel to the shoreline, up to the extent where the mapping of the land uses was to take place. This pilot survey was done on three selected sites, each one having different environmental properties from the other two. However, all three sites were collectively representative of the local coastal area.

The second stage was the coastal land use survey itself. By using the mapping key developed during the pilot survey, the whole coast of the Maltese Islands was mapped from the shoreline to an inland extent that in general varied from 100 to 200 metres. This spatial limit depended on a number of variables that are explained below. The results obtained were presented in a format identifying the percentage of the littoral that was occupied by each one of the 13 criteria. The results are shown in Table 1.1 and are presented in two sets: one for Malta, and one for Gozo and Comino together. A paper was produced as a result of the survey (Anderson and Schembri, 1990). This included six maps that are reproduced in Figures 1.2-1.7, three for Malta and three for Gozo. These highlight the main coastal land uses for the Islands.

For the purposes of this thesis a third stage was necessary. This stage included further studies. These were based on the experience gained on the first survey and employing the same landward boundary to delimit the coastal zone. The results of these additional studies form the basis of this thesis with the main exercise focusing on 16 land use categories that represented the area from the shoreline to the backshore zone as delineated for the 1989 survey. The results were presented by the author in areal format. In addition I subdivided the littoral length of the Maltese Islands into 16 segments. The results are presented in Appendix 1.These constitute the basis of the main text of the thesis.

A fourth exercise involved a number of cartometric measurements. These measurements were done to assess three main variables. The first variable concerned the estimation of the different land uses along the coastal zone, with the results forming the basis of the land use data and the subsequent statistical interpretation that formed the major analytical part of the thesis. The second and third variables dealt with the physical aspects of the coastal zone.

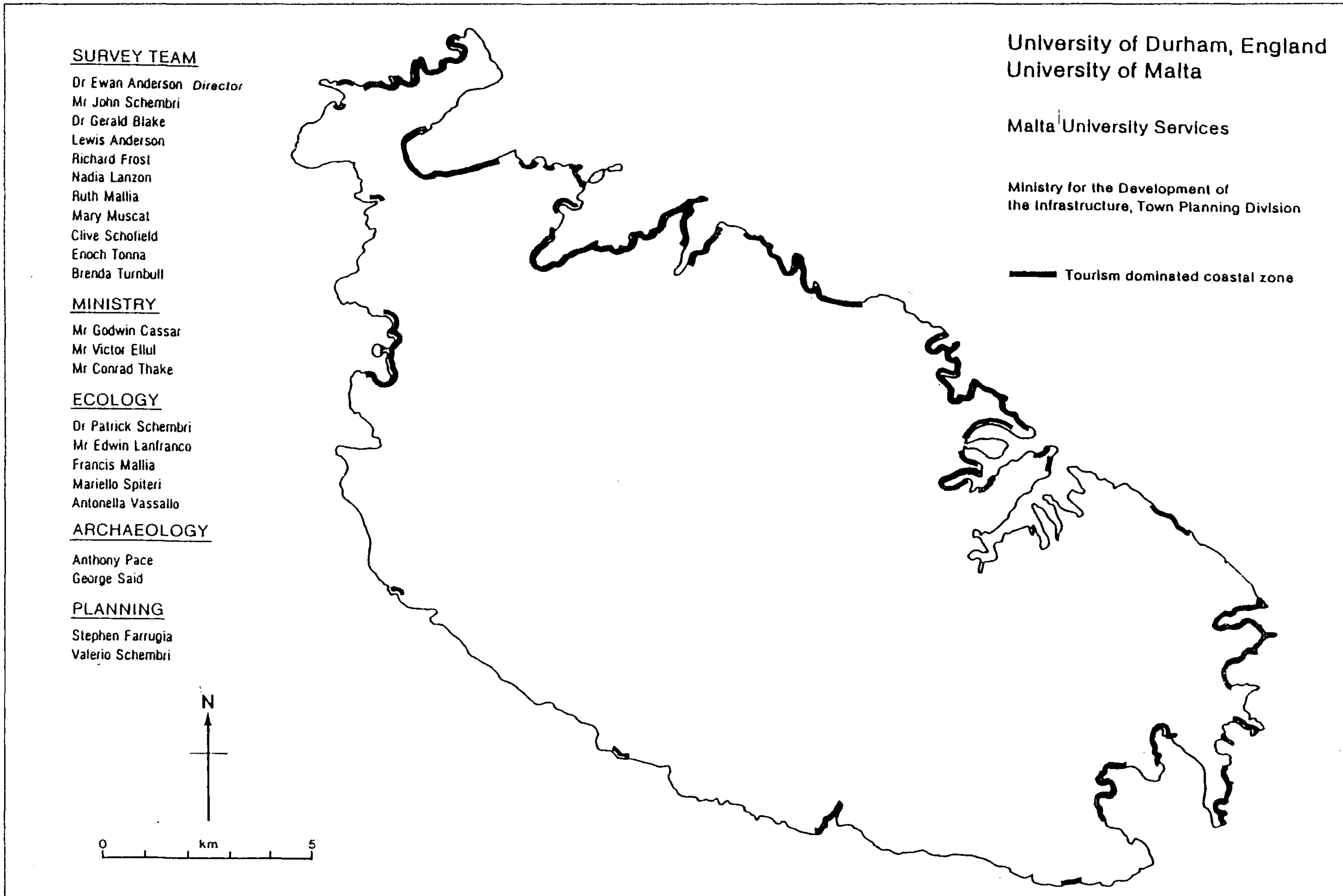


Figure 1.1: Malta Coastal Zone Survey, 1989

Source: Anderson, E.W. and Schembri, P.J. (1989)

Table 1.1 Key land use results from Coastal Zone Survey, 1989. (Figures shown are linear measures expressed as a percentage of the total coastal length of either Malta or Gozo and Comino) *

	Categories	Malta	Gozo and Comino
1.	Coastal zone obscured by development	30.5	7.5
2.	Lowland coastline (unobscured by development)	30.5	16
3.	Coastline accessible	50	26
4.	Tourism dominated coastline	35	19
5.	Coastline dominated by industry	8	4.5
6.	Coastline frontage with maritime activities	16.5	4.5
7.	Coastal zone agriculture in use abandoned	23 11 12	57 16 41
8.	Coastal zone vegetation (green all year)	9	8.5
9.	Coastal zone dominated by pollution (oil and Dumping)	3	1.5
10.	Coastline of international scientific importance	0	2.5 (Inland sea and Dwejra Bay)
11.	Coastline of national Scientific importance	6	6
12.	Coastline of international importance (recommended)	5	2.5
13.	Coastline of national importance (recommended)	13.5 (Fortification in Grand and Marsamxett harbours)	14 (Inland sea and Dwejra Bay)

Sources: Anderson and Schembri, J.A. (1990); Anderson and Schembri, P.J.(1989)

* As linear measurements overlap figures do not add to 100 per cent

Figure 1.2 Malta: Coastal Zone Variables 1
Source: Anderson and Schembri, (1990)

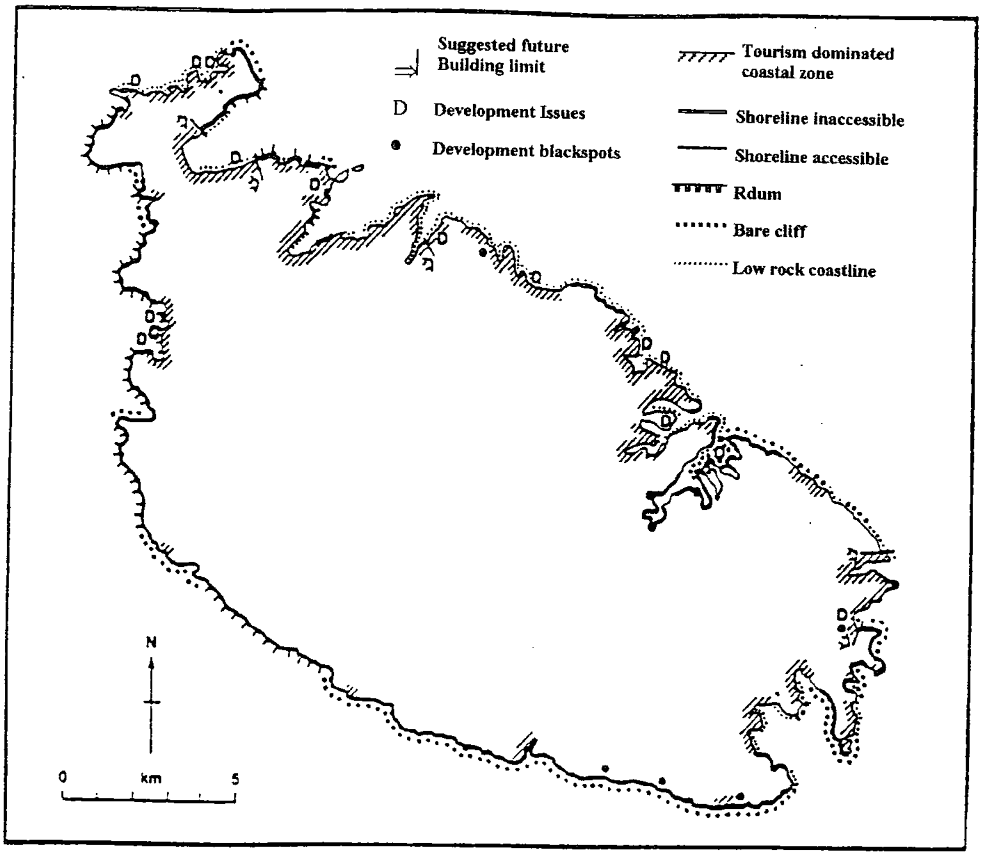


Figure 1.3 Gozo and Comino: Coastal Zone Variables1
Source: Anderson and Schembri, (1990)

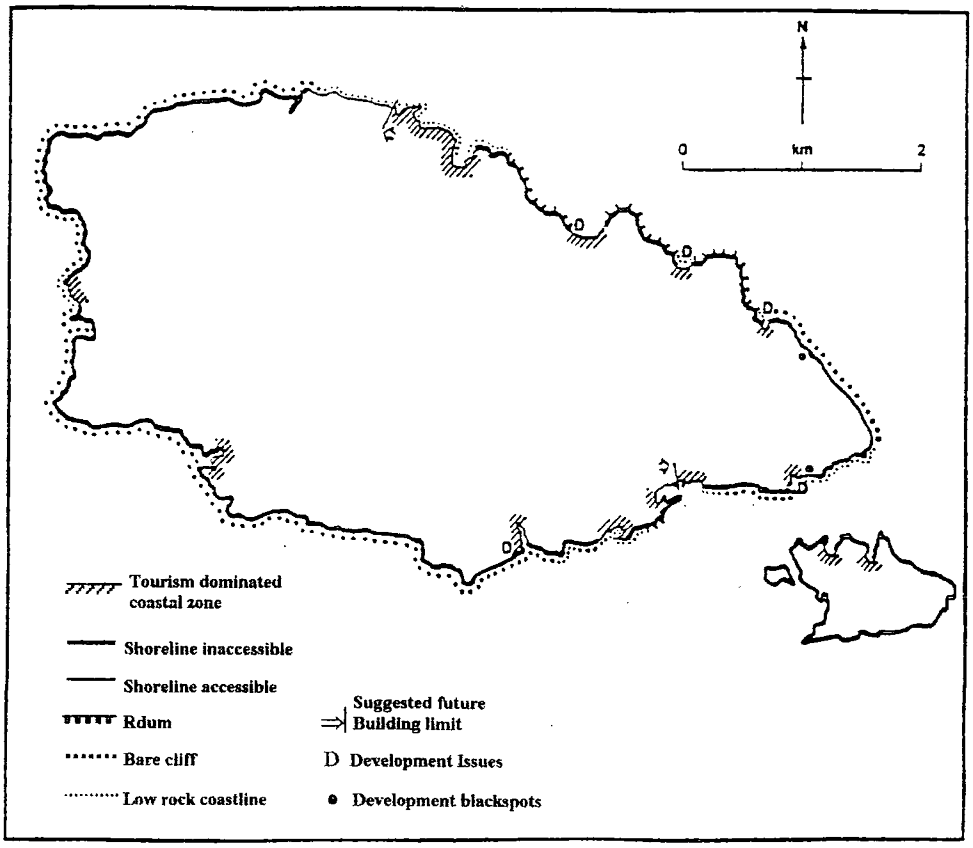


Figure 1.4 Malta: Coastal Zone Variables 2
Source: Anderson and Schembri, (1990)

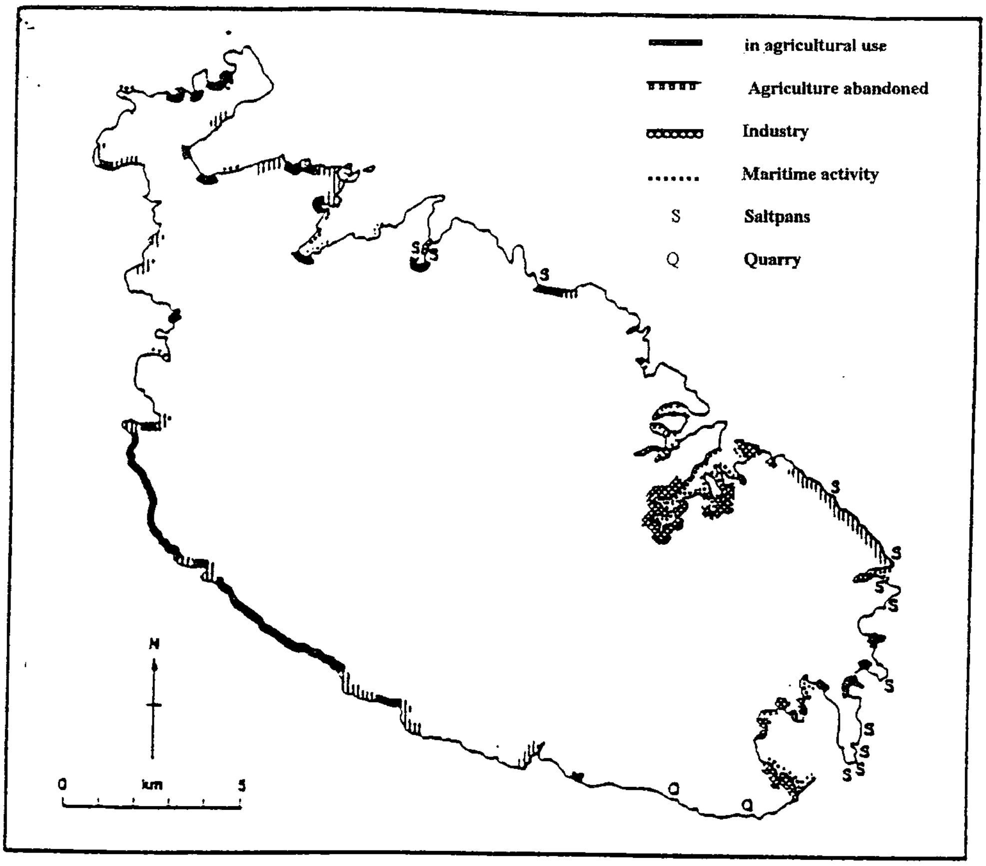


Figure 1.5 Gozo and Comino: Coastal Zone Variables 2
Source: Anderson and Schembri, (1990)

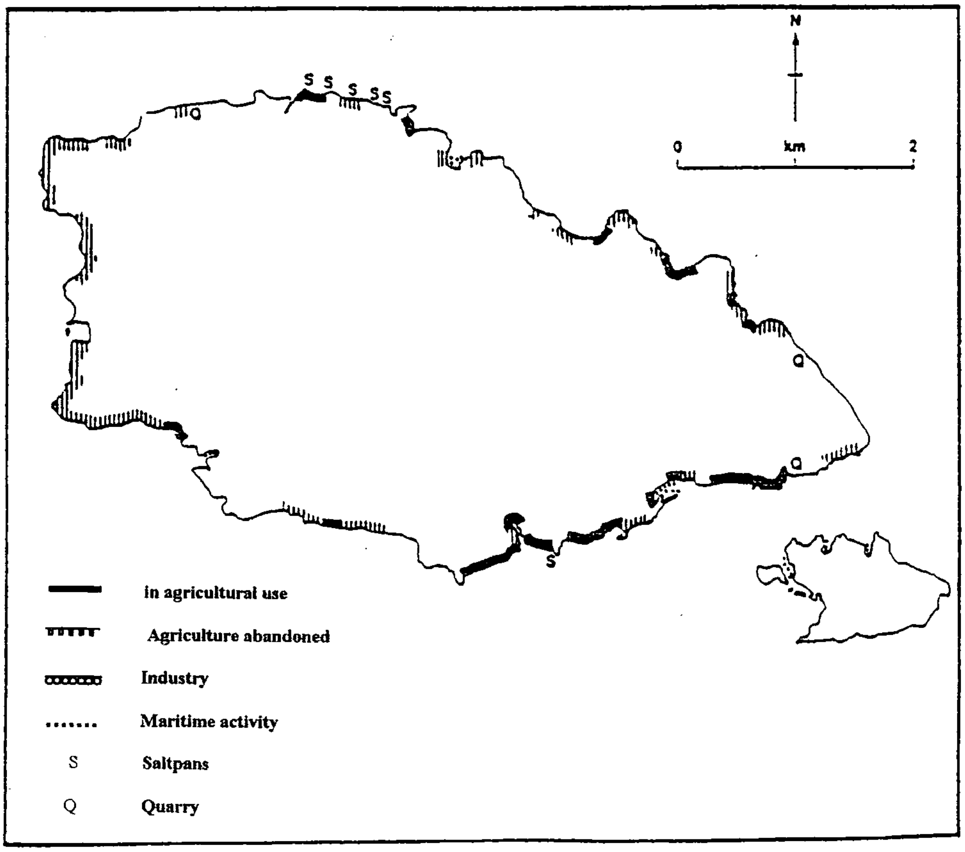


Figure 1.6 Malta: Coastal Zone Variables 3
Source: Anderson and Schembri, (1990)

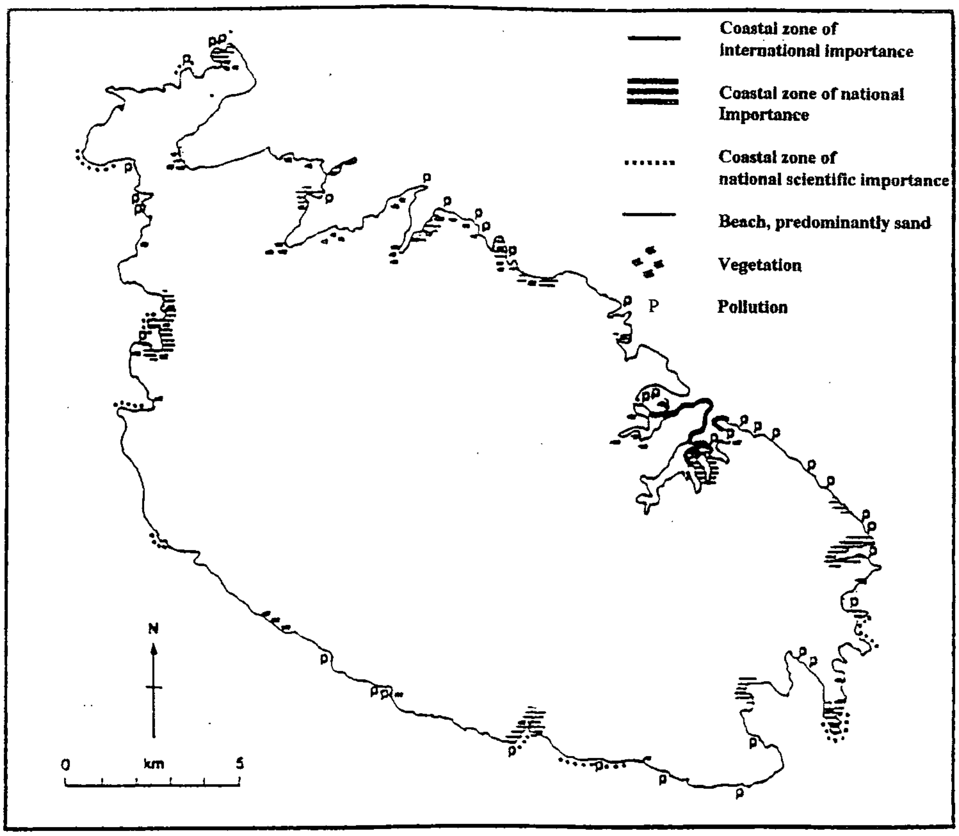
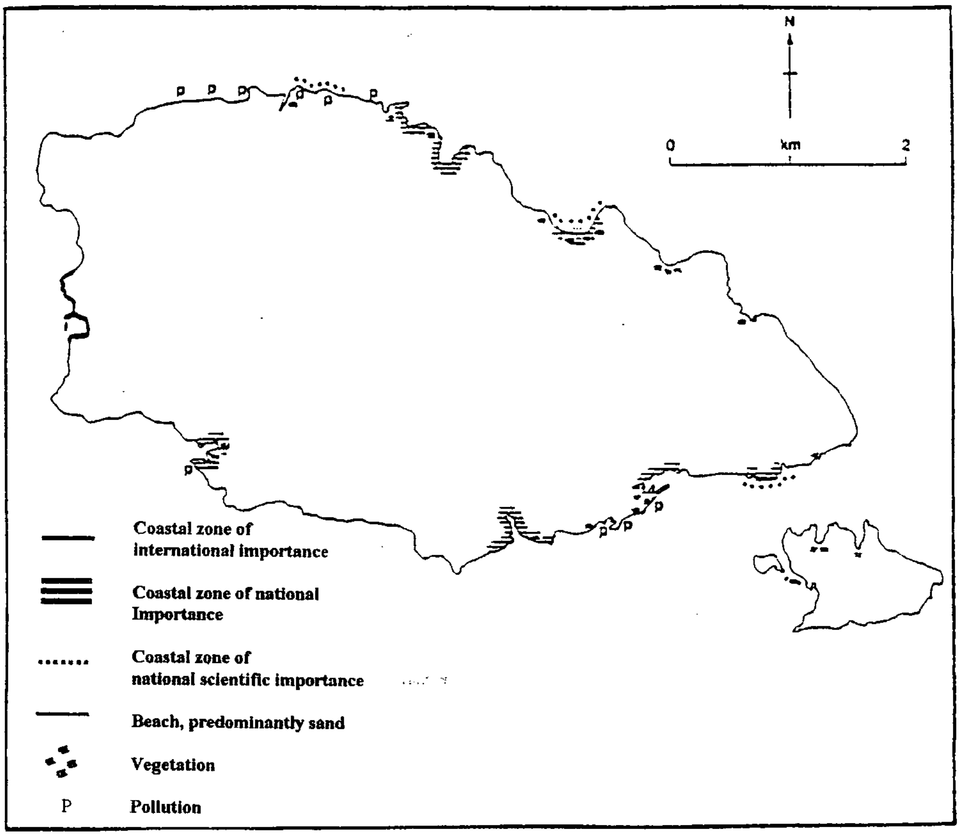


Figure 1.7 Gozo and Comino: Coastal Zone Variables 3
Source: Anderson and Schembri, (1990)



The results were mainly used to complement the land use results and showed the percentage distribution of the rock type (geology) and rock form (geomorphology) of the coastal zone. The need to perform this function was due to the fact that the scale of coastal development and the spatial distribution of a number of coastal land uses are partly the result of the geology and the geomorphology of the coast. Although other key issues, such as marine flooding, are also a function of the physical character of a shoreline (Arthurton, 1996), it was the impact of the land uses in the coastal zone that is the central focus of this thesis.

A fifth exercise was to search, evaluate and read secondary sources. These sources were crucial in supporting the field material gathered. The two broad areas that the literature was based on were land use and coastal management. In addition, land use material was generally taken from sources dealing with the coast and not from literature on land use *per se.* Publications dealing with coastal management featured prominently in the literature consulted. In addition, a further assessment of selected areas along the coast was made between April and May 2003. Primarily these included the coastal urban areas, especially locations where development and changes to the coastline were made, and a couple of coastal rural sites. Reference to these is to be found in Chapter 7 and the utilization of local press cuttings in substantiating the arguments local debate were found helpful.

Managing coastal land use is particularly critical at this time in Malta's history because the pressures on land are great. With a small area and the second highest population density of any nation state (http://www.fao.org), land is a scarce resource. Coastal land, in particular, is under pressure because the largest and fastest growing sector of Malta's economy is the tourist industry. Tourism developments are highly concentrated in coastal areas and today receive over a million international visitors annually.

The ways in which land is used represent a confluence between possibilities and restraints in both the physical and human environment. This dissertation presents the "stage" of physical geography and the human "play" that has been acted on it to produce the current patterns of land use. However "the play" influences "the stage" and turns the whole system into a dynamic area. The coast was portrayed through the 1989 survey and the report and maps that followed. This thesis elaborates on this report through a survey of the coast undertaken in 1998 and by representing the land uses spatially in hectares and analyzing the subsequent results. In addition, the human use of Malta's coast is summarized, its current use assessed, and the possibilities for the future are proposed. Since my interest in this topic and my research began, a national Planning Authority has been established in Malta. The Town Planning Department was organized into a Planning Authority in 1992, and ten years later, in March 2002 amalgamated with the Department of the Environment and referred to as the Malta Environment and Planning Authority (MEPA). In this thesis the reference to these institutions follows this chronological order.

Some regulations are now being enforced with respect to land use, and local plans are being drawn up to guide future development. A local conference (April, 1996) entitled "Towards an Integrated Coastal Zone Management Strategy for the Maltese Islands" indicated the felt need for managing the coastal zone. Another conference held in November, 1997 raised a wide range of issues for discussion some of these are presented in Table 1.2. This dissertation combines two strands of geographic thought - coastal zone management and land use planning - whilst providing a method for mapping and evaluating coastal land use.

Although in other contexts coastal zone management entails a broad range of issues such as dune protection, ground water salinization, mangrove protection, hurricane and other hazard management, in Malta the primary problems and challenges are those of competing and conflicting uses and over-development of the coastal land. Other problems in the coastal area include the pollution of marine waters, problems generated by sea use management, especially in highly accessible near-shore areas within enclosed bays, and also the protection of archaeological and historical sites within the coastal zone. The focus of this study is on land use, as the problems associated with the coastal area, whether those found on land, or in the water, but mainly due to activities happening on land.

Table 1.2 Selected list of themes discussed at the Coastal Zone Management Conference, November, 1997.

The Coastal Environment, its Exploitation, Management and Protection
Integrated Coastal Zone Management
The Value of Coastal Resources
Climate Change, Sea Level Rise & Extreme Events
Physical Processes
Science and Management
Case Studies in Coastal Zone Management
Recreation and Tourism
Modeling
Geomorphology
Regulation and Control
Shoreline Management
Management of the Coast of Mediterranean states
Sedimentology
Human Exploitation of Coastal Resources
Environmental Agencies
International Initiatives and Partnerships
Remote Sensing Mapping and GIS
Exploitation and Management of Biotic Resources
Networking, Education and Public Participation
Funding and Management of Coastal Zone Management
Monitoring
Pollution and Water Quality
The Management of Coastal Resources

Source: Ozhan, E. ed (1997) Medcoast '97, Qawra, Malta.

1.2 Chapter format

This thesis is presented in a chapter format with Chapter 1 introducing the thesis through the platform upon which the coastal land use study of the Maltese Islands unfolds: the need for a rational plan in the utilization of coastal resources, the commissioning of the Coastal Zone Survey with the involvement of the author, and the coastal land use survey that formed the basis of this thesis.

The focus of Chapter 2 is on placing the Maltese Islands within their geographical context by giving a description of the Mediterranean environment and its islands, and the background of the coastal zone of the Maltese Islands, presented in a number of relevant sections. These sections outline the main geographical properties, emphasize selected coastal properties that are of importance to the thesis, such as the geology and the geomorphology of the coast, and include the cartometric data gathered that pertains to these physical properties.

Following the introductory sections, the thesis then proceeds to examine the epistemology and meaning of coastal land use study in Chapter 3. The central argument here is a review of the literature concentrating on a series of key words that were important in the thesis. As this thesis is essentially about land use within coastal management, terms such as land, land use, and coastal management are explained so as to bring out the *raison d'etre* of coastal management, the meaning of land use, and the philosophy behind the need for proper management of coastal land use. The experience gained with similar exercises elsewhere, and the identification of key themes in forming the central part of all literature searches, were valuable in compiling this chapter.

As this thesis is essentially concerned with the impact of humans on the local coastal land use environment, Chapter 4 presents a brief overview of the history of the Islands. To keep in line with the theme of the thesis, the human use and development of the coast is given due importance including the part played by MEPA in the development of the coast in Malta.

The fieldwork aspect of the thesis is then brought into focus with Chapter 5, where the selection process in the choice of the base key used together with the criteria employed in the selection of the land use categories, are the main themes. The map of the Maltese Islands with the location of a number of place names is an additional feature in this chapter. This map helped to establish the anthropogenic influence on the coast by showing the names assigned to coastal features and localities and also helps to identify the various localities mentioned in the thesis. A discussion on the criteria used for delimiting the terrestrial area of the coast follows, as it is important to present at the initial phase of the thesis, the choice of the "stage". The final sections of this chapter deal with the method of data reduction where the data gathered was compressed into "legible" proportions and the reasons for dealing first with eight and then with 16 land use categories is explained.

Chapter 6 is the product of the field studies done to evaluate the state of coastal land use. The study quantifies the various land uses in hectares and simplifies the discussion on the coastal land use situation by means of the division of the littoral length into a number of coastal segments. The chapter concentrates on treating the sixteen main coastal land uses as spatially distributed on the Maltese Islands' coast.

In Chapter 7 the main focus is on the description of the land uses as they occurred on each segment. Two sections are devoted to each segment. In the introductory part one finds the general physical features of the segment such as aspect, geology and overall geomorphology whilst in the second part land uses and the recent problems resulting from development are examined. In addition, the final part of the Chapter includes the selected assessments done between April and May 2003.

Further analysis of the land use situation is developed in Chapter 8, where the data is analyzed employing a number of histograms. The relationship between the coastal land uses, coastal geomorphology and the geology of each segment is examined in the light of the degree of accessibility of the coast and the existing land use conflict.

The final chapter outlines the main contributions of the thesis and proposes a number of options for rational land use management, especially where land use conflicts occur. The role of the planning process in Malta is also assessed.

1.3 Aims and Objectives of the study

The concern shown for the state of the Maltese coastal environment has been documented through the publication of the proceedings of a conference held under the auspices of Europa Nostra in 1960. In this publication the rapid and haphazard development of the coastal area as a way of meeting the needs of the tourist industry was the prime motive behind the philanthropic organisation that convened the meeting (Agius Muscat,1968). *Din l-Art Helwa,* (trans: "This sweet Land") is a National association for safeguarding the historic, artistic and natural heritage of Malta and Gozo. Founded in 1965, it is an independent, non-political body, the local sponsor of the event. The society has recently been given trust of a 17th century watch tower. The aims of my study are to:

(a) Map the coastal land uses exploring the least number of categories for a quick assessment of the coastal terrestrial resources;

(b) Identify the inland extent of the coastal zone so that future planning and management of the coast can have a spatial focus;

(c) Develop a methodology for combining the physical and human related elements that make up the coastal zone;

(d) Develop a methodology for classifying the coastal areas into a series of categories by grouping the coastal areas having similar physical and anthropogenic features;

(e) Identify areas were land use conflicts are occurring;

(f) Evaluate the extent to which the geology and the geomorphology of the coast, as important physical attributes, condition coastal development;

(g) Predict the sites where future coastal development should be directed.

1.4 Conclusion

My involvement in the 1989 Survey was the inspiration for this thesis. In what follows I will try to develop an approach that will be relevant to the coastal land use issues that are so important in Malta. The thesis may be described as applied geography and in chapters two to nine we will see that there is a wide range of methodological and theoretical literature that is relevant. I hope that my work will be of interest and of value to the various coastal stakeholders and planning authorities.

Chapter 2: Background to the Mediterranean and the Maltese Islands

2.1 Introduction: The Mediterranean setting

Literature on the geography of the Mediterranean can be divided into three broad classes. In the first category, descriptions of the Region are given in a systematic manner where the various physical components of the lands and the sea surrounding them are treated from the aspects of the geology, tectonic, bathymetry, climate, natural vegetation, soils and flora and fauna. The human components of the population, history, economy, trade and tourism are normally found in the second part of the books (Branigan and Jarrett, 1975; Robinson, 1970). The second type of sources treat the Mediterranean from the environment and society point of view, where after a brief account of the physical conditions of the Region the human aspect is developed at length (King, R., De Mas, P. and Beck, J.M., 2001; King, R., Proudfoot, L. and Smith, B., 1997). The third type consists of the classical volumes (Braudel, F., 1975; Horden, P. and Purcell, N., 2000). Braudel (1975) is influenced by the events of long duration such as the mountains, climates and the desert and portrays these as giving the Mediterranean its overall uniformity in the 16th century. Islands are also described as mini-continents having a rhythm of their own. Horden and Purcell (2000), in treating the Mediterranean from antiquity to the medieval period, emphasize the existence of communities within micro-ecological environments. It was these sources that were of assistance in writing this section on the Mediterranean.

The Mediterranean Sea (Figure 2.1) has an area of about 2.9 million km^2 and is 3600 km in length from the Straits of Gibraltar in the west to the Lebanese shores in the east. The comparative north - south distance between the continents of Africa and Asia is about 1600 km if measured from the Gulf of Sirte to the North Adriatic. The main physical features of the Sea are the two main basins, each of which is divided into a number of seas. Table 2.1 gives the regional subdivisions for the Mediterranean, showing the areal extent of the various constituent seas that make up the larger Mediterranean. The western basin is clearly more compact than the comparatively large areas of the Central and Ionian basins. This is mentioned here so as to emphasize both the isolation of the Maltese Islands from the Eastern Mediterranean and their proximity to the more compact Western Basin, and thus partly account for the mainly

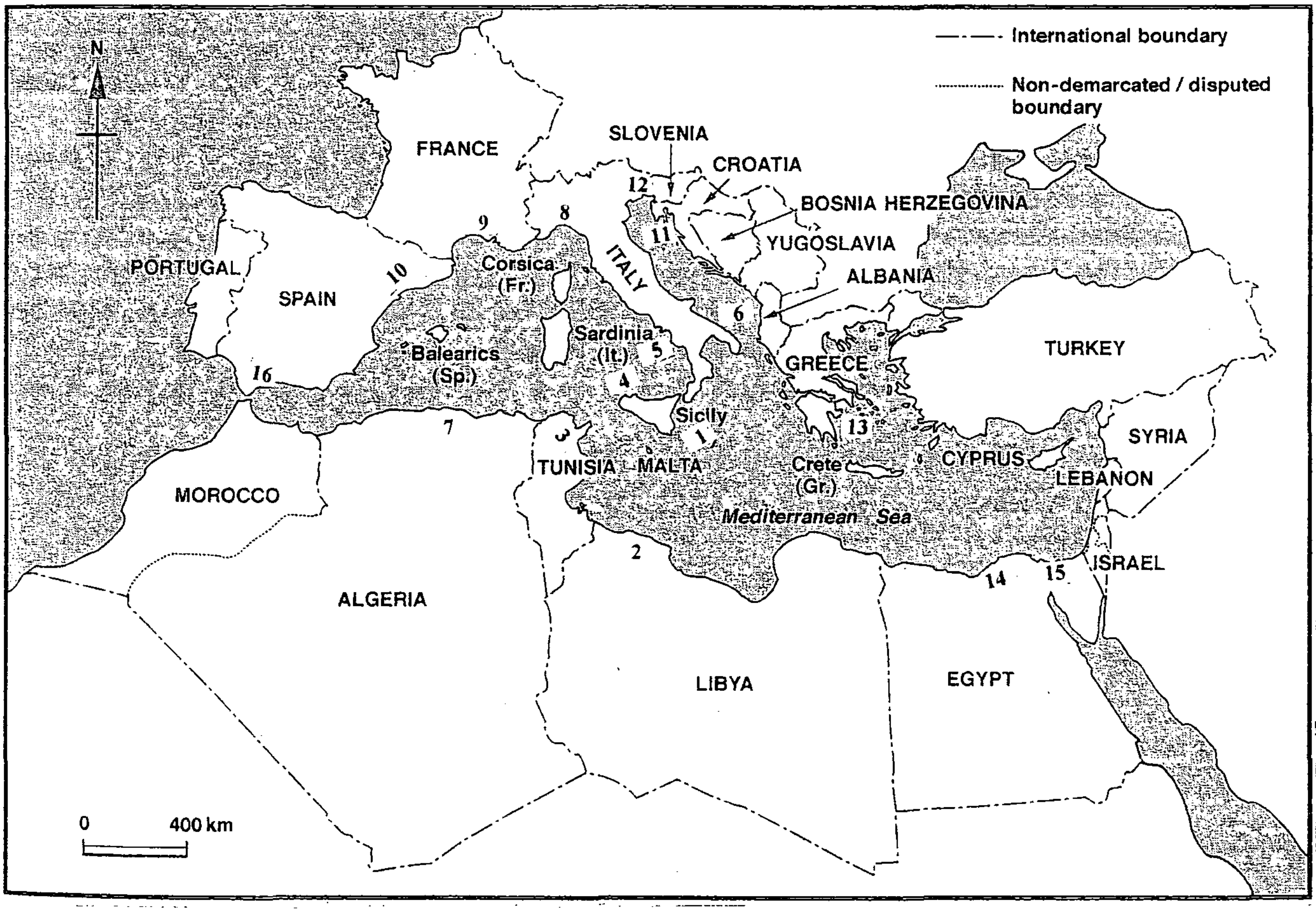


Figure 2.1 The Mediterranean: island setting and principal ports
Sources: Espenshade *et al* (1990); King *et al* (1997)

Key to Mediterranean ports

1	Catania
2	Tripoli
3	Tunis
4	Palermo
5	Naples
6	Dunes
7	Algiers
8	Genoa
9	Marseilles
10	Barcelona
11	Rijeka
12	Trieste
13	Piraeus
14	Alexandria
15	Port Said
16	Gibraltar

European influences on the cultural development of the islands. This situation may have added to the strategic value of the islands, especially at times when communications by sea were slower and wind-powered. Other important physical features are the fold mountains that encircle the western basin and most of the northeastern basin; a desert to the south east; five main peninsulas that provide the irregular coastline, and a large number of islands that are mainly located along the northern coast.

Table 2.1 Mediterranean Sea: regional subdivisions

Region	Name of Sea	Approx. area 1000 km^2
I	Alboran	68
II	North-West	287
III	South-West	264
IV	Tyrrehenian	231
V	Adriatic	133
VI	Ionian	151
VII	Central	583
VIII	Aegean	143
IX	North Levantine	177
X	South Levantine	500
Total western basin (I-IV)		850
Total eastern basin (V-X)		1687
Total Mediterranean		2537

Source: Kuwabaro, 1984

The coastal configuration and bathymetry of the Mediterranean are an important feature in its water circulation and upwelling patterns. A number of Straits constrict the various subsidiary basins and impede the flow of large volumes of water but increase the speed of water flow. This latter feature, together with the substantial depth of some of the basins, provide the necessary flushing of the waters and are important features of the circulatory patterns of the Atlantic waters that enter through the Strait of Gibraltar and take a century to circulate back through.

Descriptions of the Mediterranean physical environment normally give the impression that the sea and lands surrounding it possess uniform patterns of climate, temperatures and sea salinity. However regional differences at all scales are evident. The water circulation pattern is such that the salinity of the Mediterranean waters on entering the Straits of Gibraltar is around 36‰. Due to the high degree of insolation and both local and other winds, salinity increases as the waters circulate along the south Mediterranean coast raising salinity levels to around 38-39% along the eastern seaboard. This high salinity is compensated for by waters flowing into the Mediterranean from the Black sea (salinity 20‰) and with fresh waters from rivers and precipitation. Water flows out of the Mediterranean again mainly through the Straits of Gibraltar as a bottom, denser layer.

Differences in the overall climate that affect the coastal areas is also evident depending on the air masses that influence the Mediterranean in general. Overall, four air masses condition the Mediterranean environment throughout the year. The Continental Tropical Air Mass originates from the African continent and is associated with a dry, warm atmosphere. It is responsible for giving the climate the long-term stability associated with the Mediterranean mostly during the summer months and aiding navigation with calm seas and clear skies. However, the passage of this dry air mass over the Mediterranean waters increases the humidity levels on the islands and the northern shores over which it passes, giving the notorious hot and humid summer environment. The attraction of the Mediterranean as a touristic area is mainly due to the stable climatic conditions afforded by this air mass in addition most naval battles were fought when these conditions prevailed. The Maritime Tropical Air Mass has similar characteristics but since its origins lie in the mid-Atlantic Ocean it already contains a substantial amount of humidity before it reaches the Mediterranean area. It is this air mass, which, when coming into contact with the Maritime Polar (wet) and Continental Polar (dry) air masses from the North Atlantic Ocean and Northern Europe respectively, produce what is known as the Mediterranean Front. This gives the Mediterranean most of its precipitation, the bulk of its unstable weather conditions in the autumn and winter, the main source of river water flow in addition to snow melt in higher mountainous levels, and stormy seas that hinder navigation by small sea craft but are crucial in the water circulation and oxygenation systems.

Local winds, rainfall regimes, insolation, humidity and cloud cover are all features that are conditioned by the prevailing air masses that do not originate on the Mediterranean. However they determine the socio-economic pattern of the Mediterranean lands and their populations. Most coastal activities are also greatly influenced by the rhythm of the seasons especially with the prevailing local winds, bathymetric features of the basins, coastal configuration and indentation and geomorphological properties. Most of the physical features of the Mediterranean coasts are due to the processes that shaped the Mediterranean over millions of years. The salient events are the plate tectonic movements that shrunk the Tethys Sea into the Mediterranean, the changes to the sea levels due to the drying up (desiccation) and subsequent filling up of the Mediterranean, the changes to coastlines and associated hinterlands during the Ice Ages and the pattern of land emergence and subsidence generally as a result of local tectonic effects. These conditions created a heavily indented coastline with a large number of islands. In addition, the geological nature of the Mediterranean lands, with an overall soft lithological base, permits rapid erosion by marine, terrestrial and atmospheric waters to influence and shape the local coastal geomorphology.

Effectively the human response to these physical properties of the coasts and their associated hinterlands was one where the Mediterranean attracted a series of peoples some of which developed into key civilizations that later influenced global cultures. Basically two sets of cultures were prominent: those associated with the riverine environment (eg. Egyptian) where the annual flooding of the rivers on to the surrounding flat land provided water and nutrients for crops, and those civilizations that were associated with the coast (eg. Phoenician) whose main source of income was trade through the maritime connections and sea-faring. Mountain civilizations (eg. Berber) played a minor part in the coastal affairs of the Mediterranean. Thus one can put forward the idea that the human modification to the coasts has been around for about ten millennia with various degrees of intensity depending on the population density of the location and on the particular use to which an area is put to. Whatever the origin and duration of the Mediterranean civilizations, the scenario is one where a rich cultural heritage has been left and is now part of the contemporary coastal management process.

Further issues influencing the coastal management process in the Mediterranean lands are the problems generated by population increase and coastal urban development, the development of industries especially those associated with maritime trade and traffic, and the growing importance of tourism and recreation in the economies of the states concerned. All these factors have transformed the land uses in the Mediterranean to an extent that concern for the overall environment of the region has been around for the last decade. In fact, two particular publications provide a succinct analysis of the situation. Allen (2000) quoting Grove and Rackham (1998), provides four illustrative models of land use change that can be applicable to most of the northern Mediterranean presenting the situation in four time-frames: BC, AD 50, AD 1770, and AD 1990. The main modifications to the Mediterranean environment were associated with food production. These included the introduction of terraced and irrigated agriculture to the sea levels since the pre-historic period, drainage of wetlands for providing more arable land, the construction of dams, the decline of the forest cover, and the introduction of new plant species since Roman times. Industrialization brought about changes to the transport systems through trains and automobiles and the influence of industrial activity in the abandonment of agriculture and later in the last century the influx of tourists and the associated land use changes along the coast. Change to the sea level since pre-historic times is one of the main physical modifications to the coastal environment.

2.1.1 The Mediterranean Coastline

The total length of the Mediterranean coastline is 46,000 km with the northern shores comprising 85 per cent. This is due to the highly indented coastline to the north of the basin and the presence of a large number of islands. In addition, only about 40 per cent of the coast is accessible, thus causing a concentration of most human activities. With a coastal urban population expected to reach about 200 million in 2025 and the concentration of tourism, industry, hydrocarbon ports, refineries and thermal power plants located mostly along the accessible areas, then the problems of the Mediterranean coastal zones will escalate if no precautions are taken to decrease the effects of these problems (The Blue Plan, 1989). Table 2.2 has selected data for Mediterranean countries where the large North African states (Egypt, Libya and Algeria) have a relatively smaller coastline than the smaller (in overall area) of North

Mediterranean (European) states. In addition, the two Mediterranean island states (Cyprus and Malta) have a coastline which is as long as some other smaller Mediterranean states such as Albania, Syria and Lebanon. Other points shown in Table 2.2 demonstrate that from the predicted population estimates a substantial increase in the coastal populations of all North African states is envisaged whilst European states on the Mediterranean watershed can exhibit a marginal increase or even a decline (Italy and Greece). These demographic situations are similar to the overall scenarios of the demographic patterns for Mediterranean states (King, R., De Mas, and Beck, J.M., 2001).

Table 2.2 Selected data for Mediterranean countries

Countries	Population in millions	Population in Mediterranean watershed in millions	Total area km^2	Estimated length of Mediterranean coastline km	Range of predicted population in Mediterranean watershed for 2025 in millions
Spain	38.5	13.9	551 200	2 600	17.9-20.0
France	54.6	5.5	543 965	1 700	5.9-7.9
Italy	57.8	42.2	324 000	8 000	39.2-46.2
ex-Yugoslavia	23.2	2.3	255 800	6 100	5.4-3.9
Albania	3.0	3.0	28 863	200	n.a.
Greece	9.9	8.9	133 022	1 500	8.5-10.7
Turkey	49.3	9.9	770 246	5 200	15.6-24.2
Syria	10.5	1.2	185 200	200	n. a.
Lebanon	2.6	2.6	11 175	200	n.a.
Israel	4.2	2.6	20 800	200	3.4-5.3
Egypt	46.9	16.4	1 003 000	900	28.9-36.0
Libya	3.6	2.3	2 105 000	1 700	7.6-10.2
Tunisia	7.1	5.0	164 150	1 300	7.9-10.4
Algeria	21.7	11.5	2 224 000	1 200	17.6-27.7
Morocco	21.9	3.3	458 730	500	5.9-6.8
Cyprus	0.7	0.7	9290	800	0.8-0.9
Malta	0.4	0.4	316	200	0.4-0.45

Sources: The Blue Plan (1989)
Branigan and Jarrett (1975)

In addition, the depletion of fish and other marine food stocks and the problems associated with sea-level changes can only increase the pressure on the coastal environments. Viles and Spencer (1995) cite the concentration of the tourism industry around sandy beaches that has increased the problems along the Mediterranean coast. The change to the natural supply of beach material has drastically changed the coastal environments where the construction of dams in the hinterland has decreased the supply of sediment sources and the artificial accretion of beaches to generate more recreational space and drastically increased the coastal problems. In addition, the construction of ports and marinas with their associated engineering works limit the circulation of water in bays and increase eutrophication, the rapid growth of algae that take up most of the dissolved oxygen, deplete the biological capacity of the waters and drastically increased the coastal problems.

2.1.2 The Mediterranean Action Plan

As a result of the United Nations Conference on the Human Environment in Stockholm in 1972 the United Nations Environment Programme (UNEP) was set up. Awareness of the increasing deterioration of the Mediterranean coastal environment, the increasing population in the coastal states and the pollution caused by industries and tourism, a number of Mediterranean countries proposed the setting up of the Mediterranean Action Plan (MAP) under the auspices of UNEP entitled "The Blue Plan". The main objectives of the Plan were: to develop a series of legally binding treaties to be signed by the governments of Mediterranean countries; the creation of a pollution and research monitoring network; and, a socio-economic programme that would reconcile development priorities with a healthy Mediterranean environment. The Blue Plan (1989) presented an overall view of the situation in the Mediterranean concerning the demographic and economic scenarios, selected physical (forest, soil and water) environments, and the importance of the coastline and the sea in the development of the lands bordering the Basin. Most of the data presented covers up to 1985 but different scenarios are postulated for the period 2000-2025. The overall conclusion is one where the increase in the populations for the southern Mediterranean states together with the increasing tempo of industrialization in the northern states will put further pressure on the physical and human resources of the region. Attention focused on a number of problems, mainly the control of urbanization through better guidelines on coastal development, enforcement of legislation to decrease the disposal of industrial waste through rivers, and the development of educational programmes to increase awareness and information on the environment and broaden employment opportunities. These initiatives will then pave the way for the separate national programmes to participate in a concerted Mediterranean-wide effort.

2.1.3 Mediterranean Islands

Mediterranean islands present a special geographical context in that their location in a sea renowned for its long historical traditions and human settlement patterns have put them in closer contact with the continental land masses that their counterparts in the Atlantic or Pacific Oceans. As a result the problems generated by Mediterranean states regarding pollution, dumping of industrial waste, pressures produced by tourism development that spill over to islands form the mainland, and the passage of maritime traffic places them within easy reach of the environmental problems of larger land masses.

Islands in the Mediterranean can be grouped into two, depending on their size: large islands such as Sardinia, Corsica, Crete, Sicily and Cyprus and Euboea, and the small islands such as those on the Aegean and Adriatic, the Italian Islands, the Balearic Islands and the Maltese Islands (cf Figure 2.1). Table 2.3 gives the area for a number of Mediterranean islands, besides the differences in size the fact that only two are sovereign states shows that Mediterranean states have always displayed a need to control the islands nearer to their mainland. The two exceptions of Cyprus and Malta were colonies of Britain, a non-Mediterranean state but a Mediterranean maritime and military power by all means up to the mid-20th century. The problems faced by many Mediterranean lands in their economic development are greater in islands due to a number of factors. Distance from the mainland makes communications by sea and possibly by air as the only options and these can be interrupted during inclement weather conditions. The depletion of aquifers, through overuse and contamination by nutrients, and the generally thin soils put agricultural practice at a disadvantage when compared to northern arable land practices in Europe. Population changes affect islands when the economic conditions deteriorate but also when the population densities become high for an insufficient resource base.

Table 2.3: Area of selected Mediterranean islands and archipelagos

Islands and archipelagos	Area km^2	Sovereign State
Balearic Islands	5,014	Spain
Corsica	8,618	France
Sardinia	23,813	Italy
Aegean Islands	25,610	Greece
Crete	8,261	Greece
Euboea	3,655	Greece
Corfu	592	Greece
Rhodes	1,398	Greece
Sicily	25,460	Italy
Maltese Islands	316	Sovereign state
Cyprus	9,251	Sovereign state
Elba	223	Italy
Djerba	510	Tunisia

Source: http://users.erols.com

Although island populations are also affected by adverse international political situations, when generally an exodus to the nearest mainland occurs and the demographic profile generally ages, leaving sparse human resources behind, the situation in Malta is opposite to this general trend. It was during world wars and political tension in the Mediterranean that the islands enjoyed economic progress especially when their geographical position was strategically important. As a result emigration during these periods was minimal and employment opportunities high. During other periods it was the state with large public works that kick-started the economy. Cases in point in Malta are the building of the breakwater at the Grand Harbour entrance in 1900s, road construction in the 1950s, the residential and industrial building boom in the 1960s, the new airport runway in the 1970s, and the Container Terminal in the 1970s and its extensions in the1980s together with the Power Station. Throughout the last forty years heavy investment on hotels and recreational establishments ran parallel to the above industrial and infrastructural works. It is clear that these construction works have taken their toll on the islands' coastal resources and apparently the trend for the immediate future includes the further development of the coastal environment.

The importance of the development of the tourist industry in the Mediterranean over the last five decades has spilled over to the islands and this has benefited in changing the economic base of many of them and provided alternative sources of employment opportunities to the islanders and other people on seasonal employment from the mainland. However some of the land use problems associated with the mainland coastal urban centres are also to be found on islands especially when the islands in question have unique features that are marketable to the tourist industry. Two examples are the volcanic islands of Stromboli and Capri off the Italian coast. Elba, off the Tuscan coast of Italy, with a population of about 30,000 and an influx of two million visitors annually, has problems with safeguarding its historical heritage and keeping up its image of an up-market tourist destination.

Nicholls (1998) outlines a number of factors that are relevant to coastal management in islands given that islands are different from mainlands and also from larger islands. A small land mass means that important natural resources are limited in supply, a high dependency on international trade is crucial to economic viability, the natural storage capacity of water is limited to the extent of the small land mass, public administration generally takes up a substantial amount of the annual budget. Micallef (1997) provides guidelines for the sustainable development of small islands and proposes that since these small land masses are extremely fragile in their economic performance because of a small natural resource base, problems with communications, a poor agricultural output, and economic investment relying mainly on developing tourism, makes the continued assistance of their mainland administrators of vital importance.

2.2 The Maltese Islands: Location, size and selected physical features

The selected study area of this thesis is the Maltese Islands, which are located in the central Mediterranean about 93 km due south of Sicily and 290 km east of Tunis. Figure 2.2 gives the location of the islands within the Mediterranean. The islands lie at the exact centre of the Mediterranean with a 19 degree distance from either end of the Mediterranean, and a longitudinal distance from both the eastern and the western ends at 7 and 9 degrees respectively from the northern and southern limits of the Mediterranean shores. This geographical location throws light on and partially accounts for the socio-economic and cultural influences experienced by the islands. As a result of the central location, the islands were occupied by successive military powers that were dominant or influential in Mediterranean affairs. This long series of political occupants left their mark on coastal land uses and conditioned the strong economic and cultural links with Europe, with which 80 per cent of trade is still done and where 90 per cent of tourist visitors originate. Semitic links with North Africa are seen in the language (Mifsud Bonnici, 1960; Serracino Inglott, 1981) and place names (Wettinger, 2000; Schembri 2001).

The relative location of the Islands, i.e., their location in relation to the adjacent lands and seas, is another factor that may have contributed to the present pattern of coastal land use and is therefore worth mentioning. This highlights the importance of the maritime dimension of the Maltese Islands in the Mediterranean. Two tables give an indication of this situation. Table 2.1 presented details on the regional subdivision of the Mediterranean into a number of constituent Seas that make up the larger Mediterranean. Table 2.4 lists the distances of the important ports from Malta and from this the proximity to ports in the Western Mediterranean basin is evident (cf Figure 2.1). The relative isolation of the Islands can also be examined from the position of the other central Mediterranean islands, Pantalleria, Linosa, Lampedusa and Lampione that make up the Pelagic group of islands. These have very small populations and were never considered as possessing viable socio-cultural links with Malta except for the provision of wood in the 16th century.

Having an area of approximately 320 km^2, the archipelago consists of three main islands Malta (245 km^2), Gozo (68 km^2) and Comino (6 km^2), together with a number of other smaller islands and rocks. Table 2.5 gives the relevant dimensions. Their total length is about 45 km, trending north-west to south-east. The islands lie on the submarine ridge that divides the Mediterranean into two halves and have an area of 69 000 km^2 as Exclusive Economic Zone. Like all other small island states the Maltese Islands possess a small area per kilometre of coastline (Table 2.6) whilst larger states (Table 2.7), mainly continental land masses, have a far larger land mass for the same coastal length. This means that small islands depend relatively more on their coastal resources than larger states. In addition, Table 3.1 gives the population densities for selected small states and territories.

Table 2.4 Mediterranean Sea: distances of selected seaports from Malta

Seaport*	Km	Nautical miles
Catania	110	203
Tripoli	195	361
Tunis	222	411
Palermo	231	428
Naples	325	602
Dunes	400	741
Algiers	572	1065
Genoa	580	1074
Marseilles	635	1176
Barcelona	666	1233
Rijeka	686	1270
Trieste	730	1352
Piraeus	517	1057
Alexandria	822	1522
Port Said	937	1735
Gibraltar	996	1789

Source: Malta Maritime Authority (1989)
* Location of ports is in Figure 2.1

Table 2.5 Selected dimensions for the Maltese Islands

	Area	Length (km) trending NW to SE	Width (km) trending SW to NE	Shoreline (km)	Comments
Malta	246 km^2	27.3	14.5	136.8	Main island with administrative Capital
Gozo	67 km^2	14.5	7.2	45	situated 8 km to NW of Malta
Comino	6 km^2	2.75	2.25	7.5	2 km to NW Malta 1 km to SE of Gozo
Cominotto	9.9 ha	450m	225m		near Comino
St. Paul's Islands	0.02 ha	100m	200m		North of St. Paul's Bay
Manoel Island	included within area of Malta	1.25 Km	0.45 Km	2.8	within Marsamxett Harbour;land bridge
Filfla	2.0 ha	400m	250m		3 km off S. Malta coast; Nature Reserve
Fungus Rock	0.7 ha				Gozo
Gebla tal-Halfa	0.4 ha				Gozo

Source: Adapted from Azzopardi A. (1995).

Table 2.6 Selected criteria for the smallest maritime states

	State	Area km^2	Coastal Length Km	Area/Length km^2/ km
1	Monaco	1.5	4	0.4
2	Macao	15	40	0.4
3	Maldives	298	644	0.5
4	Gibraltar	6	12	0.5
5	Bermuda	54	103	0.5
6	Gilbert Isl.	684	1143	0.6
7	Seychelles	404	491	0.8
8	Nauru	21	24	0.9
9	Tuvalu	26	26	1.0
10	Wallis & Futuna	207	129	1.6
11	Antigua	280	153	1.8
12	Cook Islands	240	120	2.0
13	St.Kitts, Nevis Ariguilla	389	193	3.0
14	**MALTA**	**313**	**140**	**2.2**
15	Tonga	997	419	2.4
16	Grenada	344	121	2.8
17	Singapore	583	193	3.0
18	Bahrain	596	161	3.7
19	St. Lucia	616	158	3.9
20	Barbados	430	97	4.4
21	St. Vincent	389	84	4.6
22	Sao Tome & Principe	964	209	4.6
23	Dominica	790	148	5.3

All states are islands except Monaco, Sao Tome and Gibraltar.
Source: Dahl (1991)

Table 2.7 Selected criteria for the ten largest states

State	Area km^2	Rank	Coastal Length km	Rank	Area/Length km^2/km
Ex-USSR	22,274,000	1	46,670	3	477
Canada	9,971,000	2	90,908	1	110
China	9,600,000	3	14,500	10	662
USA	9,363,396	4	19,924	7	469
Brazil	8,521,000	5	7,491	15	1,137
Australia	7,692,000	6	25,760	5	299
India	3,136,500	7	7,000	17	448
Argentina	2,771,300	8	4,989	22	555
Sudan	2,504,530	9	853	82	2,936
Algeria	2,460,500	10	1,183	69	2,079

Source: Dahl (1991)

The Maltese Islands, a sovereign state within the British Commonwealth (Cremona, (1994), have a population of 382,525 (National Statistics Office, 2002) making them one of the most densely populated nations of the world (United Nations Demographic Yearbook, 2001). About one-third of this population lives in localities that are immediately contiguous to the coast (Central Office of Statistics, 1996; Schembri and Bonavia, 1998). In addition, 1.2 million tourists visit the Islands every year (National Statistics Office, 2001a). These visitors put pressure on the infrastructure and coastal resources, as most of the recreational establishments are located on the coast (eg. National Tourism Organization, 1995; Lockhart, 1997a). The Maltese Islands are no exception to the general trend that the coastal areas of many countries have increased in importance with economic development. Marine-related industries and services are located mainly in the protected areas of a coast, notably in harbours, and also occupy extensive physical space along the coastal fringe (Schembri, 1993).

These scenarios cause a degree of conflict of land uses along the coastal margin, especially in areas where there is a high degree of accessibility mainly brought about by a low sloping land profile. Thus the coastal area can be reached easily either from the landward or from the seaward side or from both. The intensity of land use can also be influenced by the general shape of the coast, i.e., whether the littoral is embayed (having a harbour or bay) or rectilinear in outline. Other factors that influence coastal land use are the degree of slope of the land towards the shoreline, and the geology and geomorphology of the coastal margin. Recent coastal land use development has also been superimposed on an architecturally-rich historical environment, mainly the military architecture of a succession of occupiers (Hughes, 1993; Spiteri, 1989; Spiteri, 1999), and also on ecologically-sensitive areas that grew out of the interactions within the natural environment. The latter include salt marshes, sand dunes and beaches (Schembri and Sultana, 1989).

Within the milieu of a fast pace of coastal development, efforts at introducing a degree of planned development have been attempted. A summary of these efforts is shown in Table 4.2 in Chapter 4, where the studies and reports commissioned by successive Maltese Government administrations are listed and reviewed in chronological order. These start in the immediate post Word War II period (Harrison and Hubbard , 1945) for the Harbour areas and end with the legislation that introduced the Malta Structure Plan in 1992. Since then a number of local plans have been published: the

Marsaxlokk Bay Local Plan (Planning Authority, 1995); the Grand Harbour Local Plan, (Planning Authority, 1997a; Malta Environment and Planning Authority, 2002a); the North West Local Plan - consultation draft (Planning Authority, 2001); the North Harbours Local Plan - consultation draft (Planning Authority, 2000b); the Gozo-Comino Local Plan - consultation draft (Malta Environment and Planning Authority, 2002b); the Malta South Local Plan – Report of Survey (Malta Environment and Planning Authority, 2002c). All these deal in part with coastal land use.

In the meantime, the Ministry of Tourism under the auspices of the World Tourism Organization has prepared a master plan for Tourism as a guide for the upgrading of the industry (Horwarth and Horwarth, 1990). Allied to these activities, the ship repairing industry, the development of the Cottonera waterfront, the extension of the Cruise Liner Terminal in Grand Harbour, the proposed development of Manoel Island and Tigne, and the development of the container terminal at Marsaxlokk Bay, together provide other facets of coastal land use.

Up to 1989 the only land use data available for the Maltese Islands was that dealing with the extent of urban areas. These data indicated an urban sprawl growing from 5.5 per cent of the surface area of Malta in 1955 to 16.5 per cent in 1985 (Cilia, 1995). However, in 1990 it was estimated that the island of Malta alone had 28 per cent of its surface used for urban, industrial, touristic and airport facilities (Duca and Zammit, 1989). Table 2.8 gives the most recent data collated (National Statistics Office, 2001b).

Table 2.8 Main categories of land use for Malta and Gozo

Land use	**km^2**	**Per cent**
Agricultural land	107.19	34.90
Land under forest and wooded land	13.37	4.23
Built up and related land	73.38	21.97
Wet open land	1.60	0.50
Dry open land	114.57	38.40
Total	**310.11**	**100**

Source: National Statistics Office, 2001, 3.

Fortunately for the Maltese Islands, the mapping of the land (and waters) has been reproduced fairly regularly by the British Directorate of Overseas Surveys and recently by the French Geographical Bureau (see chapter 5). Thus reliable base-line cartographic representation of the land surface is readily available in Ordnance Survey sheets. These sheets give the topographic outline at 25-foot contour intervals, identify the main geomorphological features such as cliffs and steep slopes, indicate the names of the localities, and show all built-up areas. Further details in this regard are provided in Chapter 5. The land-use mapping for this thesis was done on these sheets, with the features mentioned providing a guide to site location and on-site assessment of land use variations. As a result of the cartographic representation of the land surface and features on these sheets, the mapping of the land uses by the author was facilitated. Mapping is influenced by the choice of the mapping scale, the time span available for the mapping exercise itself, and the area to be mapped. So as to minimize these problems I identified and delimited the mapping area, basing my selection on the experience on the 1989 survey work and the numerous tasks assigned to students on coastal field projects. As a first exercise towards this end, a number of studies were consulted so as to justify the method used in delineating the coastal zone (cf. Tables 2.12 and 2.13). In addition, these geographic limits influenced the categories of coastal land uses that were to be mapped and then fitted to the needs of this study. Essentially, the main sources tapped for this were Coastal Management studies. An additional exercise involved the subdivision of the coastal zone into a number of segments.

2.3 The Geology and Geomorphology of the coast

In general, the natural features of the land influence land use. Crofts (1973) identified topography as being the main element that conditions land use. The scheme developed by Crofts and reproduced in Gardner and Dackombie (1983) associates various land uses to the degree of slope of the land. In general, gentle slopes are associated with urban and industrial development and also with agriculture. Steeper slopes tend to inhibit development options. Slopes are conditioned by the geological condition of the terrain, the tectonic system influencing the area, and the meteorological situation (Selby, 1993; Waugh, 2000). In coastal areas and especially along the nearshore and backshore areas, slopes are also affected in the very long term (millions of years) by water run-off from the land and by marine conditions such as storm and tidal wave action. The end result, relating the geology (the type of rock) to the slope of the terrain, produces distinct geomorphological features such as cliffs, screes, and beaches. This section provides a brief overview of the geology and the geomorphology of the coast of the Maltese Islands to furnish the necessary background for the coastal land use study.

2.3.1 Geology

The geology of the Maltese Islands is made up of a succession of marine sediments deposited during the Oligo - Miocene period (ca. 60 million years ago). The succession is based on a temporal scale, and we can estimate the approximate period and time of deposition. Two main studies have been consulted, namely, Zammit Maempel (1977), to guide on the lithological aspect of the strata, (see Table 2.9); and Alexander (1988), to provide a spatial context for the occurrence of the type of rock (Figure 2.2). However, for the purposes of this thesis the discussion on the geological aspect will focus on the spatial extent of the various strata as each Member outcrops along the littoral.

The main cartometric exercise relevant to this section of the thesis was taken from a Geological Survey of the Maltese Islands published by Ordnance Survey (British Petroleum Exploration Company Limited, 1957 - scale 1:31,680) and the Geological Map of the Maltese Islands (Oil Exploration Directorate, 1992 - scale 1:25,000) published by the Government of Malta. One of the main results of this exercise was the compilation of the raw data presented in Tables 2.10 and 2.11. These tables give the percentage distribution of the different types of rock and the percentage occurrence of the coastal geomorphological properties for the Maltese Islands as a whole, and for the separate islands that make up the archipelago, i.e., Malta, Gozo, and Comino. The data were compiled whilst measuring the coastal length of the Maltese Islands from the 1:2,500 scale maps at 25 m (1 cm) length transects and denoting as accurately as possible the rock type and the coastal features. The length of coast for each separate rock type (geology) and each geomorphological property were entered in a table against the respective Ordnance Survey (O.S.) sheet number. The figures presented in Tables 2.10 and 2.11 are the percentage value for each column of figures from the total for the Maltese Islands and form a synopsis of the data gathered. Each table gives the percentage distribution of rock type for each individual island and for the whole archipelago. As it was felt necessary to provide a diagram with giving the distribution of rock type over the whole island so as to present the distribution for the whole of the islands Figure 2.2 was provided. However the data in Table 2.10 appertains to the situation along the coast.

The type of rock that forms the coastal margin is basic to coastal management practices. The disposition of an area for development is in part dependent on the rock type. Thus the different islands, though possessing similar geological strata, have notable differences in the percentage composition of each littoral facies and outcrop. Table 2.10 compares the three main islands and also gives figures for the whole archipelago. The Globigerina limestone formation is shown in its three main subdivisions. The importance of this lies in the friable nature of the Upper and Middle Globigerina limestone formations that may not encourage development where they outcrop, although the Power Station foundations at Delimara were built on these rock types. Table 2.10 also identifies alluvium and sand percentage distributions to demonstrate the limited amount of these types of beaches on the local littoral. A number of significant points emerge that throw light on the general properties of the coast and at the same time highlight the physical differences between the separate islands.

Table 2.9 Selected geological data of the Maltese Islands

	Upper Coralline Limestone	**Greensand /Blue Clay**	**Globigerina Limestone**	**Lower Coralline Limestone**
Maximum thickness below surface	160	70	25-200	140
Percentage surface area Outcropping (Malta) [1]	22.6	12.3	44.5	20.6
Percentage of Coastal Length [2]	16.4	9.4	35.1	36.0
Main Geomorph-ological Features	low sloping rock/rdum	beach/ rdum/talus	low sloping rock/shore platform	plunging cliff, shore platform

Main source: Zammit-Maempel (1977) [1] Estimated by weight of paper, described above

[2] Measured on 1:25,000 scale maps at 25 m intercept intervals. The remainder 3.1 per cent is covered by beaches and other coastal deposits.

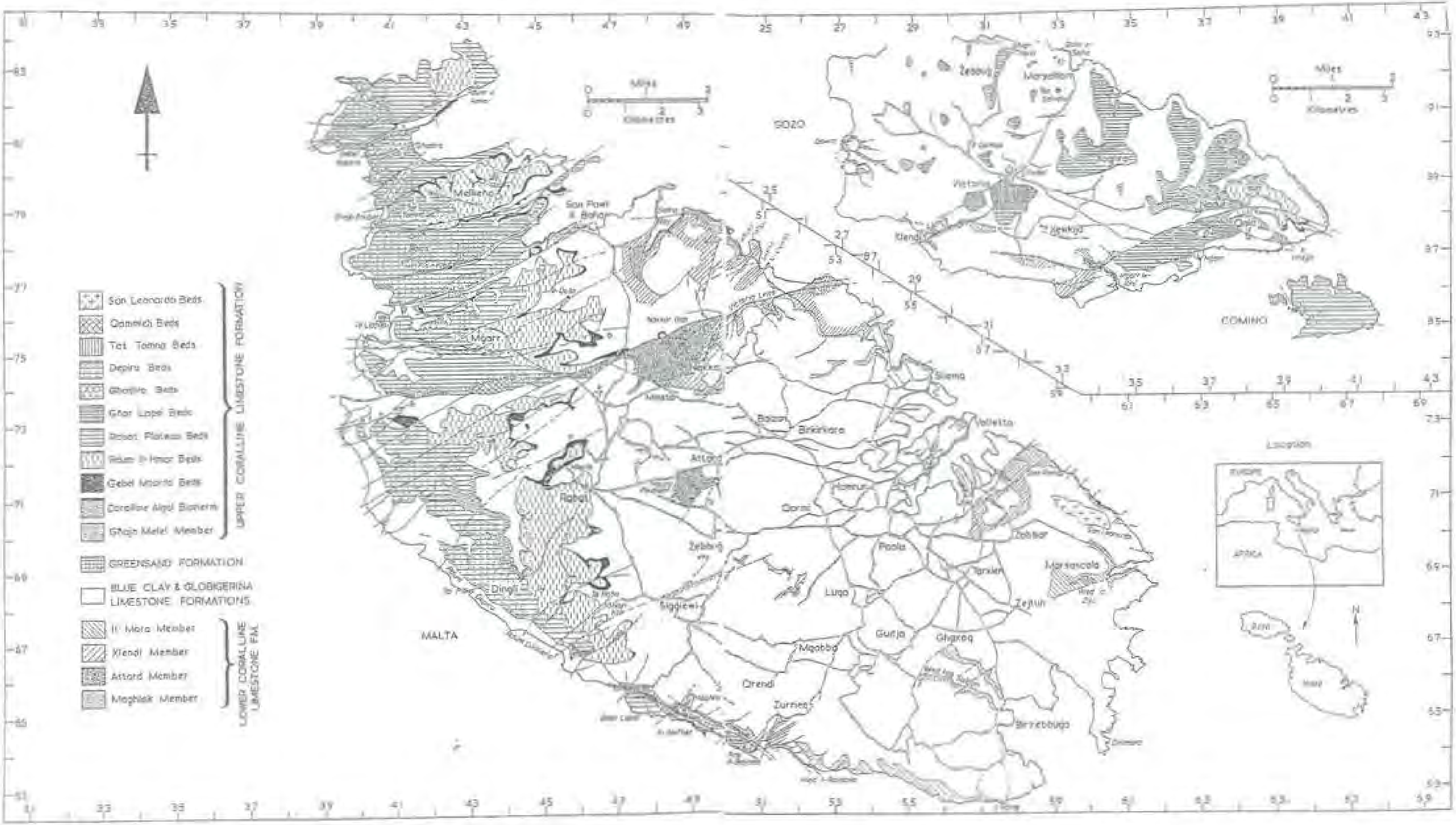


Figure 2.2 Geology of the Maltese Islands

Source: Alexander (1988)

Due to the absence of any data referring to the spatial extent of the different rock outcrops, an easy and quick method was devised to determine the surface area of the different rock outcrops. Essentially, a photocopy of the geological maps of Malta and Gozo was weighed on a Sartorius Analytical Balance. The different rock outcrops of each separate island were cut out with a pair of scissors and weighed on the same balance. As the whole area of Malta is 245 km^2 and that for Gozo is 67 km^2, the relative proportions, represented by the different pieces and shapes of paper, for the islands was calculated. The results are given in Table 2.10. Although the method was rather crude, it was faster than estimating areas by superimposing a transparent sheet with metric scale and grid squares. In addition, the accuracy demanded from such an exercise was in estimating relative proportions and not in calculating precise data. These figures show that 70 per cent of the coastal littoral of the archipelago consists of two types of rock Lower Coralline Limestone (LCL) and Globigerina Limestone formations. The former occurs at 30 per cent of the Malta coast and 61.8 per cent of the Gozitan littoral. Globigerina Limestone outcrops at 42.5 per cent of Malta coastline and only less than 20 per cent for Gozo. Extreme values show that the whole Comino coastline is composed of UCL and the almost two-thirds of the Gozitan coast has LCL outcropping. Of significance is that all of the strata are represented in Malta and Gozo with the exception of Middle Globigerina for Gozo, and of the 12 values falling between 10 and 20 percentage points, two in the 20-30 per cent range and one at 61.8 per cent is the highest after the UCL for Comino. In all, this shows a varied coastline geology that indicates a variety of landscapes which in turn have encouraged different types of land uses and led to a number of coastal management practices.

A number of factors account for the importance of coastal geology to the study of coastal land use and consequently has implications for coastal management. The areas with intensive coastal development in the Maltese Islands are areas were harbours and creeks are present. These coastal geomorphic landscape features are the result of erosion of the soft lithological structure that the Globigerina Limestone is made of. A process that spanned millions of years produced features classified as rias (Strahler and Strahler, 1984) with the excellent natural inlets that have been used by humans as zones for trade and commerce by successive occupiers of the Islands all of whom leaving their imprint on the landscape. This is in sharp contrast to the situation in Gozo where the coastline shows a marked absence of notable inlets due to the absence of the soft Globigerina Limestone along most parts of the coast resulting in a limited economy based on the development of creeks and harbours.

Other coastal areas, having a different geology, have developed diverse landforms and encouraged different land use patterns. The combination of the geological nature of the Maltese Islands, composed mainly of sedimentary deposits of marine origin, and the prevailing tectonic activity, give a varied structure to the coastline. Lower Coralline Limestone formations present steep cliffs in areas where the land was tectonically uplifted, and a low lying coastline in zones of land subsidence. In general, the coastal margin formed is rather linear with few inlets. Globigerina Limestone formation has a highly erodable lithological structure that produced large-scale coastal indentations and a shore platform that skirts the areas with high cliffs; a low sloping coastline being an additional feature in some localities. Malta's harbour network is the end product of these processes. Clay, being unconsolidated material, exhibits unique properties. It produces spectacular concave cliffs and slopes where it outcrops alone, and boulder fields where Upper Coralline Limestone plateaux are to be found above it. The latter becomes unstable as a result of the wetting of the clay. Large blocks being dislodged from the cliff face fall on to the slopes below creating boulder scree zones. The scenery here is spectacular with the coastline having an irregular shape from the large boulder spread at sea level. The major fault zone that produced the Great Fault in Malta and isolated Comino was also responsible for the formation of a number of bays to the north. This process produced a succession of ridges and valleys; the latter formed due to the collapse of sections of the ridges as a result of faulting. The sea drowned part of the valleys and formed bays and inlets. Land use along the coastal margin is partly the result of the physical processes outlined above. In areas where the low sloping rock prevails and access to the coast is high, development has taken place. The opposite is true for areas with high cliffs and boulder scree slopes. In addition, development has been attracted to areas where bays, creeks and inlets are located.

Table 2.10 Maltese Islands, Coastal Geology: Percentage Distribution of Coastal Rock Type of the Maltese Islands, Malta, Gozo and Comino.

Category	Maltese Islands	Malta	Gozo	Comino
Alluvium	0.9	1.3	-	-
Sand	2.2	1.9	2.6	0.2
Upper Coralline Limestone	16.4	15.3	1.5	99.8
Greensand/ Blue Clay	9.4	8.6	14.2	-
Upper Globigerina Limestone	8.4	6.0	17.8	-
Middle Globigerina Limestone	7.7	10.7	-	-
Lower Globigerina Limestone	19.0	25.8	2.1	-
Lower Coralline Limestone	36.0	30.4	61.8	-

Source: Author's calculation presented in synoptic form compiled from 1:2500 scale sheets measured from using 1cm divider width.

2.3.2 Geomorphology

A number of classifications of the Geomorphology of the coastline of the Maltese Islands have been attempted with Paskoff and Sanlaville (1978), reproduced in Figure 2.3 for Malta and Figure 2.4 for Gozo, and Ellenberg (1983) for Gozo. However, no quantification regarding the predominant features was produced. As a general observation, the coast of the Islands can be simply classified as upland or lowland, with the former predominant in the southern and western coast reaching a maximum height of 253 metres above sea-level. The rest of the coast, can be classified as lowland, at an altitude of not more than 75 metres. For Gozo practically the whole coastline is an upland one with only a few exceptions.

The distribution of the geomorphological features of the Maltese Islands is examined in Table 2.11. In general, a large part of the littoral is accessible, with almost 50 per cent of the coast made up of low sloping rock or reclaimed land. The latter essentially consists of coastal areas that have been covered with concrete to accommodate marine-related industries or to enhance coastal facilities such as jetties, promenades

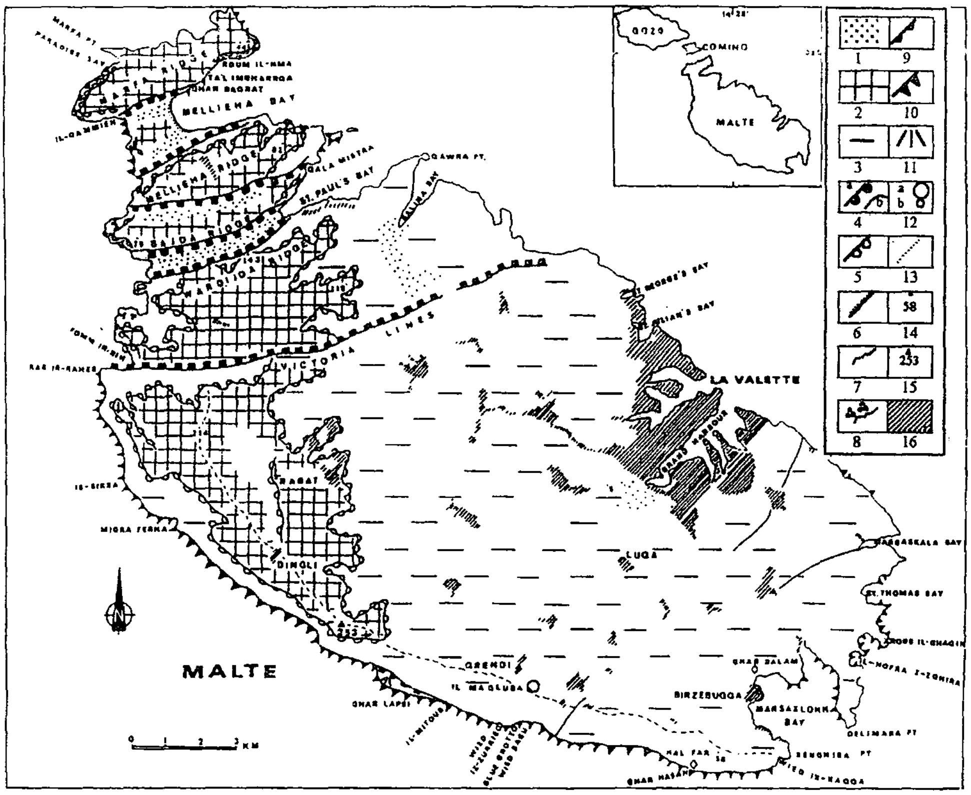


Figure 2.3 Geomorphology of Malta

Source: Paskoff and Sanlawille (1978)

Legend

1 Quaternary continental deposits
2 Upper Coralline Limestone
3 Globigerina Limestone
4 Tectonic faults: (a) fault plane
   (b) fracture
5 Clay slopes
6 Beach
7 Low rocky coast
8 Rdum – Coastal scree slopes
9 Cliffs
10 High cliffs
11 Slickenside
12 Underground karstic formations: (a) sinkholes
   (b) underground watercourse
13 Water drainage division
14 High coast
15 Highest altitude
16 Built-up area

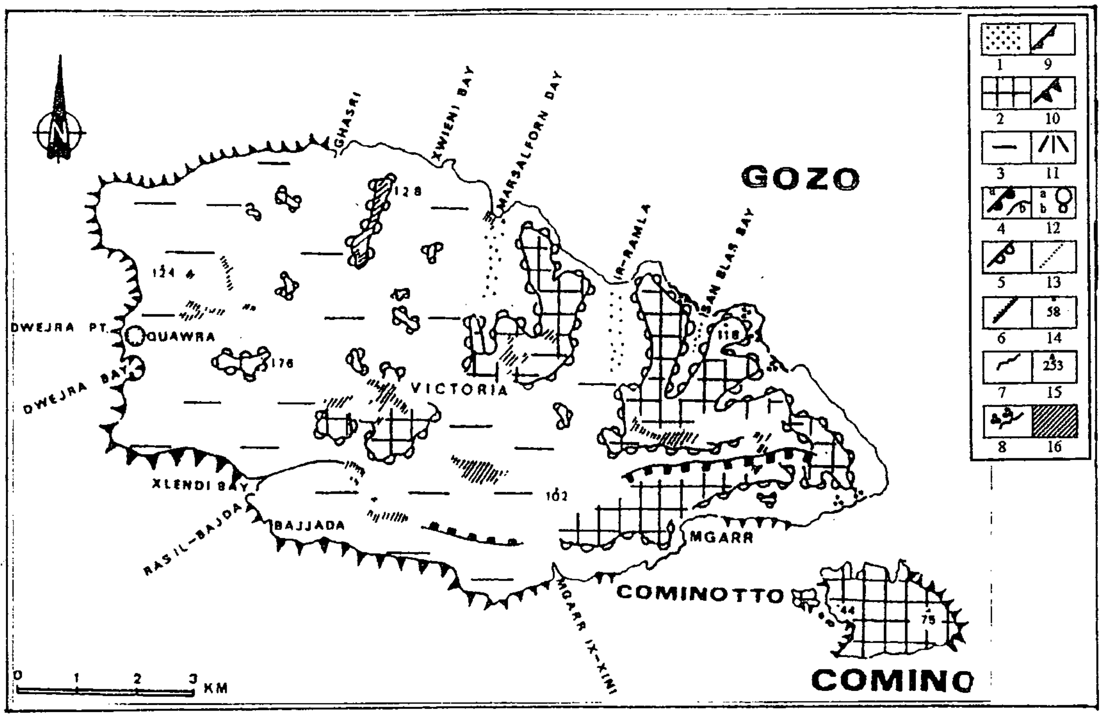


Figure 2.4 Geomorphology of Gozo

Source: Paskoff and Sanlawille (1987)

Legend

1. Quaternary continental deposits
2. Upper Coralline Limestone
3. Globigerina Limestone
4. Tectonic faults: (a) fault plane
   (b) fracture
5. Clay slopes
6. Beach
7. Low rocky coast
8. Rdum – Coastal scree slopes
9. Cliffs
10. High Cliffs
11. Slickenside
12. Underground karstic formations: (a) sinkholes
    (b) underground watercourse
13. Water drainage division
14. High coast
15. Highest altitude
16. Built-up area

and slipways, although only a small percentage of this is evident on Gozo. The boulder scree areas, steep rock faces and cliffs constitute the inaccessible half of the littoral. However, Gozo has two-thirds of its coast made up of these features whilst Malta has 40 per cent. Sand is found only in small proportions, a matter of not inconsiderable inconvenience for the tourist industry.

Table 2.11 Maltese Islands, Coastal Geomorphology: Percentage distribution of coastal rock features of the Maltese Islands, Malta, Gozo and Comino.

	Maltese Islands	Malta	Gozo	Comino
Mud	0.5	0.7	-	-
Sand	2.2	2.1	2.9	1.6
Boulder Screes	18.3	18.4	20.2	7.8
Low Sloping Rock	36.7	37.3	30.6	60.6
Steep Rock Face	3.7	3.2	3.9	10.1
Cliff	25.2	20.3	41.4	19.7
Reclaimed Land	13.2	18.0	1.0	-

Source: Author's calculation presented in synoptic form compiled from 1:2500 scale sheets measured from using 1cm divider width.

The combination of the geological nature of the Maltese Islands, composed mainly of sedimentary deposits of marine origin, and the prevailing tectonic activity, give a varied structure to the local coastline. This combination of the main geological and geomorphological features can be examined spatially on the map produced by Paskoff and Sanlaville (1978). The maps indicate that the occurrence of Lower Coralline Limestone formations present either steep cliffs where land has been tectonically uplifted or a low-lying coastline in zones of land subsidence. In both cases the coastal margin formed is rather linear, with few inlets. In areas where the Globigerina Limestone formation is present a highly erodible lithological structure has developed into large-scale coastal indentations. In the latter cases there is either a shore platform that skirts the areas where there are high cliffs. In other localities a low sloping coastline prevails. In both cases the areas have been intensively developed.

Another coastal feature is the boulder fields and screes. These are the result of the unconsolidated clays becoming unstable when wet and destabilise the capping Upper Coralline plateau above, dislodging large blocks on to the lower slopes and creating boulder scree areas. Where the boulder screes reach the sea, the coastline is largely inaccessible, has an irregular shape and is generally not amenable to development. This landscape pattern is prevalent along the coastal margin of western Malta and north eastern Gozo, although a number of sand beaches and beach pockets are to be found along parts of the boulder screes. The combination of these geomorphic features provided an aesthetically pleasing coastal environment.

The importance that this author attaches to the geology and geomorphology of the coast in relation to the land use can be gauged from the Figures 2.5 and 2.6 where the steepness of slope and the system of faults on Malta are shown. Thus these figures provide an indication on the coastal geology and the coastal geomorphology. These figures formed part of a poster session (Schembri and Magri, 1996) and a short communication on ongoing research at *Littoral '96: Partnership in Coastal zone Management*, a conference held at Portsmouth, England.

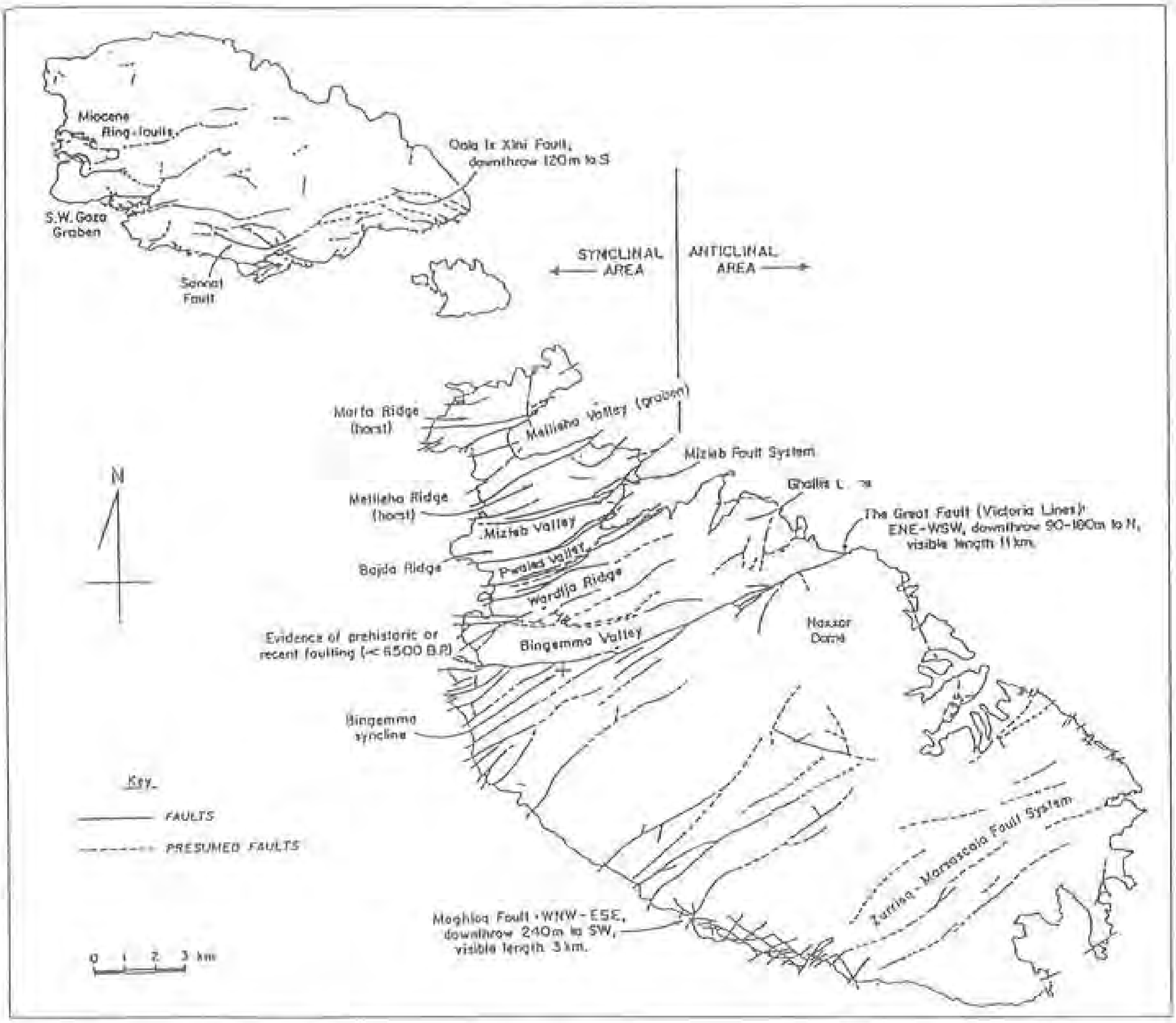


Figure 2.5 Maltese Islands – Fault Systems

Source: Alexander (1988)

Malta Steepness of Slope

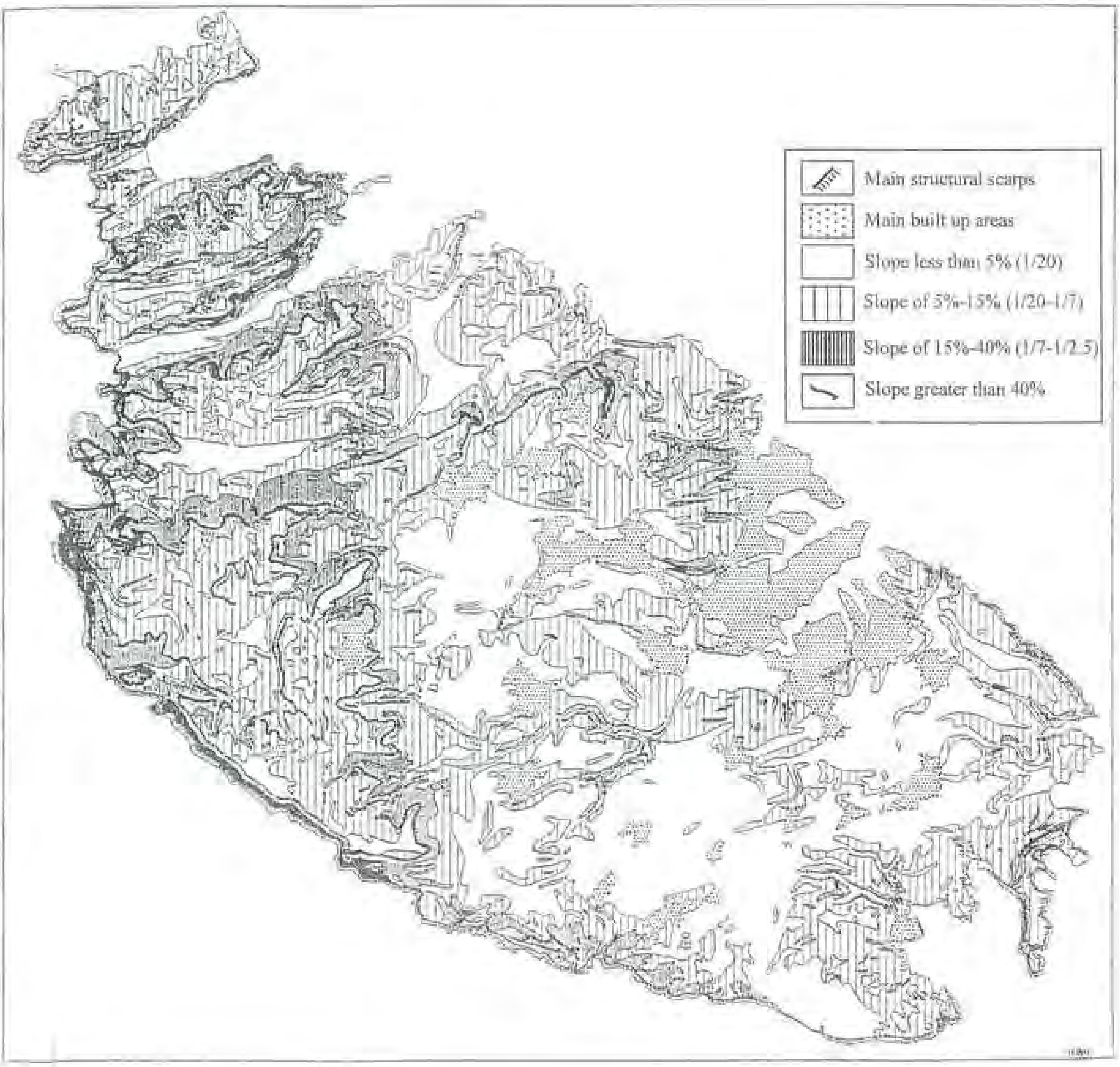


Figure 2.6 Malta Steepness of Slope

Source: Bowen-Jones *et al* (1960)

2.4 Conclusion

It is therefore apparent that the Maltese Islands whilst having most of the physical characteristics that appertain to the Mediterranean environment and have been subject to cultural influences from adjacent Mediterranean shores they have characteristics that make them unique within the wider Mediterranean world and the closer island community characteristics evident for small Mediterranean islands. In addition, the Maltese Islands, together with Cyprus in the Mediterranean, are a sovereign state, but having a very high population density, makes their overall political and socio-economic situation in a different league to other islands. In fact, this chapter served to illustrate these traits and in Chapter 4 the characteristic that the islands were ruled by the Knights of St. John, a European-based military and religious society and by Britain give further weight to the fact that the islands cultural characteristics are not purely Mediterranean. These factors are now part of the socio-physical fabric of the islands and manifest themselves in all strata of land use planning. However, to bring back the argument of coastal zone management and coastal land use, the next chapter will focus on the meaning of these terms and the need for both coastal management and the rational use of coastal land.

Chapter 3 Coastal management and coastal land use in perspective

3.1 Introduction

This chapter will focus primarily on the two main themes that form the basis of this thesis: coastal land use and coastal management. The focus will be to provide an epistemological background to the central themes of the thesis. This background will involve an explanation of the meaning of the main themes, the development of the disciplines of land use and coastal zone management, and the evaluation of the contemporary need for the two disciplines, especially within the context of the local situation. Finally the focus will be on the contemporary theories that emerged from these two strands of inquiry.

As a result of the overlap of land use and coastal management in this thesis, another two areas of interest have emerged: coastal land use and integrated coastal zone management, with land use and coastal land use bracketed within the same paradigm and coastal management and integrated coastal zone management within another. Studies on land use in general have predated those on coastal land use, with the former having a larger physical area and being broader in scope, normally encompassing the larger coastal hinterland and beyond. Coastal land use studies, on the other hand, have a more limited area, and, in general, are limited to matters that are affected by marine influences. A similar situation exists between coastal management and integrated coastal zone management, with the former pre-dating the latter but being narrower in scope and situation. The distinction between the two will be explained below. As a result of this, a number of strands of thought emerge in this thesis, all of which are commented upon.

As explained above, the data gathered for this thesis is the result of two coastal land use surveys, together with a number of cartometric measurements. Following these studies, other themes and fields of study arose and this author developed additional interests, sought the meaning of various terms and felt the need to seek the necessary epistemological background particular to these themes. Two particular areas came into focus. The first is Fractal Studies: the variation of coastal length with changing scale of map. This theme has already been referred to in Chapter 2, where the variation in the length of the coast was examined with respect to the change in map scale. The second theme was the use of simple statistical methods normally employed to examine the relationship between variables as tools for coastal management. These themes have been mentioned according to the order in which each one appeared to me to be important in the development of this thesis. However, the list below presents these themes in a specific sequence that follows a progression, from the basic notion of land availability to the ultimate concept of integrated coastal zone management. In the opinion of the author, this progression is the logical development of the whole study as developed in this thesis. The main essence of the thesis is that aspects of these themes have been drawn upon by the author to provide a methodology for the study of coastal land use as a basis for coastal zone management.

Therefore, in summary, the main themes on which this thesis is built are:

- land
- land use
- coastal land uses
- surveying and scale
- methodology of analysis
- coastal zone management
- integrated coastal zone management.

An epistemological background to each theme will be given following the sequence established above. Simultaneously, the literature consulted will be also reviewed.

3.2 Land

The first element to be discussed is the primary base on which this thesis is focused: land. Land constitutes about 30 per cent of the surface of the earth, and is

- essential to the sustenance of life (Clark, 1995, 651),
- with a limited carrying capacity (Yunlong,1990,337),
- basic to all aspects of development (Okpala,1992,92).

The concept of land and the population that utilizes it are best summarized in the concept of density: essentially an index establishing the number of people that occupy the land surface for every areal measure of land. The units of measurement are normally taken to be persons per km^2. Although the index is not an ideal one (Clarke, 1972), it provides a uniform measure by which countries and regions can be compared.

Normally, the first, and probably the crucial variable to be considered is the food-producing potential of the land. On this basis one might compare the 0.6 ha per capita of China with the 3.06 ha of Australia and the 0.06 ha of the Maltese Islands. Here Malta has one of the lowest ratios. However, such comparisons are facile because Malta imports a significant proportion of its food and its agricultural resources are not the main foundation of the economy. Perhaps more realistic might an analysis of the pressure of population upon all types of land because areas for the development of housing, industry and other urban-related uses is in short supply. A comparison with other micro states and territories (Table 3.1) shows that Malta is amongst the most challenged in this respect also.

Table 3.1 Micro states/territories and their population density

State	Population per km^2 (1998)
Macao	20824
Monaco	16486
Hong Kong	65715
Singapore	5539
Gibraltar	4486
Gaza Strip	3090
Vatican	1977
Bermuda	1249
Malta	1192

3.3 Land use

Closely linked to the notions of land are those of the utilization of the land surface: *land use*. Land is effectively fixed in supply taking up about 29 per cent of earth's land surface (Best, 1981), but the use to which it can be put is flexible. The first basic estimate of the use of the 149 million km^2 area of the terrestrial part of the world, excluding the 14m km2 which is permanently covered by ice, is the subdivision into four main uses: 11.3 per cent - arable land; 25.3 per cent - grassland; 31.2 per cent - forest; and 32.2 per cent - other uses.

Land use deals essentially with the spatial aspects of all people's activities on land and the way in which the land surface is adapted, or could be adapted, to serve human needs (Clarke, 1996). The main human uses can be classified as either intensive (services, roads, industries) or extensive (agriculture) (Healey and Ilbery, 1990). Conventionally, four major uses are defined: agriculture, forest and woodland, urban land, and miscellaneous.

The concern on the capacity of the earth to contain all the human-generated needs has led to debates that developed into the 'environmental revolution' of the 1960s and 1970s (Owens, 1992). Meadows *et al* (1972) cited the Club of Rome's seminal publication *Limits to Growth* as the watershed that threw light on the matter and further citing sources that pinned the reason for the depletion of the earth's resource base on the 'loss' of land to economic development.

Further groupings of land parcels are identified: land units and land systems being two important categories. A land unit has a simple form and usually occurs on a single rock type or superficial deposit. Land units are often recognized on the basis of their geomorphology. A land unit may be composed of two or more separate elements. Land systems comprise a number of land units. They on the other hand can be defined as subdivisions of a region into areas having within them common physical attributes which are different to those of adjacent areas. Any one land system normally has a recurring pattern of topography, soils and vegetation reflecting the underlying rocks (geology), erosional processes (geomorphology) and the climate under which these processes operate. A land unit, the detailed component of a land system, is particularly useful in evaluating land for agricultural and engineering purposes and in devising problem-oriented classifications. The resultant land-systems maps are easily interpreted, and both rapid and economic to produce (Cooke and Doornkamp, 1974).

Best (1981) defines land use as that which deals essentially with the spatial aspects of all the activities of man on land and the way in which the land surface is adapted, or could be adapted to serve human needs. Van Duivenbooden *et al* (1996, 143) define land use as "the human activities that are directly related to the land, make use of its resources or have an impact on it." Whilst both definitions concentrate on the utilization of the land, Best focuses on the adaptation of the land surface, and van Duivenbooden *et al* (1996) mention the impact of man on the same surface, and further adds that land use is made up of three interacting aspects. The first is the biophysical land use aspect, and refers to "the human interference in the functioning of a given agro-ecosystem"; the second aspect is termed land use purpose, and refers to "the socio-economic use that people make of the land"; the third aspect is termed land use circumstance and combines the first two aspects as it describes "the socio-economic and biophysical environment in which a particular type of land use is applied." The latter concept of *impact* is probably the contemporary philosophy behind two main authors' theories of the state of the world, namely, Simmons (1996) and Goudie (1997).

In addition, a further projection of the *land use* concept is one that introduces the idea of *land cover*. This puts forward the idea that, whilst land use identifies parcels of land according to the use which people make of them, land cover identifies parcels of land according to what is actually covering the land surface (Badruddin and Hamilton, 1996). Land cover denotes physical features, both natural and human-made that occupy and cover the surface. Land use is the activity associated with a parcel of land. Although the problem in the local context of a land-use survey may not be significant, as the land cover associated with the Maltese environment does not have the wooded canopy normally linked to "wetter" and "greener" locations, uses of buildings within the urban environment could pose problems of interpretation. However, as the mapping done by the author for this thesis was based upon a good practical knowledge of the prevailing coastal urban architecture and this problem was resolved.

Another problem that links land-use studies with Satellite Imagery and Remote Sensing, as applications of modern technology, is the fact that notwithstanding their efficiency they do not interpret land uses but only distinguish land cover. In fact in many Remote Sensing applications and analyses, land use and land cover are used interchangeably (Badruddin and Herrington, 1996), which for the purposes of this thesis is unacceptable. Badruddin and Herrington (1996) claim that land-use maps prepared from land cover images can generate misleading results.

In an attempt to solve this problem over, Thibault (1999) provides two lists, one of land use and another of land cover, and helps in distinguishing between the two. These are shown in Table 3.2. As an example, educational land uses (identified as No.3 in the list) are associated with 'building' in the land cover list (identified with the lower case 'h'). However, he further elaborates his argument by introducing the concept of *land print*, in addition to that of land cover, to fine-tune the factor that is present on the land surface. Essentially this method associates the type of land use to its particular extension on the land in its immediate vicinity. Thus a school (educational, No.3) has 'building' as its land cover but lawn, 'e', as its land print.

Table 3.2 Indicators of land uses and land covers

Types of land uses	Types of land cover / land print
1 agricultural.	a. woods
2 commercial	b. trees
3 educational	c. shrubs
4 recreational	d. pasture
5 residential	e. lawn
6 transportation	f. till
7 industrial	g. bare ground
8 idle	h. building
9 unknown	i. paved
	j. railroad
	k. miscellaneous

Source: Thibault (1999)

For the purposes of this thesis, it is the land use concept that has been applied. Effectively the main epistemological difference between the survey of 1989 and that of 1998 is that the greater mapping detail of the first survey included the concepts of land use, land cover and land print without distinguishing particularly between each one of them, whilst the second survey classified land by the type of uses to which it is put.

As the identification, analysis and classification of land use is the main epistemological basis of this thesis, a brief history of its systematic analysis during the twentieth century is timely at this stage. The need for baseline information had long been felt, especially as data on the resource potential of the earth was needed. The seminal land use surveys by Stamp (1948) paved the way to further studies elsewhere, especially in the lands of the British Empire. Of particular note here is the land use survey performed by the University of Durham's Department of Geography in the 1950s, probably influenced by Stamp's work, where teams of mappers surveyed the whole area of Malta and Gozo focusing on agricultural land use (Bowen-Jones, H., Dewdney, J and Fisher W.B., 1960). This also included studies on the geology, soils, urban areas and demography, seminal papers in their own right. It is important to mention at this point that further land use surveys in Britain were conducted by Coleman (1961) and Walford (1997) both of which employed the systematic mapping of surface features of the whole territory. In fact, the data presented for this thesis groups the results of a systematic mapping of the coastal zone of the Maltese Islands.
Local studies on land use emphasized the changing pattern of the utilization of the land surface as a result of urbanization and development. Six significant sources can be cited. The first is the local seminal text on the geography of Malta (Bowen-Jones *et.al.*, 1960) which was the result of a five-year land use survey of the Maltese Islands. Charlton and Beeley (1993) examined land use change in a number of sites as an update of the Bowen-Jones (1961) *et al* study. Their main concern focused on the depletion of arable land in Malta as a result of urbanization. Schembri and Lanfranco (1993) showed the depletion of natural habitats for flora and fauna on the Maltese Islands including the change in the land use patterns as affected by deforestation, afforestation and land reclamation. Mallia (2000) draws a land use picture for the turn

of the millennium by noting the population changes since 1948, up by 15 per cent compared to the 400 per cent increase in the built-up area. In addition, he identifies industry, commerce, quarrying and tourism as the main contributors to land use change in Malta. Cilia (1995) reviewed the growth of the built-up area throughout the 20th century. The values for Malta were 4.1per cent in 1910 increasing to 18.1 per cent in 1995 and an estimate of 21.7 per cent for 2010. The comparable figures for Gozo are 1.6, 7.3 and 8.7 per cent respectively. Details on quarry, agricultural and landfill areas are also given. Schembri and Bonnici (2000) review the changing pattern of population growth and settlement as key factors that conditioned the change in the land use patterns. In fact from the data examined it was concluded that it is the coastal localities that have experienced the highest rate of land use change.

The second strand of thought is the local contemporary land use issue where a three-pronged debate is developing. One debate in Malta has focused on vintners requesting the release of more land for the development of vineyards in the light of growing competition from European wine producers. The argument here is one that cites the accession of Malta into the European Union and the subsequent removal of government protection. Local vintners expect more competition in the local market from foreign wine producers; and the local wine industry would also find it difficult to make an impact on the European market as the volume of produce will not be large enough.

Secondly, housing needs for a growing population is an issue being debated in Malta. With a limited area of land available and the needs of tourism and industry still unsatisfied, land for housing is scarce. High-rise buildings provide part of the answer. However, most local councils are against high-rise buildings as it changes the traditional architectural cultural fabric of low-rise development.

Thirdly, the re-use of the existing land seems to be the most plausible answer to urban and rural land use problems (The Times [of Malta] 16 September 1999). Within the urban environment the re-use of old buildings in the village core areas may be gathering momentum, and in rural areas the rehabilitation of abandoned fields can be an answer towards increasing the agricultural potential of the islands.

These arguments provide scope for yet another aspect in the vast ancillary terminology associated with land use, that of *land user*. Whithby and Ollerenshaw (1986) use the term to differentiate between identifying the uses to which land is being put by means of a land use survey and interviewing the actual users of the land to identify the amount of produce. Cadastral surveys are a case in point and have a history that pre-dates that of land use studies. In fact, the original Domesday Book in Britain dates to 1086 (Upshall, 1992).

The introductory part of this thesis (Section 1.1) highlighted the need for the rational management of land use in the Maltese Islands especially in view of the limited spatial resources available. In fact Schembri (2000) presents the problem posed by increasing population density in the Islands on the land available as being the nation's main environmental concern at the start of the new millennium.

3.4 Coastal land uses

The local debate regarding coastal land use is one that centres around the provision of touristic and recreational areas. The major projects range from the provision of better facilities for the ferry service between Gozo and Malta at Cirkewwa in the north of Malta; the building of the Hilton Hotel and associated yacht marina at St. Julian's Bay; the development of Manoel Island and the Tigne Peninsula in Marsamxett Harbour; the extension of the cruise liner terminal; and the development of the Cottonera waterfront in Grand Harbour. The local debate is about changing the present land use pattern through land reclamation as is the case for the Grand Harbour projects; constructing high-rise buildings as with the Hilton project; and the encroaching of the land area on the nearshore zones and affecting scuba-diving sites, as at Cirkewwa. These problems are typical of the urban littoral frontier (Hudson, 1996) and the surveys conducted in the last decade of the last century show the growing importance of the coast as an investment potential.

As the focus of this thesis is on the coast, it is the land uses that prevail along the coast that are of interest to the author. Essentially these land uses are determined by activities normally associated with the coast. The identification of the coastal land use indicators as presented for this thesis was the result a number of studies, surveys and secondary sources. These can be summarized into: a pilot study, the 1989 survey, a number of coastal land use exercises developed for undergraduate courses, and a review of technical and academic literature on coastal zone management. It was only after these were completed then that the land use indicators used for the 1998 survey were identified. A full account of this procedure is given in Chapter 5.

In order to decipher the epistemology in the selection of coastal land use indicators by different coastal surveyors, a number of land use categories that were used in surveys to map the coast of a number of countries (South Africa, Puerto Rico and Portugal) are shown in Tables 3.3 - 3.6. The distinctive element that emerges is that there is a general inconsistency in the indicators used. The first difference noted is that one survey uses indicators for both the land and foreshore area (South Africa) whilst the other (Puerto Rico) uses indicators for the land area only, and the San Francisco classification develops mainly the human element of the whole land use concept. In addition the indicators for South Africa can overlap on one another, making field identification problematic and difficult to interpret the results.

3.5 Surveying and scale

The similar need for the rational use of land led to the already-mentioned pioneering Land Utilization Survey of Great Britain in the 1930s by L.D. Stamp which was followed by a major report in 1946 " The land of Britain and how it is used." This was followed by a second major survey in 1960. Although land-use surveys entail the investigation of the land surface and the cartographic representation of the land use, they are largely descriptive exercises (Johnston *et al*, 1994) with the emphasis of Stamp's work being on the " use and misuse of land in Great Britain" (Johnston *et al*, 1994, 316). A third Land Utilization Survey was held in 1996 (Walford, 1997).

Although the level of detail mapped had increased since the 1654 -1658 Down Survey of Ireland and the Tithe Surveys of Great Britain of the 19th century, a number of problems were apparent throughout; even as the method and technology for field mapping and representation improved with the introduction of Satellite Imagery, Remote Sensing and Geographic Information Systems applications. Whithby and

Table 3.3 Selected land use categories, South Africa.

1. Conservation areas;
2. Low Intensity Use areas;
3. High intensity boating;
4. Multi-purpose Boating;
5. Commercial and recreational Harbours;
6. Industrial waterfronts; and
7. Commercial naval channels.

Source: Olsen and Seavey (1990)

Table 3.4 Selected land use categories, Puerto Rico

1. cropped land;
2. pasture and harvested forage;
3. forest brush;
4. non-productive land;
5. rural public community service land;
6. land used for quarrying or mining;
7. urban and manufacturing; and
8. miscellaneous.

Source: Martin and James (1993)

Table 3.5 Selected land use categories, Portugal

1. rocks
2. beaches
3. wetlands
4. shrublands
5. agricultural areas
6. foreseted areas
7. urban areas
8. golf courses
9. camping sites
10. docking areas
11. beach parking areas
12. stone quarries
13. estuaries

Source: Andersen *et al.* (1996)

Table 3.6 Selected land use categories, San Francisco estuary, USA

1. residential
2. commercial / light industrial
3. heavy industrial
4. intensive agriculture
5. rural

Source: Mc Creary (1992)

Ollerenshaw (1986, 10) give three examples as being common problems for most surveys:

(a) the consistency of interpretation of land use by surveyors;
(b) the different definitions for land cover and land use; and
(c) the difficulty in interpreting urban land uses from the external form of buildings.

In order to place this issue of mapping problems into the perspective of this thesis, the concern for maintaining consistent land-use interpretation throughout is explained in Section 5.4. Basically this involved adhering to the mapping key developed for the 1989 coastal land use survey of Malta that was used by all mappers, and also keeping in line with the new categories established for the 1998 survey. The level of generalization was higher for the 1998 survey as a number of land uses identified in the 1989 survey occupied small patches of land and could therefore be grouped together or included within a major land-use category without disrupting the main scope of the survey. This situation is elaborated upon in Chapter 5. In addition, the decade that separated the two surveys gave ample time for the author to develop the required number of land use categories sufficient to include the whole coastal littoral.

3.6 Coastal management

Although the main focus of this thesis is coastal land use, a large part of the literature cited deals with coastal management. This was due to the fact that coastal land use issues were mostly found in sources that dealt with coastal management *per se*. Following the definitions of the coastal zone, that were used to assist in the identification of the geographic limits of the local coastal zone especially its landward boundary, presented above in Section 2.5, a clarification of the terms of reference of coastal management is timely at this stage. A fairly broad spectrum of opinions emerges.

In fact, the term *coastal management* can lead to a number of interpretations. It can be broadly interpreted to mean:

- "a type of public activity or intervention that is applied to the coastal and marine environment and its resources" (Klarin and Hershman, 1990, 144);
- "involving concerns related to economic development, land use and port development, and fisheries management, as well as coastal resource protection" (Dean, 1979, 287);
- "including multiple goals, involving the preservation and development of coastal resources, some of which can be conflicting" (Owens, 1992, 144);
- land and sea managed as one unit (Amir, 1984);
- the voluntary sector played a key role in placing coastal management centre-stage (Ballinger, 1999,511).

Carter (1988) acknowledges that coastal management has been around ever since humans tried to use the resources of the sea and adjacent coasts, however it is only recently that the management of the coastal areas has been given a scientific approach.

These definitions show that coastal management encompasses a wide spectrum of issues and therefore that the definitions linked to it are broad in scope. Two reasons can be identified for the relatively large number of definitions of coastal management.

First, the term and the terminology associated has been around for about 25 years. This has generated a large amount of literature, provided innumerable jobs, and originated academic and technical courses to train the Coastal Manager. In the wake of all these scenarios, coastal management has developed its own epistemology (theory of the method of knowledge). Second, coastal management involves a broad number of traditional disciplines such as the pure sciences, social sciences, and the humanities. In fact, meetings on coastal management have a broad brief involving physical, human, economic and social scientists as well as planners, managers and politicians. Therefore the study of coastal management can be considered to fit in fairly well within the terms of reference of geographers, whose discipline spans the physical and social sciences. Appendix 4 gives the range of publications.

Sorensen (1997) provides a brief review of the development of the term *coastal management* and also gives an explanation of each of the words that make up the term "integrated coastal management" (ICM). As a theme for international conferences, Coastal Zone Management (CZM) presents a large number of issues and subjects, Table 1.2 has some examples. In addition to the above aspects, CZM also relates to the terrestrial, marine, aquatic and atmospheric domains.

Mitchell (1986) identifies coastal management with a *system* in that the needs to manage coastal resources are essentially based on a pattern that has been developed in the United States and used all over the world. This system runs from the gathering of information (baseline studies) to the enactment and enforcement of laws that help to safeguard the coastal resources. However, an interpretive tool is needed for the analysis of the coastal land use results gathered, that can be effective for coastal management purposes.

3.7 Methodology of analysis

A statistical tool that facilitates the automatic identification of groups of clusters of observations in a data set is cluster analysis (Sokal, and Rohlf, 1995). Holt (1998) identifies cluster analysis as an effective statistical tool to group variations in a data set. Lipshitz and Ravel (1998) use a method of multivariate analysis to examine socio-economic differences among localities that make up "large" geographic units. The outcome of the study encouraged the formulation of varying regional development policies to areas having different socio-econmic bases. This policy was used in preference to a "homogenous" policy applied across the board irrespective of the cultural condition of the locality. Ravichandran, *et al* (1996) used this method naming it the "ecoregional concept," in which the regional approach was used for the management of environmental resources. The authors identified 23 features including geological, geomorphological, morphometric and land use for 63 micro-basins in Tamiraparani Basin in Southern India in an attempt to describe water quality patterns. As this study aims to group coastal regions (segments) that have similar land use patterns and at the same time set out to establish a heirarchy of coastal areas based on the prevailing type of land use the cluster analysis method is preferred. In addition, as the method uses the regional approach by examining whole areas irrespective of their land use fabric, the analytical procedure advocated by a number of authors working in coastal management in the Mediterranean and Middle Eastern areas was found suitable. In fact, the use of cluster analysis in the interpretation of data is widely recognised as a tool for effective coastal management.

The reasons for utilizing the method are given below:

Mokiri *et al* (1996,172)

(a) "analyse the conflicts in coastal uses ;

(b) to explore the potential for development of the different parts of the island;

(c) to examine the effects of multivariate procedures and multiple criteria analysis as integrated tools in coastal management;

(d) to assist the development of guidelines for future planning and decision-making in the area".

Legakis, *et al* (1993,144)

(a) "local authorities, developers and planners can use this methodology as part of a formal evaluation procedure to (i) assess the environmental quality of an area by summerising the main elements of the natural environment (ii) can help solve problems caused by lack of background knowledge in various elements of the natural environment

(b) can help solve problems caused by inexistance of communication between planners and ecologists;

(c) can help solve the problem of an indifferent and hostile attitude of authorities and local people towards nature by providing quick and hard evidence of the ecological value of an area;

(d) this methodology can be used to determine the level of human disturbance that can be sustained by a coastal area."

Price (1990,3):

(a) "knowledge where particular coastal resources overlap with resources uses or impacts;

(b) provides an approximation of where the main conflicts and possible threats to natural resources occur along the shoreline;

(c) identification of areas in greatest need of control and regulation;

(d) areas where future development could occur with minimal environmental disruption".

Price (1989) "for management purposes, a synoptic picture of coastal conflicts can be particularly useful. This can be obtained by identifying areas in which concentrations of key resources overlap with concentrations of major resource uses/impacts".

Simeoni, *et al.*, (1996, 314)

"Classification is important for coastal management strategies, to reduce, but not eliminate the need for monitoring activities".

3.8 Integrated Coastal Zone Management

The literature surveyed brought up a number of definitions pertaining to Integrated Coastal Zone Management (ICZM) and Table 3.7 has its chronological development. Although searching for an ideal definition is an ambitious undertaking, it can be taken to mean an approach at integrating policy and planning into a balanced programme that meets the needs of the physical and cultural resources of the coastal zone (Klarin and Hershmann, 1990). Jorge (1997) maintains that ICZM is essentially a government-driven process that links four main elements: private sector forces, public resources, Non-Governmental Organisations' actions, and local communities. In fact a number of researchers in ICZM emphasize that it is the central administration of the area being managed that should be given the leading role in the administration of an ICZM policy. Kawabe (1998) suggests that for the "alleviation of friction" between different administrative bodies concerned with coastal management implementation of an ICZM policy under a single authority would help in decreasing friction. In Central America, Windervoxel (1999) identified that the ICZM version termed as the "alliance for sustainable development" is backed by the ministerial and political level and includes a large number of political agreements. Windervoxel (1999) cites three reasons for the involvement of the central administration in such matters: gaps in the data that provides the information, a restricted technical and financial capacity, and strong sectoralism. However, the main issue that emerged from the literature surveyed is that notwithstanding the involvement of the government in assisting in the implementation of ICZM it is the bottom/up approach and not the top/down approach that succeeds in the end (Aston, 1999). The author cited the example of small islands as a primary case where this notion (bottom/up) has been successful. The small size of a number of Pacific Islands, the close association between the coast and the remaining terrestrial area together with the strong involvement of the community in the management of coastal ecosystems have made ICZM the ideal tool for managing coastal resources (Aston, 1999).

Community involvement in ICZM is an issue that has been tackled by a number of authors and an acronym CB-CMR (Community-Based Coastal Resource Management) was coined. Van Mulekon (1999) describes it as "localised co-management systems wherein small-scale fisherfolk take up a dominant role in fisheries management in the Philippines". Lowry *et al* (1999) state that CB-CMR is being introduced in Sri Lanka "as a political strategy to respond to conditions of poverty and unsustainable resource use practices." In N E Tanzania the programme provides training in a wide range of skills aided by facilitation by government workers through technical advice (Makoloveka and Shurcliff, 1997). The continuous failure of contemporary management techniques has encouraged managers to accept the development of "inter-generational equity" by which a lifetime of experiences and knowledge is used as a basis to propose changes for the next generation of stakeholders to uphold (Veitayaki, 1997). In the Bay Islands of Honduras, Luttinger (1997) proposes the notion that due to increasing tourism the conflicts between the economic and environmental processes have increased. Thus "building consensus and reserve organisation "can help solve future conflicting issues that may threaten the community based marine conservation initiatives. Citing a final example taken from the Philippines, Rivera and Newkirk (1997) maintain that the poverty driven over-exploitation of coastal resources has decreased from Mindanao to Luzon due to community-based coastal resources management projects. These include bio-physical, social, economic and legal scenarios.

Although most of the examples mentioned above deal with the marine environment in developing countries, and essentially involve rural communities, the situation in the United Kingdom is not very different. Edwards *et al* (1997) mention the fact that rural communities are more participatory than urban communities when it comes to introduce an element of community participation.

Table 3.7 Integrated Coastal Zone Management chronological development

1992	Rio declaration on environment and development, Agenda 21 and Chapter 17 on the Protection of the Oceans
1992	UNCED (United Nations Conference on Environment and Development) Convention on Biodiversity
1992	OECD (Organisation for Economic Cooperation and Development) recommends ICZM
1993	UNCED Convention on Climate Change
1993	Noordevijk guidelines for ICZM
1996	Coastal zone Canada Conference on cooperation in the coastal zone

Adapted from Lawrence (1997)

3.9 Conclusion

This chapter reviewed the meaning of a number of key terms that were seen to be crucial to this thesis. The identification of the terms came about during the course of the research, when besides the literature consulted on coastal management (Bowker's R.R. Seriels Bibliography Department, 2000; Appendix 4), so as obtain a general view of coastal matters and problems, other issues emerged, notably land use and integrated coastal management. The key terms were then put in a conceptual order, with the concept of 'land' first, as it is the basis of all the discussion of the thesis, and the concept of 'integrated coastal management' the last, as it is the most complicated of the terms used in this thesis. The discussion of each main term or phrase occupies a separate section in this chapter.

The other relevant secondary literature consulted is reviewed in the sections where the particular coastal land use is discussed. This method was used throughout the thesis. An example of this method can be seen in, for example, Chapter 5, where secondary literature for different coastal land use identification keys is reviewed. Literature reviews for aspects of each main coastal land use category are seen in the relevant sections in Chapter 6. In addition, the literature cited also tapped the general economic situation of the Maltese Islands pertaining to that particular land use under discussion. The development of the local coast through the last four centuries was thought to be of an important influence in the contemporary situation and, as a result, the following chapter deals with the issue and also uses general historical texts to present the background.

Chapter 4 The history of coastal land use in Malta.

4.1 Introduction

To put coastal land use in perspective, two factors need highlighting. The first is that the contemporary land use situation is a function of historical developments and therefore a brief overview of the history of the islands has to be presented. Secondly, the land uses along the littoral are influenced by the land uses in the hinterland. Thus, although this work examines land use along the littoral fringe to a distance inland (cf. Chapter 1), land uses further inland, up to the whole spatial extent of the islands, must also be mentioned.

4.1.1 Previous studies on land use

Studies on land use for the Maltese Islands have largely concentrated on descriptive accounts focused primarily on agricultural activity, residential buildings and industrial development. Duca and Zammit (1989) were the first to attempt to relate all elements within a spatially coherent whole when they outlined the areal distribution of the main land uses of the individual islands and for the archipelago as a whole. However five sources do give a detailed account of the geography of the islands with an indication of a land use history. Bowen-Jones, *et al* (1960), Bruce (1965), Ransley (1985), Blouet (1992) and Azzopardi (1995) all treat the geography of Malta in sufficient detail that a pattern and process account of land use is possible. Further data can be derived from the maps and charts for the Maltese Islands, notably those produced in 1895 (Vassallo *et al*), British Petroleum Exploration Company Limited (1957), Public Works Department (1983a, 1983b, 1983c), and Planning Authority (1996). Further studies on land use *per se* were done by Charlton and Beeley (1987) as part of a review to the land use situation done for their Doctoral theses with Durham University in the 1950s. Cilia (1995) reviewed the land use situation in the light of population growth and its projections and the land areas, identified for urban expansion, within each of the local council boundaries and produced a spatial estimate of the land uses. Mallia (2000) outlined the present land use situation linking it to energy use and the production of solid and liquid waste. Schembri and Lanfranco (1993) deal with the encroachment of the urban land on the local natural environment.

For the purposes of this present account, a series of four maps (Figures 4.1-4.4) showing the extent and development of the built-up areas for the past century are presented to help the discussion. As the residential category is one of the highest land users of the Islands, population data is important, as it gives an idea of the need for expanding residential space to accommodate changing demographic demands. Further details in this regard are provided by the results of the decennial census-taking introduced by the British in 1842 which gives the necessary information. Schembri, J.A. (2000) provides a detailed account of the population changes over the last century. Successive Abstracts of Statistics, Demographic Abstracts and Censuses of Agriculture and Fisheries also provide supplementary data.

4.1.2 The history of coastal land use

The core matter of this section is to review the history of coastal land use from a chronological perspective, identifying the main land use elements left by former occupiers of the islands. Other reasons for the inclusion of a historical account of coastal land uses are:

a) the historical heritage of the Islands dates back 7000 years, with some of the surviving artefacts located in the coastal areas; contemporary land uses and development sites overlap or have even displaced this historical heritage. In some cases land uses are conditioned by the presence of historical remains;
b) the history of the coastal defensive network is part and parcel of the military, political and strategic situation of the Islands and is a reflection of the broader Mediterranean and global geo-political situation. It is also important for an understanding of the coastal character, as defensive works are part of the architectural heritage; and
c) the coastal historical heritage is a particular form of land use that occupies a limited amount of land sites but its presence adds chronological and temporal depth to the coastal uses. The establishment of historical heritage paths has in fact been the subject of a seminar organized by the Tourism Authority on the 25th June 2001.

4.2 The influence of the political history on coastal land use

The history of coastal land use in the Maltese Islands can be linked to the history of occupation by successive powers. Table 4.1 highlights this chronological sequence, giving also the main residential form and urban land uses. The list is not exclusive to the coast but a part of the heritage listed is located on the coast. The strategic geographical location of the Islands in the central Mediterranean, occupying a 45 km stretch in the Sicilian Channel, made them attractive for domination. In fact a succession of occupying peoples has been documented through literary references, archaeological finds, some extant land uses and personal accounts (the first of which dates to 1536 (Vella, 1980).

Table 4.1 Main occupiers of the Maltese Islands, showing period and principal architectural expression

Occupier	Period	Main architectural expression and predominant land use
Neolithic	5000 - 2000 BC	menhir, dolmen, megaliths
Megalithic	3750 - 1800 BC	megaliths, rock cut tombs
Phoenician	800 - 480 BC	tombs
Carthaginian	480 - 218 BC	tombs
Roman	218 - 395 AD	houses, mosaic floors, baths, rock-cut chambers, catacombs
Byzantine	395 - 870 AD	hypogea
Arabic	870 - 1090 AD	small nucleated villages with serpentine streets, flat-roofed squat houses
Norman	1090 - 1194 AD	Norman houses
Sicilian and other Europeans	1184 - 1530 AD	a large number of small villages and hamlets built along Arabic tradition
Knights of St. John	1530 - 1798 AD	urban development around Grand and Marsamxett Harbours; growth of villages
French	1798 - 1800 AD	war situation
British	1800 - 1964 AD	urban development along eastern coastal areas
Independence	1964 -	explosive urban growth in rural areas; tourism

Source: Compiled from Blouet B (1992) & Azzopardi (1995)

4.2.1 Prehistory to Medieval period

The coastal areas of the Maltese Islands, as identified in this thesis, have a limited share of the archaeological heritage. However, the overseas links with Sicily, evident from the obsidian and other sherds (i.e. not found in the geology of Malta), show that the coast played an important part in the development of the Islands and can be identified with putting them within the archaeological map of the Central Mediterranean. Thus Renfrew's (1973) identification of six clusters of chiefdoms (groups of settlements) does include parts of coastal areas that were under the influence of separate clans. He lists agriculture as being the main land use, attributing to it 70 per cent of the land surface. He estimated a population of approximately 11,000 (ca. 4000 BC) living off the staple foodstuffs of wheat and barley, bovines and pigs. This largely agrarian diet was supplemented by a diet of fish and shellfish, putting the coastal resources into perspective.

The transition from archaeological (temple buildings) to the pre-knights period shown above (Table 4.1) saw the occupation of the Islands by Mediterranean and European powers notably by the Romans and Muslims. However, the coastal areas remained extremely vulnerable to both organized invasion and haphazard incursions. With the former, the islands served merely as an outpost commanding a strategic waterway and as a pawn in the Punic Wars with Carthage. The Muslims had a long-lasting effect on the culture with the introduction of the Semitic language, still predominant today, a serpentine street pattern radiating from a central core, and irrigated terraced agriculture. A cubic form of squat one-storey high buildings was the main type of residential housing enforced - this was probably the first planning scheme used in the history of the Islands. The introduction of field terracing provided more space for growing food and allowed for a population estimate of 21,000 by the year AD 991 (Bowen-Jones *et.al.*, 1960). The coastal heritage left by the Muslims is to be found in the coastal place names (Wettinger, 2000) where the lexicography used is still extant.

The effect of the water supply on settlement and development was great especially along the coast. Figure 4.1 shows the limited area of settlement north of the Great Fault and along the coastal perimeter. The main reason for this was that the coastal areas were not considered safe enough for habitation due to frequent pirate raids that disembarked parties in search of water. In part, these raids were brought about by the availability of water sources along the northern coastal periphery of Malta. Thus settlements were essentially clustered south of the Victoria Lines fault and forced the population to live within a narrow topographic range and a limited economic spectrum. From archaeological evidence it has emerged that these settlements were essentially rural; a few exceptions were however in evidence notably the Borg-in-Nadur site at Birzebbugia.

During the medieval period attempts at watching over the marine approaches to the Islands have been identified by Wettinger, (1979) with the organisation of coastal roster watches by the military set-up of the time *(dejma)*, although the coastal areas still remained extremely vulnerable to both organized invasion and haphazard incursions. The gentle topography of the eastern Malta coast and the deep coastal creeks on the south and western side and in Gozo had a large bearing on this inland settlement pattern.

The result is that settlements in Malta follow two broad patterns, neither of which had an influence along the coast: first, one that is dependent on a permanent supply of water for agriculture (this produces crops all year round) and the other that develops solely on rain-fed crops, here the range of food being limited. The results of this on the settlement pattern were the following: (a) villages utilising the permanent supply of water grew faster and accommodated larger populations, eg, Mosta, Birkirkara, Qormi, Zebbug and Siggiewi. These are distributed between the Victoria Lines Fault and mid-way between a line drawn from the harbour to the Southern coast; and (b) villages living off fodder crops and other activities not associated with agriculture. These are located further south and east of their northern counterparts, and had smaller populations. None of these settlements in these the two categories are located on the coast.

4.2.2 The period of the Knights of St. John

The general picture of the settlement pattern of the Islands *vis-à-vis* the coast is one that highlights the fact that, prior to the 16th Century, settlement was largely away from the coast. The Knights changed the settlement pattern of Malta by establishing themselves around the Grand Harbour and moving the administrative capital of the island from an inland location (Mdina) to a coastal one (Vittoriosa and later, Valletta). The building of a large number of coastal defences, especially around Grand Harbour, and also the building of Valletta itself and its subsequent elevation to being the capital and administrative city, made the harbour region an attractive area for residential purposes. This situation was also partly due to the establishment of the harbour as the main locus of shipbuilding and repair. The Knights also changed the spatial distribution of the traditional land uses of the islands, introduced new land use elements within the coastal area and in the hinterland, prominent among which were country houses, hunting lodges, aqueducts and fortifications, and, above all, laid the pattern for the present-day residential harbour conurbation. Thus from an island looking inwards and drawing its living from the limited space available, Malta sought to optimise its maritime character by utilising the resources provided by its ports and harbours. It was this political situation that started the development of the coast. In contrast, Gozo retained the medieval land use vestiges well into the 20th century.

Maritime activity in Malta has a long history and it took on a new dimension with the arrival of the Knights of St. John to Malta and the building of Valletta and the fortifications around Grand Harbour. This new security helped to start changing the geographical location of population settlement, from the spread around the inland areas to a movement towards the harbour zone. This depleted the population of a number of villages and caused the abandonment of some Wettinger (1979) Figure 4.5). It also changed job prospects from those of a totally agriculturally oriented economy incresingly to jobs associated with coastal and port activities. The erection of a number of coastal defensive structures all around the coast of the Islands, especially in areas that were considered vulnerable (watch towers, forts, defensive walls, redoubts and batteries), further enhanced the security of the island. The strategic location of Malta, together with the availability of secure all-weather and deep water ports, turned the island into a centre for trade in the Mediterranean.

4.2.3 The British Period

The British era is important because it concentrated development along the coastal littoral in areas other than the Harbour region. The land use changes occurring during the British period were influenced by advances in warfare technology spanning the 160 year period. The political fluctuations in the world stage at large and in the Mediterranean in particular added further importance to the strategic value of the Islands. Table 4.6 shows the main events in chronological order of the British rule. The table highlights the international and local political situation, the demographic and economic situation in Malta, and also shows some land use changes occurring around the Harbour littoral as a result of the political and social changes occurring during the period. The tabular format of presentation seeks to link the various political and cultural factors to land use. Four main elements connected with the coast can be identified:

a) the initial land use intensification of the sites occupied by the Knights around Grand Harbour with building and excavation so as to construct the docks needed for ship repair;
b) the enhancement of a number of coastal fortifications with increased wall buttressing;
c) the construction of a number of large forts along the great fault of the Victoria Lines, which were part of the defensive network that was set up by the end of the 19th century to form a second line of defence should the coastal defenses fail at the northern end of Malta;
d) the construction of residential units for British forces personnel, the majority of whom did not reside in the capital city but were accommodated in areas specifically built for this purpose. These were spread along coastal areas north of Marsamxett Harbour and in the southern part of Malta around Hal-Far and Kalafrana, both of which are located on the coast.

The British also occupied a number of other sites. A map (Figure 4.6) showing such sites is reproduced from Nehring (1966). It gives a compact picture of the land uses for the islands in presenting areas that were used for military purposes by the British. Most of these zones had a coastal area that was partly sheltered from rough sea swell. The utilization of the coast for maritime purposes to patrol the internal waters saw military bases established at Kalafrana, Rinella and Marsaxlokk, whilst areas in Grand Harbour were reserved for British Naval ships (Harrison and Hubbard, 1945). In addition, the dockyard was the British Admirality ship repair station for the

Mediterranean. This situation influenced residential land use development in a number of ways, especially in the coastal areas. The series of Figures (4.1 to 4.6) illustrate the main patterns listed below:

a) new areas around Marsamxett Harbour, in line with British forces housing for services personnel, were developed;

b) along Pieta' to St. Julian's seafront for the middle and upper classes moving away from the crowded Grand Harbour region;

c) housing for a newly emerging working class concentrated on providing domestic help for resident British families occupied the area at the back of the coastal houses along the Sliema seafront; and

d) the housing and married quarters for the British services, such as Tigne with its complex of Barracks, and the areas of Pembroke, St. George's and St. Andrew's;

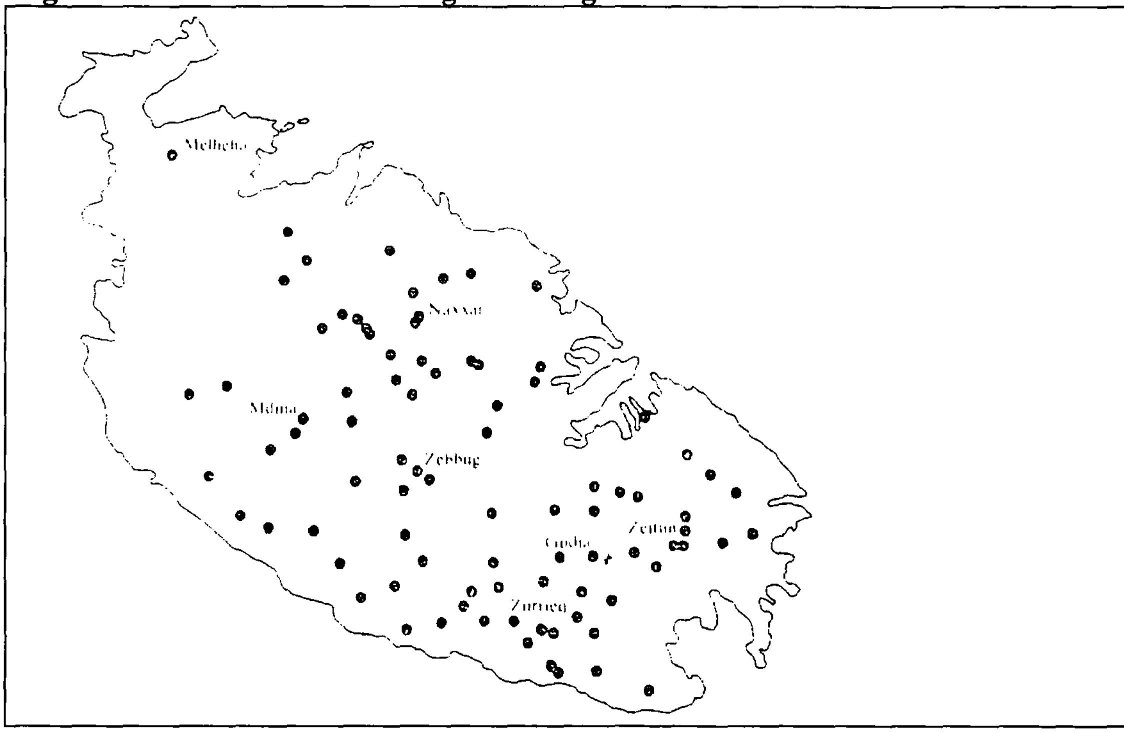
e) military establishments at:

- Kalafrana and Marsaxlokk, within the more protected parts of the South Eastern bay, these were associated with sea planes and a sea rescue squad;
- Mgarr, where a large slipway for launching small torpedo ships was constructed;
- Grand Harbour, where the military dockyard was the main repair base for the British Fleet;
- Marsamxett Harbour, having a number of shoreline facilities for the mooring of ships;
- Pembroke, with their associated firing ranges;

f) residential establishments at:

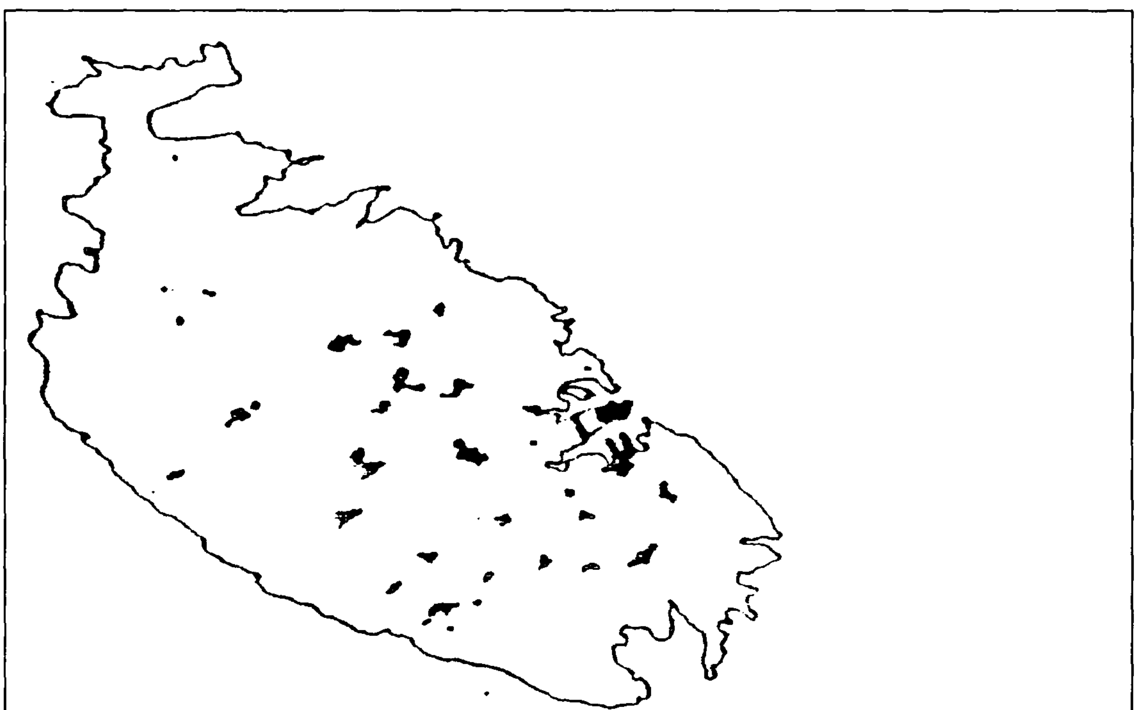
- Kalafrana;
- St. George's Bay (limits of St. Julians), Tigne' and Sliema.

Figure 4.1: Distribution of villages existing before 1419



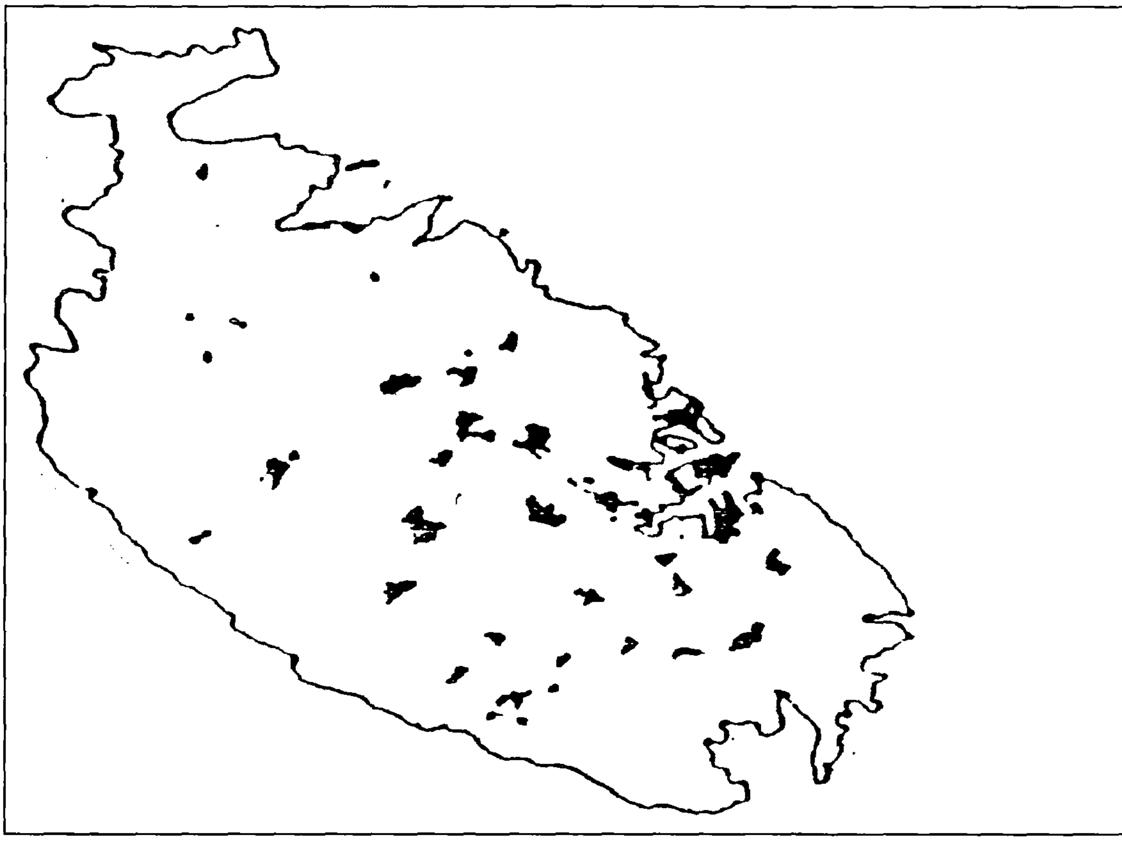
Source: *Wettinger, G. (1975) in Luttrell, A.T. Medieval Malta: studies Malta before the Knights.*

Figure 4.2: The spread of settlement in Malta -1824



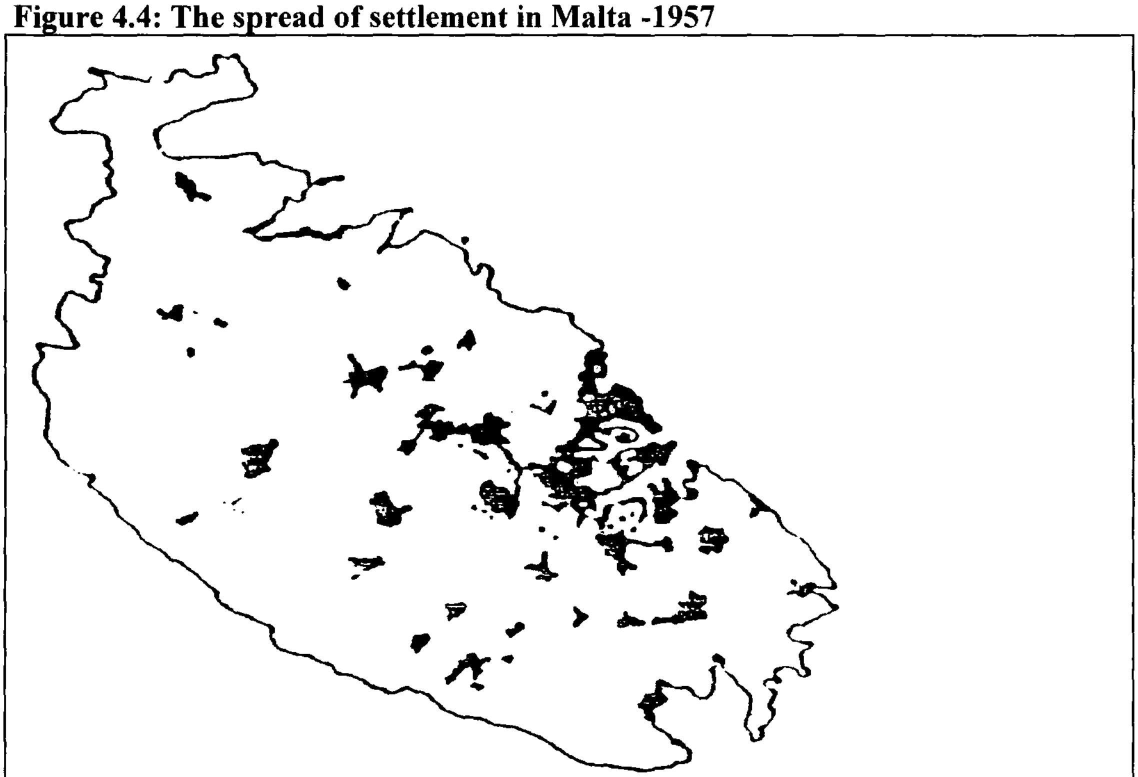
Source: Bowen-Jones *et.al.* (1961)

Figure 4.3: The spread of settlement in Malta -1895



Source: Bowen-Jones *et.al.* (1961)

Figure 4.4: The spread of settlement in Malta -1957



Source: Bowen-Jones *et.al.* (1961)

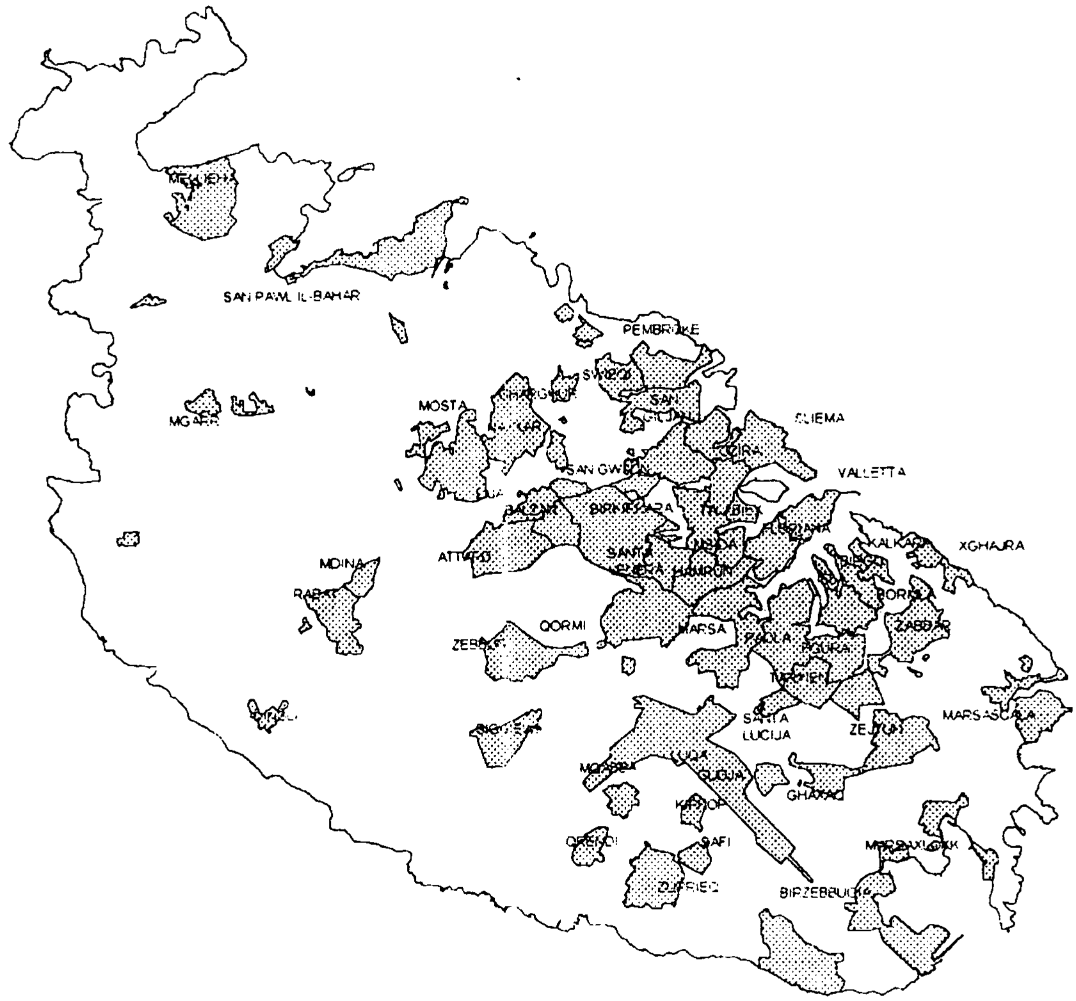


Figure 4.5: The spread of settlement in Malta -1995
Source: Planning Authority (pers.comm.)

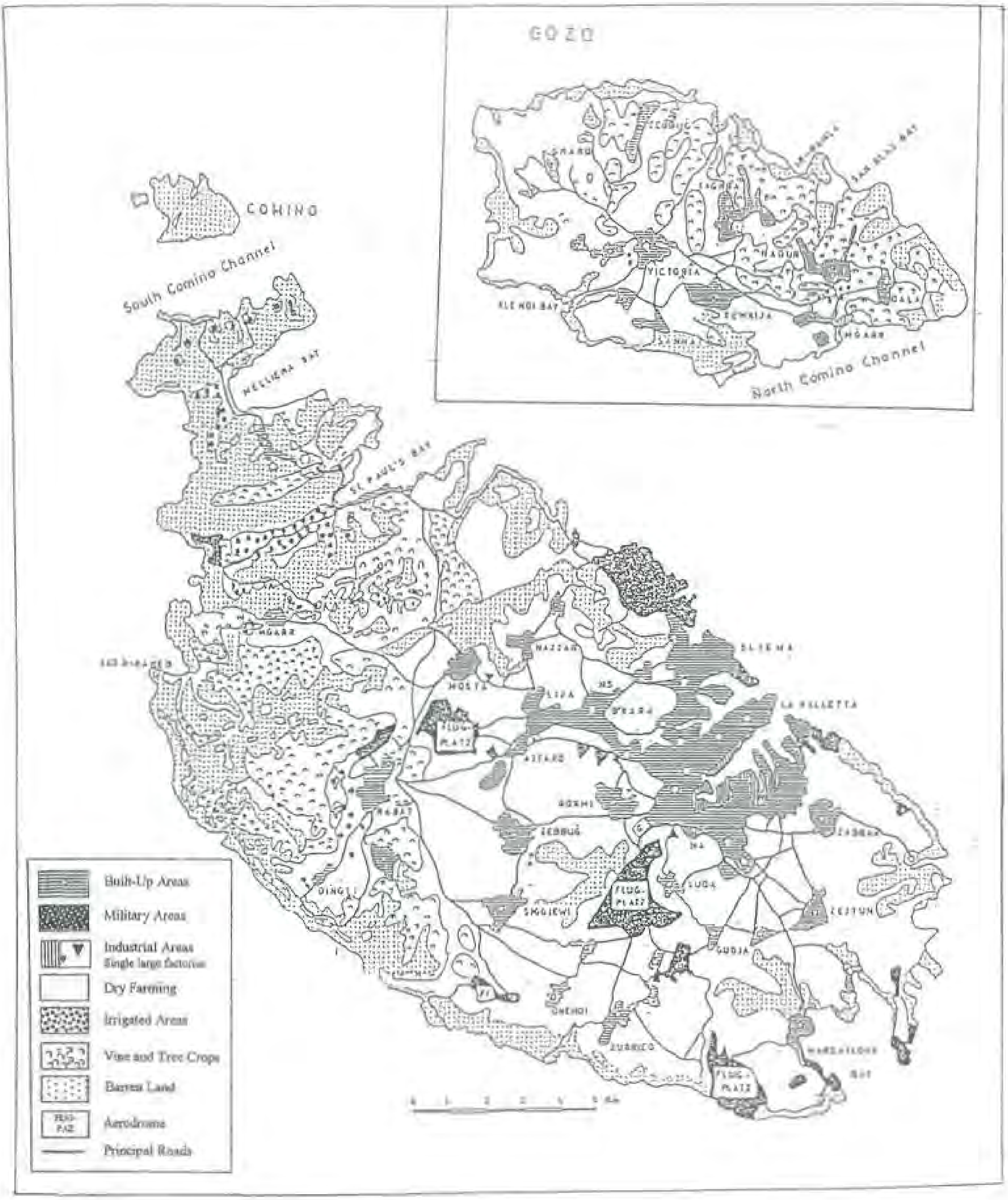


Figure 4.6 Landuse in the Maltese Islands, 1960

Source: Nehring (1966)

In addition, the main inland establishments were a number of airfields at Luqa, Ta'Qali and Hal Far with their operating facilities in Nissan huts and other buildings.

The post-1945 period witnessed the need for economic diversification away from dependency on the presence of British Forces with the establishment of a new economic order based on manufacturing industry and tourism. This paved the way for a number of land use changes some of which affected the coastal zone. Prominent among these were:

a) the loss of agricultural land to industry and the urban sprawl, including some land on the coast;

b) the establishment of a number of industrial estates within the suburban region to cater for the increase in the light industrial base, one of which, at Rinella, is located near the coast;

c) the expansion of tourism. This was initially concentrated around the Sliema - St. Julians area, only to expand to the northern areas of St. Paul's Bay - Bugibba - Qawra and Mellieha later. Coastal land use was greatly affected by this, as a number of recreational establishments also occupied part of the foreshore;

d) the urban residential sprawl affected the littoral with second home ownership by Maltese, most of this development occurred near the coast, and

e) the industrial intensification of Marsaxlokk Bay put further pressure on coastal land resources in the south.

4.2.4 The post-Independence period and the Structure Plan

The post-independence period saw an intensification of land use in a number of areas. Inland land uses changed predominantly from an agricultural to a residential one, and, the Harbours' hinterland witnessed the sub-urban sprawl adjacent to areas devoted to light industries. Along the coastal margin the touristic and recreational aspects developed at a fast pace, with the construction of tourist accommodation, such as, hotels, holiday flats and second homes for the Maltese. In the harbours the intensification of the maritime and industrial base put increased pressure on the limited land available.

The situation as shown in the above table focused attention to some extent on planning. This gradually emerged after 1945, partly as a result of the infrastructural damage caused by the Second World War. Table 4.5 highlights the principal efforts made to address this problem. It shows the flow, at intermittent speeds, of legislation and studies aimed at making efficient use of space. The period spans the last two decades of British rule and the three decades since Independence. At times, planning legislation efforts ran right across the local party political spectrum, with sharp dividing lines in 1964, 1981 and 1987, all years marking notable changes, with independence in 1964 and general elections in 1981 and 1987. However, throughout this half-century a number of issues emerged:

(a) the preparation of a national physical plan (1990);

(b) the setting up of a Planning Authority (1992);

(c) the formulation of a National Tourist Plan and the setting up of a Tourism Authority (1999);

(d) the building regulations reviewed and enforced (2000) and

(e) the merging of the Environmental Protection Department and the Planning Authority into the Malta Environment and Planning Authority (MEPA).

In addition, the Structure Plan for the Maltese Islands was published in 1990, it has three major goals:

a) "to encourage further social and economic development and to ensure as far as possible that sufficient land and support infrastructure are available to accommodate it;

b) to use land and buildings efficiently and consequently to channel urban development areas, particularly through rehabilitation and upgrading of the existing fabric and infrastructure thus constraining further inroads into underdeveloped land, and generally resulting in higher density development than at present; and

c) To radically improve the quality of all aspects of the urban and rural environment"

Source: The Sunday Times [of Malta] 20 November 1994

Essentially the Plan encompasses eleven policy sectors aimed at managing development:

a) settlement patterns;
b) tourism and recreation;
c) transport;
d) conservation and public utilities;
e) land and property management;
f) minerals;
g) built environment;
h) housing;
i) social and community facilities;
j) commerce and industry;
k) agricultural, horticulture and fisheries;

All eleven sectors are present at varying scales within the coastal area and we may argue that a land use inventory of the coastal zone is a basic requirement for the identification of coastal properties, with a view to managing them efficiently as set out in the Structure plan. In 1989 a Coastal Land Use Survey was commissioned by the Planning Services Division to serve as a basis for examining the existing use of the stock available and to make recommendations for future development potentials. In addition this coastal survey was to identify areas that could tolerate further development and areas where development would be detrimental to the natural environment. This was the first survey in which the coast was mapped, examined and studied for its land use properties in the Maltese Islands.

Evolving planning policies were also noted throughout this period. These were the result of change in environmental awareness that was essentially influenced by NGOs who lobbied the political establishment to incorporate the need for Environmental Impact Assessments prior to major projects. In fact the first EIA ever to be commissioned Malta was at Delimara prior to the building of the Power Station (Government of Malta, 1988a; Government of Malta, 1988b; Government of Malta, 1988c). The introduction of Local Councils in 1992 established the boundaries for each of the 68 Local Councils. This brought for some localities, that were not traditionally associated with the coast, stretches of coastline for which they were responsible under their jurisdiction. A case in point is the inland locality of Naxxar having Bahar ic-Caghaq in its territorial limits. Local Council legislation also influenced policy in that all local structural needs of any size had an administrative and legally-binding voice. Notable changes made to the littoral areas in all coastal localities are the upgrading of areas especially the paving of promenades and increase in street furniture. In addition, the marine servicing areas, with the mooring of boats and the on-shore servicing areas, became more organized with zones earmarked for sea craft of different sizes. Changes in policy are also noted in the demarcation of swimming zones to render selected bay and inlets safe from moving seacraft (The Times [of Malta] 14 June 2003, 14) and the regular testing of sea water for monitoring safety swimming standards.

Changes to planning policies greatly affected the coastal urban areas with various measures intended to safeguard the aesthetic environment. These include the classification of each building within one of four categories depending on the state of repair and the architectural, historic or archaeological value. Some of these sites are also 'scheduled' and under no circumstances can they be modified without stringent planning permission. Heights of buildings are also controlled with only the areas where intensive tourist development takes place such as the Sliema/St. Julians and the Qawra/ Bugibba seafronts can buildings be taller than seven stories. This legislation follows the aesthetic problems generated from the permission granted in the 1960s for a 13-storey Preluna Hotel in Sliema. However, following the building of the Hilton multi-storey complex in St. Julians where this planning procedure was flouted, entrepreneurs are still pressing for multi-storey developments especially in the Qawra area

Table 4.2 Sequence of main reports on physical planning of the islands.

Year	Source	Comments
1945	Harrison and Hubbard	Suggested the setting up of the Town Planning commission and the drafting of a comprehensive Town Planning Ordinance.
1947	White Paper:	Proposed draft regulations for a comprehensive building code as the need was felt for the revision of building development laws.
1959	Windyer Morris: "Building regulations and Land Use Planning"	Proposals to expedite the processing of applications for building permits and for the drafting of new building regulations incorporating new techniques for modern buildings. Recommended establishment of Planning Authority as no land use policy and no attempt had been made to carry out planning surveys since 1945 thus Morris recommended: • identification of areas for urban development sufficient for ten years growth • a comprehensive Town and Country Planning Law • preparation of an Outline Plan for the Maltese Islands, the setting up of the Lands Department and the Lands registration system.
1964	Italconsult, UNDP funded	Prepared a) a National Physical Plan b) a Tourism Master Plan Suggested the establishment of a central physical Planning Authority.
1965	Draft consolidated Act	All existing building legislation put forward
1967-1970	Sieczkowski	An outline physical development plan was prepared but never implemented.
1969	Town and Country Planning Act	Enacted after two years' debate but never brought into force
1981	Town and Country Planning Act struck off the statute book	
1983	Building Development Areas Act (BDAs)	ouraged urban development as it provided for the establishment of BDAs outside ndaries of former schemes results inunprecedant sprawl of development into ntryside and merging of settlements
1987	Planning Services Division (PSD) established	essentially this was the reactivation of the planning function within the Works Department of the Ministry for the Development and Infrastructure
1988	Building Permits (Temporary Provisions) Act	this set out a) the framework for preparing the Structure Plan b) reintroducing the Planning schemes as a legal document c) tightening up enforcement procedures proposed the setting up of the Planning Authority
1988	Horworth and Horwort	Tourism Master Plan
1989-1990	Colin Buchanan and Partners and General Progetti SpA	Inception Report for Structure Plan Report of survey summary based on 17 detailed technical reports and a number of key studies of which the Coastal Land Use Survey was one
1992	Structure Plan approved by Parliament	Establishment of the Planning Authority.

Sources: Personal communication, Planning Authority
The Sunday Times [of Malta] 20 November 1994;
The Sunday Times [of Malta] 27 November 1994.

Communication with the public is maintained by the publication of lists of sites proposed for development. These lists are published in newspapers and on-site notices are also put up. The public can witness the workings of the decision-making committee by attending the meetings and also making verbal presentations during the committee's deliberations.

The lists mentioned above present, in a nutshell, the efforts of the local authorities to plan for a more efficient use of local resources. The effects of these on coastal management have been the Planning Authority's work in the publication of local plans. Three such plans have been published to date. These are the Grand Harbour Local Plan, Marsaxlokk Bay Local Plan and North West Local Plan. Four other plans are in the draft stage: North Harbours Local Plan, Central Malta Local Plan, South Malta Local Plan, and Gozo and Comino Local Plan. In each of these, coastal matters featured prominently especially through the landscape quality assessment. This took into consideration land use, traffic and environmental resources. As a result of these exercises the coastal cliffs have been scheduled, with the limits identified on maps. In future no development can take place in these areas. Coastal cliffs and scree slope areas account for about ten per cent of Malta's surface area. In the scheduling process, information relating to the historical heritage, architectural, ecological, agricultural, archaeological and marine conservation qualities is collected and the landscape quality then assessed. The Planning Authority processes about 8000 applications every year.

The structure plan is not meant to be a static exercise but has to be reviewed to take into consideration socio-economic changes. However, an important aspect is the setting up of a monitoring programme, not only to keep an eye on any changes made to the landscape, but also to examine how the Plan's policies themselves are affecting the same landscape.

It was the enactment by the Malta Parliament of the Development Planning Act that the Planning Authority was set up in 1992. The main function of the Authority is to promote and control development through set guidelines, as published in a number of policies and plans, and also through consultations with Government departments, Non-Governmental Organizations and stakeholders. The establishment of the local councils in 1994 added a further institutionalized stakeholder.

The policies to be followed are established in the Structure Plan, and they serve as a guide towards controlling development in Malta. Their main aim is to balance development with environmental requirements. In addition to the policies, two types of more detailed development plans are put forward: Local Plans and Subject Plans. A Local Plan is essentially site-specific and deals with areas that require attention due to problems in managing the environment of the area brought about as a result of a rapid rate of development. A Subject Plan deals with policies as stipulated in the Structure Plan with a more detailed approach. Public consultation is a key feature in the formulation of the Local and Subject Plans.

Seven sets of policies relevant to the coastal zone are presented within the Structure Plan. Each set presented here is indicated by a code with upper case letters with further details found in the Appendix.

(a) Coastal Zone Management (CZM) Policies: CZM 1-3. This includes the setting up of an adequately staffed Coastal Management Unit, the formulation of a Subject Plan for Coastal Zone Management to incorporate areas identified for conservation as well as recreational and areas adequate for development.

(b)Tourism (TOU) Policy: TOU 15. The definition of a comprehensive policy for the coast formulated in consultation with government departments and agencies is the main element in this policy section. It involves the assessment of the different ecosystems pertaining to the coastal zone, the enforcement of policies and the identification of permissible coastal uses.

(c) Natural and cultural resources: Rural Conservation (RCO) Policies: RCO 10,11,16-24, 34, 36-38; Recreation (REC) Policy: REC 9; Marine Concervation (MCO): Policies MCO1-13; Archaeology (ARC): Policy ARC 4. Detailed policies consider the conservation of natural features such as springs, dunes, marshlands and coastal cliffs and areas having natural vegetation. In addition, the control of any type of development, together with the prohibition of camping, removal of dune binding vegetation and activities that increase soil erosion. The cultural features of a whole territory of a number of listed sites especially the Dwejra/Qawra area in Gozo, islands and rocks, and typical coastal habitats, including sand dunes and sandy beaches. In addition, the designation of 14 sites as Marine Conservation Areas, Areas of Ecological Importance (AEIs) and Sites of Scientific Importance (SSIs) has been undertaken.

(d) Yachting and shipping development. Tourism (TOU) Policy 13; Inter Island Transport (IIT): Policies IIT 1, 2, 4; Industry (IND): Policies IND 5,15; Public Transport (PTR): Policy PTR 5. The purpose of these policies is to determine the advisability and feasibility for various types of harbours, moorings and facilities for yachts and other boats together with the identification of sites for these activities. An important development is to enhance the ferry terminals and the elimination of monopolies with the introduction of new ventures for the Malta-Gozo connections.

(e) Development. Settlements (SET): Policies SET 11, 12; Built Environment (BEN): Policy BEN 5: These policies are set to prohibit urban development outside existing and committed built up areas. These include the development of residential units, commercial outlets, offices and factories together with any ancillary land uses such as car parks.

(f) Illegal development. Recreation (REC): Policies REC 10-12; CZM 3, TOU 5. In this type of development a number of policy-sets are present. These include holiday villages, which are to conform to Structure Plan policies, caravan sites, some of which are to be demolished, and public access to the coastline and at the top of cliffs is to be secured. This can be done by the state through the acquisition of land, demolition of illegal encroachments along the shoreline and the establishment of detours where these are not possible.

(g) Fisheries and aquaculture. Agriculture, Horticulture and Fisheries (AHF): Policies AHF 1, 13-16. Mineral exploitation. Policy IND16; Minerals (MIN): Policies MIN 5, 6. These policies are meant to put marine uses in line with Structure Plan policies especially those concerning the enhancement of shoreline facilities for the berthing of fishing craft. The policies concerning the mineral exploitation envisage the guarantees that offshore activities will not interfere with navigation and should also safeguard the natural environment.

The scheduling process is a further instrument that assists the Planning Authority to achieve its objectives. This Process restricts the demolition, extension or alteration of "buildings, structures and remains of geological, palaeontological, archaeological, architectural, historical, antiquarian or artistic importance are designated as scheduled property that is to be conserved. In addition, areas of natural beauty, ecological or scientific value are also to be protected."

4.3 The historical demography of coastal settlements

The demographic situation in Malta as a whole has been one of a constant increase of the population. However, the coastal localities have experienced a variety of different demographic situations. The localities adjacent to the Grand Harbour have a decline, especially the walled towns of Valletta, Floriana, Cospicua, Senglea and Vittoriosa, whilst those to the north and south of the island saw their populations increase. The former trend was due to the decline in the services offered by the marine-related industries (eg. the decline of the dockyard as a ship-repairing facility for the British fleet) in the Grand Harbour. Taking the Grand Harbour littoral alone, the situation is dramatic. Whereas in 1842 almost half of the Maltese population lived within the fortified precincts of the five walled towns mentioned above, by 1985 this had reduced to only 8 per cent and to 6.4 per cent in 1995. Contributory factors were the spread of industrialization beyond the Harbour area, good accessible roads leading to Outer Harbour work places, more efficient public transportation, increased car ownership, substandard housing in the densely populated inner city areas, and the availability of land elsewhere on the island. In the immediate post-war situation unemployment was high and job prospects were low. Emigration was the considered to be the main demographic and economic safety valve, thus further decreasing the Grand Harbour population.

Along the Marsamxett littoral the situation was slightly different, with an increase in the population of Sliema in the immediate post-war period, and up to 1967 for Msida. Otherwise both major localities saw their population dwindling and are today experiencing the aging of the remaining population. The figures for their populations are given in Tables 4.3 and 4.4. Using the terminology employed for the demographic census, the localities that are contiguous with the coast are called the "Inner Harbour Region" and their adjacent localities towards the hinterland the "Outer Harbour

Region". These show that a general trend of a decrease in the Inner Harbour population ran in conjunction with an increase in the Outer Harbour localities.

Table 4.3 Population Changes in the Inner Harbour and Outer Harbour regions, 1931 - 1995

Region	1931	1948	1957	1967	1985	1995
Inner Harbour	109296	120958	126114	118372	101963	87997
Outer Harbour	42456	64774	69480	74567	98610	112262

Source: Central Office of Statistics (1996)

Table 4.4 Changes to the population of the Inner Harbour localities subdivided by main geographic area

Locality	1931	1995
Sceberras Peninsula		
Valletta	22779	7184
Floriana	6241	2647
Cottonera and Grand Harbour Area		
Vittoriosa	6573	3011
Cospicua	12163	5961
Senglea	7683	3454
Kalkara	1899	2800
Marsa	7867	5285
Marsamxett Harbour Area		
Pieta', Msida, Ta' Xbiex	6334	12911
Gzira	6295 (1948)	7858
Sliema	18880	12768
Other Localities		
Hamrun	11580	11142
Paola	7297	9370
Santa Lucia	-	3606

Source: Central Office of Statistics (1996)

Table 4.3 gives an indication of the trend for 1931 to 1995, with the Inner Harbour Region losing one-third of its population from a peak of 126,114 in 1957 and the Outer Harbour Region almost doubling its population to 112,262 in the same period. Details for the individual localities in the Inner Harbour are given in Table 4.4. These indicate marked decreases for the Grand Harbour, with populations for the coastal walled towns of Floriana, Vittoriosa, Cospicua and Senglea showing on average a 50 per cent reduction (1931 - 1995) and Valletta, the administrative capital of Malta, losing two-thirds of its population. Of the other localities, the region of Sliema alone made significant losses. The other localities all experienced increases except Hamrun.

In addition to the factors cited above this movement inland was also influenced by the availability of land away from the coastal areas in the Outer Harbour region for building purposes and the abandonment of agricultural land as farmers either emigrated or obtained jobs linked to the new manufacturing industries. The latter also affected some coastal localities (cf. Chapter 6). Some displacement to inland localities of the population of the Harbour areas was due to the bombing by German and Italian airforces during the Second World War. A large number of the people did not return to the Harbour areas after the war for a range of reasons: houses that were bombed out; emigration, mainly to Australia; and alternative permanent accommodation in the inland localities.

The other harbour regions on the Marsamxett side have on the other hand increased in population but, examined separately, Sliema has experienced a decline, with growth registered mainly for a period in Gzira.

The population growth of the other localities situated at Marsaxlokk Bay, namely Birzebbugia and Marsaxlokk, the northern areas of Mellieha and the locality of Marsascala lying on the eastern coast St. Paul's Bay, have had a somewhat different demographic pattern with the population development of the two localities as shown in the Table 4.5 below. A general trend of population increase is evident.

Table 4.5 Population changes in five coastal localities in Malta, 1931-1995.

Locality	1931	1948	1957	1967	1985	1995
Birzebbuga	1724	5339	5297	4876	5668	7295
Marsaxlokk	829	1431	1469	1462	2405	2865
Marsascala	-	-	888	876	1936	4792
Mellieha	3198	4549	4290	4279	4525	6220
St.Paul's Bay	1779	3440	3040	2788	4465	7332

Source: Central Office of Statistics (1996)

It is immediately apparent that not only has the Birzebbugia population grown but that the 1931-1948 threefold increase reflects the result of the Shell fuel installation and the job prospects revolving around the British Services personnel at nearby Kalafrana. Furthermore, the prosperity generated as a result of this encouraged more people to move into Birzebbugia. This, together with the post war movement of population for the reasons mentioned above also resulted in Birzebbugia having an increased settlement rate, far greater than the other coastal localities on the Harbour conurbation. Not listed in the census were the British services personnel and their families whose presence generated income and jobs for the locals. The close proximity of the two large villages of Zejtun and Zurrieq also helped to attract new residents to the seaside resort. In fact, the percentage increases in the populations of Birzebbugia and Marsaxlokk, over the 20th century, were the largest ones recorded for all the localities in the South East region (Schembri and Bonnici, 2000).

4.4 Physical changes to the Harbours

From a naval arsenal for the Knights, the Grand Harbour was transformed during the British period (1800-1964) into a dockyard for the repair of British Naval Ships and a safe anchorage for the British Mediterranean Fleet. The economy of the Maltese Islands was, throughout the century that followed the Crimean War, linked to the fortunes of war and peace in Europe and elsewhere, depending on the British involvement in foreign or Empire affairs. Table 4.6 presents a synoptic account, in chronological order, of the main political events that affected the Mediterranean and Malta over two centuries. The physical changes made to Malta harbours were partly as a result of the same events. The naval needs of war normally brought about economic prosperity, whilst the opposite was true in times of peace. The years immediately following war were particularly harsh.

The transformation of the harbours to accommodate the needs of industry, servicing and at the same time cater for the outdoor recreation of the residents entailed extensive works, primarily of an engineering nature. These included the dredging of the sea bottom to attain the required depth for the berthing of ships; the construction of wharves for loading/unloading industrial and commercial goods and as working areas for marine-oriented industry and industrial services; the building of boundary walls to shelter and enclose industrial areas; the construction of jetties and breakwaters where heavy sea currents make working conditions hazardous; the provision of promenades for recreation in this densely populated environment; and, finally, the creation of space for pleasure boat facilities. These developments transformed the littoral of Grand Harbour and Marsamxett Harbour. Plates 4.1- 4.4, with explanatory captions, show selected changes to sites in Grand Harbour.

Following the end of the Second World War it seemed that the economic fortunes of Malta and Gozo had to depend on either industrialization through the attraction of foreign investment to the islands, or by using the safety valve of emigration so as to deplete the workforce and a potential explosion of the population. Birth rates were still very high, especially in the Grand Harbour area. One way of diversifying the economy was to turn the dockyard into a commercial enterprise. This came about partly as the global presence of British forces was to be run down.

It is thus apparent that the industrialization of the Maltese Islands hinged on the viable development of the coastal areas, with the Malta Dockyard in the forefront of these new initiatives. Throughout most of the post-war period the commercial viability of the Malta Drydocks (as they later were to be called) was always in question, yet it was nonetheless by far the largest single employer on the islands and also the major foreign exchange earner. Economically speaking, the light industrial and the artisan side of the economy helped to maintain a steady flow of jobs available outside the Drydocks complex and also to offset the debt-ridden side of heavy industry.

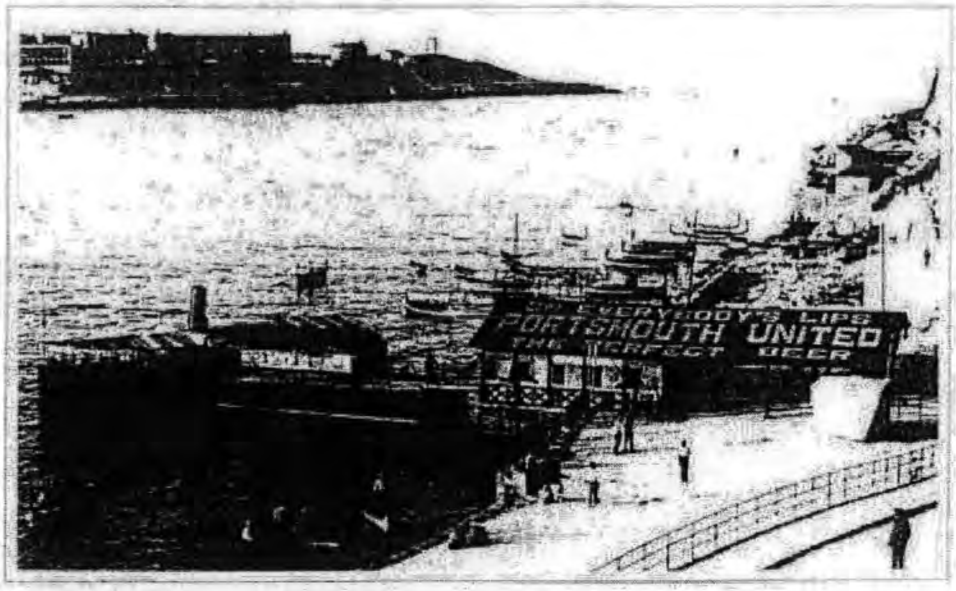
Table 4.6 Main historical events in the Mediterranean and Malta and the physical changes to the Harbours during the British military presence in Malta.

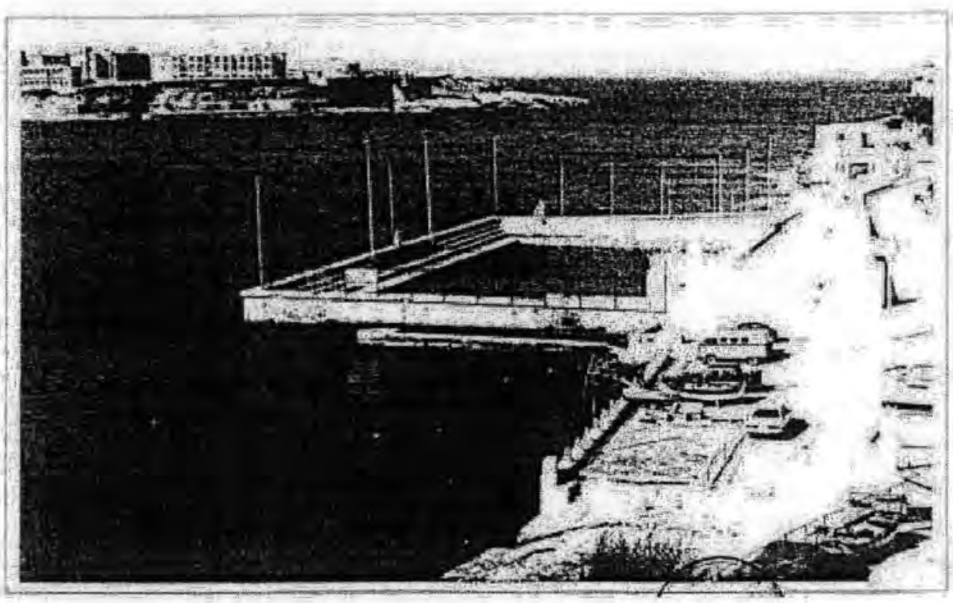
Year	Situation in the Mediterranean	British Mediterranean Policy	Malta Situation
1800-1814	Napoleonic Wars Commercial blockade	Blockade of Malta ended in 1800. Britain secures central Mediterranean island	1800-1840 British content to adapt to the Order's military installations
1814	Treaty of Amiens		Malta's strategic position in centre of the Mediterranean valued by Britain
1827	Battle at Navarino UK, France, Russia against Turkey and Egypt Britain and France compete for influence in the Mediterranean	Britain competes with France for influence in the Mediterranean	1840 - Malta redeveloped militarily on a vast scale: a place on a seaway which served a great part of the world
1830	French seizure of Algiers	Britain and France compete for influence in Western Mediterranean	Malta becomes an important base from which ships sailed into many spheres of influence
1839-1852	French Mediterranean ambitions through Egypt	Aden taken as precaution	Malta garrison improved 1848 First Drydock built Population 1842: 113,000
1853-1856	Crimean War	General Increase in Mediterranean trade	Malta forward supply and refit station for British forces in Crimea
1858	Railway from Alexandria to Suez linking the Mediterranean to Red Sea		Building of Malta railway Innermost parts of Grand Harbour used for building of commercial vessels. Introduction of tram-propelled vessels - coal-bunkering facilities for Royal Navy ships and private vessels Dock No1 built
1869	Suez Canal opened		
1878		Cyprus leased from Egypt	- Headquarters for the Mediteranean fleet- Harbours improved
1882	Other Mediterranean ports Algiers, Gibraltar Port Said. Invented - Harbour works	Egypt taken	- new static defences constructed - barracks and military hospitals
1871			2nd Dock built
1892			3rd Dock built Employment at Dockyard:10,000 Population 1891: 165,000
1899			start for 2 more docks - Harbour side workshops and refit facilities

Table 4.6 Continued

Year	Situation in the Mediterranean	British Mediterranean Policy	Malta Situation
1900-1913	German interests in the Mediterranean	British fleet strengthened	Breakwaters at Grand Harbour built. Population1901: 184,000 1911: 212,000
1914-1918	First World War	Briish and French fleets used Grand Harbour	Economic boom. Malta used as hospitalization centre.
1919-1938	Inter war period Italy invades Abbyssinia (Ethiopia)	Britain responded to italian Fascists interest	Improvement in the Maltese education system. Malta's economic performance depended on the political problems in the Mediterranean
1939-1945	Second World War	Aim to keep Malta in bid to defect Germans in North Africa. 1943 Italian fleet surrenders in Malta Harbours Malta plays part in invasions of Italy.	Dockyard workshops moved into crevices excavated works
1948-1963	Post-war period 'Cold War' starts	British military presence diluted due to NATO and US Sixth Fleet involvement	Emigration used as a safety valve for economic slump. Start of tourism as an alternative source of employment. British military presence decreased after the Suez Crisis (1956) Population 1948: 200,000
1964	Intensification of Cold war between USA and USSR	USSR interests	Malta granted independence from Britain
1965-1978	Arab/Israeli conflicts Closure of Suez Canal (1969-1975)		
1979			British forces leave Malta
1980-2000	Problems in Middle East and Balkans		Further intensification of tourist industry with Harbours' infrastructure accommodating yacht marinas and a cruise liner terminal Population 1995: 378,000

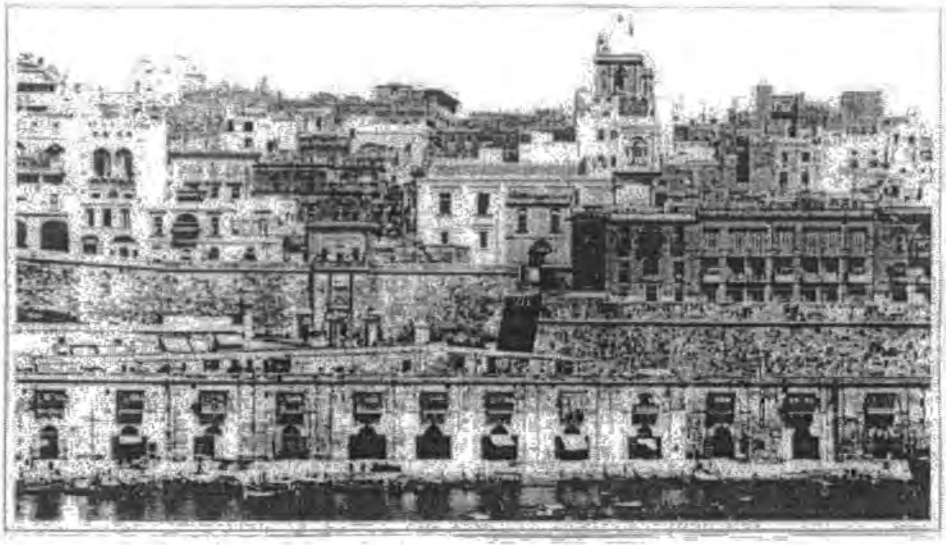
Sources: Adapted from Blouet (1992); author's additions for last row

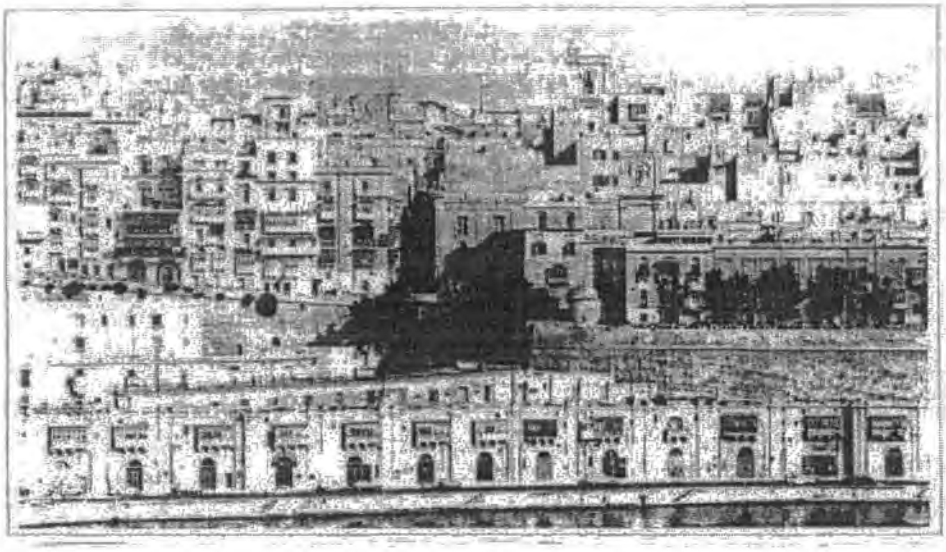




Source: Bonnici, J. and Cassar, C. (1989)

Plates 4.1 and 4.2 Malta, Valletta, Marsamxett Harbour: The effects of the development of road transport and the introduction of waterpolo as a summer sport are portrayed in these plates. The ferry service started in 1882 and serviced the Harbour crossing from Valletta to Sliema, Msida and St. Julians, a number of British military personnel also used the service. The development of the road network around the harbours, the introduction of the Malta Railway and Malta Tramways (1887-1932) and the use of private transport spelt the demise of the ferries. They have been reintroduced in the late 20th century as part of a tourist attraction and in an attempt to decrease the traffic flow into Valletta. The waterpolo pitch was built in the 1970s and was one of a series of similar facilities constructed around the coast of Malta.





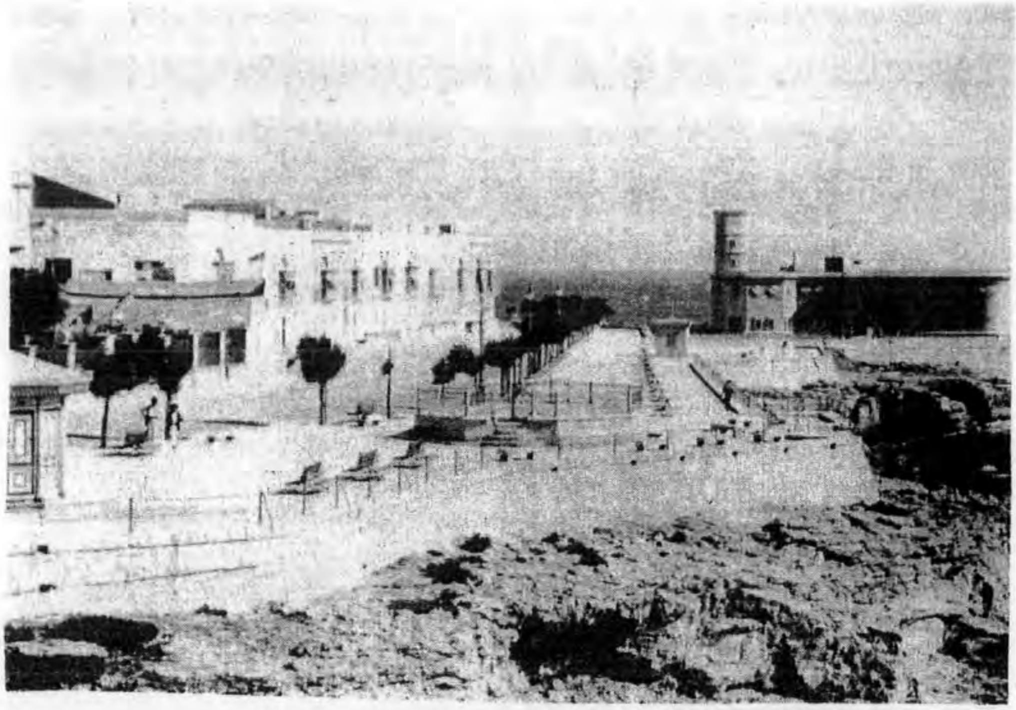
Source: Bonnici, J. and Cassar, C. (1989)

Plates 4.3 and 4.4 Malta, Valletta, Grand Harbour: The bastions and other fortifications built during the presence of the Knights of St. John (1530-1798) in Malta were also affected by changes. Although outright demolition of entire curtain walls and bastions to accommodate wider entrances to the city from the hinterland and develop the shiprepairing yard (19th century) and a hotel (20th century) were two major changes made to the littoral of the Harbour and the surrounding area, the overall character of the Valletta fortifications has been largely retained. The pinto Stores in the foreground and the bastions are still almost intact whilst a 17th century building has been retained, converted into a hotel in the 19th century and still in operation.

This situation led to different scales of development in the Harbours. Whilst Grand Harbour followed its historical pattern of marine-oriented works and facilities for ships and tankers, and saw this industrial vocation augmented by cargo berthing facilities, grain storage silos, cruise liner depots, coal and oil storage facilities, Marsamxett harbour on the other side of Sceberras peninsula remained rather dormant, awaiting, and later receiving, touristic and retail trading development. However the area that attracted touristic development was the Sliema and St.Julians area (identified as Segment IV in this thesis) area where a large number of recreational accommodation were built over a short span of time. Plates 4.5 - 4.8 demonstrate the changes made to the littoral land use pattern over a few decades. Some areas in Gozo were also affected by coastal urban development with changes to the most popular summer resort locality of Marsalforn shown in Plates 4.9 and 4.10. From a quiet, out-of-the-way summer residential and fishing hamlet it has been transformed into the tourist hub of Gozo.

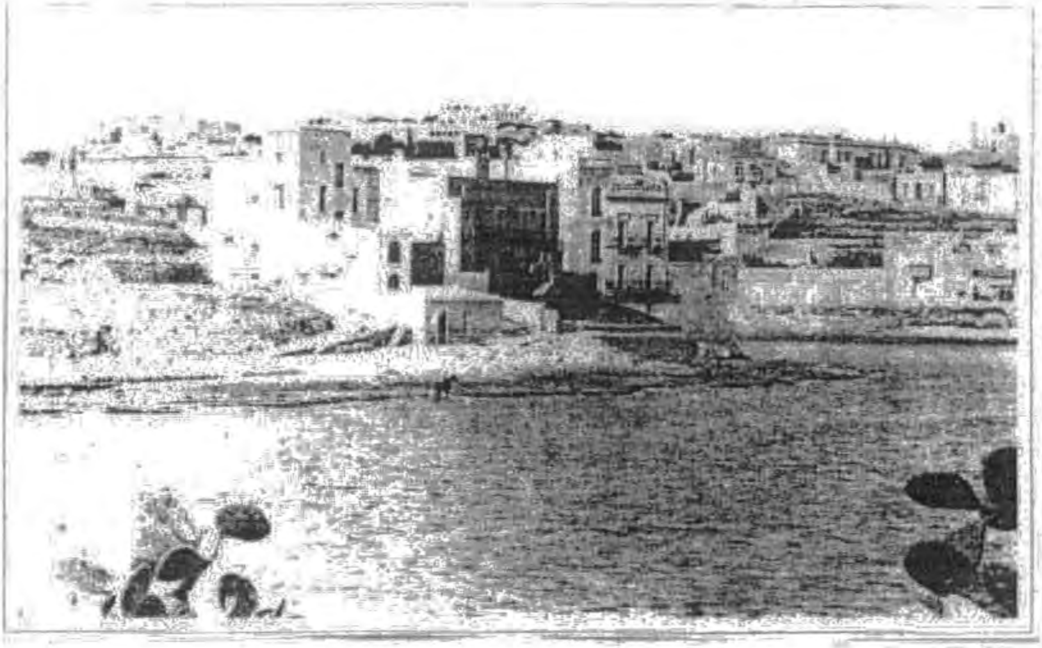
On the other side of the island to the south east, Marsaxlokk Bay lingered on in its dual functions of a fishing village locality and a summer residential area. With the location of a fuel storage depot at Birzebbugia (1916), the initial stages of an industrial base in this south-eastern Bay were started. This was followed by North Atlantic Treaty Organisation oil, Esso and Liquified Petroleum Gas storage facilities. During the last decade a new projects for a container terminal, further oil storage facilities and the siting of a new power station have completely transformed the Bay into an industrial zone (Schembri, 2002). Further discussion of these issues is made in Chapter 6, where land uses are examined in greater detail.

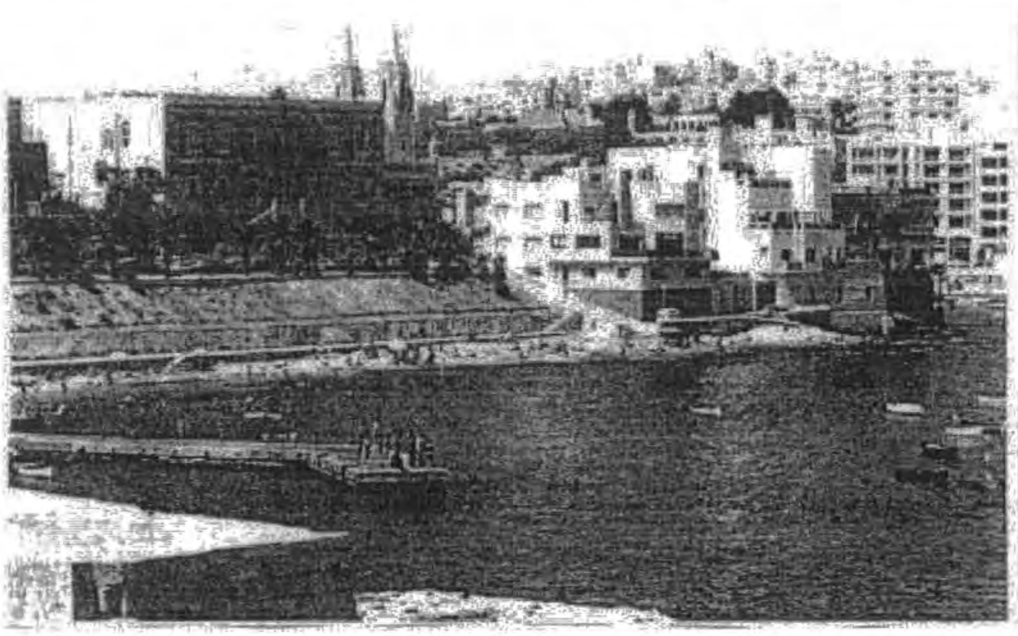
The coast of Malta can be divided into three levels of development that occurred throughout the 20th century. The first is the area around the Harbours, where the two sets of maps show that the amount of development in the hinterland was substantial. The coastal margin therefore is occupied by older buildings that give a "coastal heritage" look to the coastal zone area under discussion in this thesis. The Grand Harbour area is the best example whilst parts of St. Paul's Bay, Salina Bay, Birzebbugia and Marsaxlokk also show elements of coastal development in the mid-1930s. The second type of coastal development occurred where the built-up area along



Source: Bonnici and Cassar (1989)

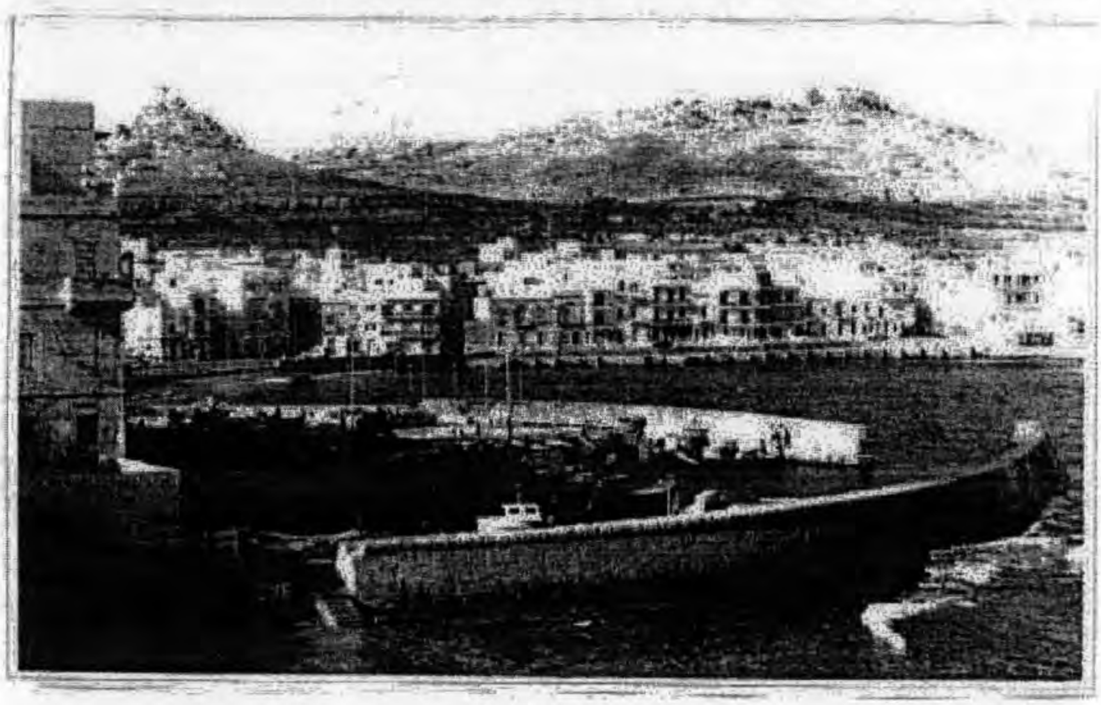
Plates 4.5 and 4.6 Malta, Sliema, Tower Road: Typical contemporary changes to the coastal zone setting can be seen around a 17th century tower with the late 19th century terraced houses have been replaced by a 20th century hotel and flats for residential development. In addition, the road has been widened covering parts of the rocky foreshore and developing the promenade. The tower is used as a restaurant.





Source: Bonnici, J. and Cassar, C. (1989)

Plates 4,7 and 4.8 Malta, Balluta Bay: Recent changes to the foreshore are evident in the sequence of plates with only the house on the edge of the promontory still standing, otherwise the area has changed considerably. The villas in the background have been replaced by flats. The site was also used for the bathing of horses and thus restricted the use by people for swimming.



Source: Bonnici, J. and Cassar, C. (1989)

Plates 4.9 and 4.10 Gozo, Marsalforn: Prominent summer resorts in Gozo have also been affected by changes. The waterfront terraced houses have been developed into flats and further encroachment on to the hinterland areas is evident over the span of a century. The loss of agricultural land and depletion of the natural resource base of the coastal zone was the direct result of these changes. Note the character of the sea craft *(dghajsa)* moored behind the jetty and used as passenger ferries within the bay and the sailing boat (*luzzu tal-latini*) used as a passenger and cargo ferry between Malta and Gozo.

the coast (termed ribbon development in urban theory; Carter, 1981) is seen to have occurred after the 1930s and before the 1990s. Areas such as Xghajra, Marsascala, and parts of St. Paul's Bay are good examples. The third type of coast within this classification includes the areas where hardly any development has taken place. As a general comment in this regard the areas near to the harbours have land uses that span this century or more, other areas depend largely on the degree of access to the coastal zone.

4.5 Conclusion

It is apparent from the above that the development of the coast of the Maltese Islands was partly due to the fact that the Islands were for the last four centuries dominated by strong military powers. These made the necessary changes to the coast to meet their needs and ambitions. The result of these factors was that the coast of Malta has a large number of historical buildings. These are today masked by the recent structures built in connection with the development of tourism and coastal industries. The range of coastal land uses that have engulfed or replaced historical heritage remains range from the demolition of entire bastions in the Harbour region to Bronze Age cart tracks in Birzebbugia. In addition, the development of the Sliema promenade saw the replacement houses built in the late 19^{th} and early 20^{th} century by modern flats. The situation has produced a coast that has a number of competing land uses. The mapping of these land uses is of importance, especially in the areas where coastal land use competition is evident. However, a good mapping technique has to be developed prior to any analysis of the land use situation is undertaken. This is the main theme of the next chapter.

Chapter 5 Mapping and surveying the coast of Malta

5.1 Introduction

This chapter examines the methodology used in mapping coastal land uses. It will review the salient points that emerged from the 1989 survey and incorporated into the methodology used for the 1998 survey such as the identification of the coastal zone boundary in establishing part of the study matrix for this thesis, and the basis for the development of the land use mapping. As the coastal area has a number of interrelated activities, land use data have become increasingly important in overcoming the problems posed by man/land relationships. This situation is put forward by Ketchum (1972) who listed six main influences by people on the coast. These were: residential and recreational; industrial and commercial; waste disposal; agriculture, aquaculture and fishing; nature reserves; and, military and strategic. Although Carter (1988) admits that these categories provide only a broad view of the human uses of the coast, they are a good preliminary tool for studying the coast.

Furthermore, the function or the role played by a parcel of land is not always discernible (Ellis, 1978). With the importance of protecting the coastal zone from haphazard development, by far the best method in drawing an inventory of coastal resources is in surveying as many of the variables as possible. This eliminates the problems associated with technical difficulties in interpreting the land use data obtained from aerial photographs or remote sensing techniques. For example, aerial photographs showing quarrying sites can be mis-interpreted as being sites in the initial stage of building development. In addition, the short coastal length of the Maltese Islands permits the precise identification of most of the coastal features in a relatively short time. Thus for the present research it was decided that the best way to identify the different types of land uses along the coast was in the physical surveying of the area through personal visual experience.

The focus in this chapter is on the methodology used in identifying and representing land uses. The material is presented in a way that shows the successive mapping stages, through to the final end-product. Throughout the various stages in which the field studies were conducted, a number of problems were tackled with the result that a systematic methodology for evaluating coastal land use could be made. As this was the first local exercise wholly done for coastal areas, the mapping technique evolved over a number of sessions into "the" method to be used for drawing an inventory of coastal resources. Essentially this method is explained in a series of techniques in this chapter from section 5.2 to section 5.16. These sections can be grouped into five steps. Sections 5.2 to 5.7 identify the study matrix of the thesis incorporating the delimitation of the coastal zone, definition of the coastal urban and rural areas, the establishment of the coastal segments and the length of the coast. Sections 5.8 to 5.11 provide information on the cartographic materials used giving details on the ranges of maps utilized in the compilation of the data. Sections 5.12 and 5.13 provide details regarding the development of the main mapping key that was used in the land use survey for this thesis with Table 5.11 as the principal factor. Section 5.14 gives details on the mapping teams used along the coast and sections 5.15 and 5.16 combine the techniques used in estimated the land use areas and bringing figures down to manageable proportion.

5.2 Identifying a coastal zone

The limits of any spatial unit are normally determined by the boundary lines enclosing it. For sovereign states this line is generally known as a border. Contiguous states have common borders. A boundary can either have a geopolitical meaning similar to that for a border or it can also mean the line or zone of separation between different units, the units having different geographical properties such as land and sea, mountain and plain. In other cases a boundary can be less evident in being represented by a vegetation line (salt-tolerant plants are sometimes used to identify coastal regions from other areas) such as those observed by botanists. Psychological or imaginary boundaries dividing areas by ethnic groups are also common. A zone is an area enclosed by a number of boundaries.

Definitions of coastal zones are an important element in planning and management as the extent of its geographic area conditions administrative systems and influences policies and decision-making processes. In fact, coastal zone delimitation is characterized by both physical and human factors and both take the shoreline as the starting point. An important physical factor is the state and level of tides with the Mean High Water Mark indicating the landward extent of the zone, although storm surge, influences of salt spray and the catchment area of the land boundary whose water run-off leads to the ocean are the various continental limits to the coastal zone generally cited (Kay and Alder, 1999). Notwithstanding these criteria influences that are beyond the outer limits of the zone can have a significant bearing on the coastal zone no matter how wide or narrow is its geographical space. Beatly, Brower and Schwab (1994) cite non-point-source water pollution as a typical example where industrial affluent dumped into the watershed well within the continental landmass is pollutes the coast. This factor is also a clear example of the situation in the Mediterranean.

One of the important facets of coastal geography is in the boundary subdivisions of the coastal area from other adjacent areas, producing an area that is referred to in this thesis as *the coastal zone*. Various definitions of the coastal zone are reviewed later but essentially this area is one that extends on either side of the shoreline: one boundary located on the seaward extension, the other on the landward part. The landward boundary forms a crucial element in framing the study matrix for this thesis. The example of the New Jersey Coastal Management Programme (State of New Jersey, Department of Environmental Protection 1980, 18) mentions the idea of a landward boundary that defines "the general geographic scope of the programme" as being one of three coastal management pedestals. The term 'geographic' here implies the area enclosed within the boundaries that falls under the jurisdiction of the Programme. The Oregon Coastal Management Programme states that the Land Conservation and Development Commission may recommend to the Legislature geographic areas to be designated as areas of critical statewide concern (State of Oregon Department of Land Conservation and Development, 1986). These two examples present the further ends of the geographic spectrum within the coastal management paradigm: one as an initial requisite to management, the other at the tail end of a coastal management exercise.

At this stage there is a need to identify spatial limits that include within them the main coastal activities. This implies delimiting a boundary on the landward side as a starting point for identifying the coastal zone from the rest of the landmass. The first factor to be considered here is the land/sea interface known also as the shoreline.

Strictly, this is 'the water's edge' (Bird, 1984, 1), the dividing line where the land is separated from the sea. The shoreline is here taken as coinciding with the high tide mark. Being a land-use exercise, this study is concerned with the different land uses occurring from the shoreline to a distance inland. A discussion of the choice of distances inland is the main theme of this section. Delimitation, in this case, is important and a number of sources were consulted in this regard. These included the Coastal Zone Management Act passed by the US Congress in 1972, the physical criteria used in delimiting this area by a number of sovereign states, selected states in the US and a number of islands. Tables 5.1 and 5.2 present these criteria. They include details taken from a broad spectrum of sources such as scientific papers, coastal zone activities brochures and personal communications. The sources are cited within the table itself.

The coastal zone in the 1972 law passed by the US Congress is defined as:

" The term *'coastal zone'* means the coastal waters (including the lands therein and thereunder) and the adjacent shorelands (including the waters therein and thereunder), strongly influenced by each other and in proximity to the shorelines of the several coastal states, and includes islands, transitional and intertidal areas, salt marshes, wetlands, and beaches. The zone extends, in Great Lakes waters, to the international boundary between the United States and Canada and, in other areas, seaward to the outer limit of the United States territorial sea. The zone extends inland from the shorelines only to the extent necessary to control shorelands, the uses of which have direct and significant impact on the coastal waters. Excluded from the coastal zone are lands the use of which is by law subject solely to the discretion of, or which is held in trust by, the Federal Government, its officers or agents."
Source: Ellis 1978,125

This definition was considered in identifying the physical extent of the coastal zone area for Malta. In addition, a number of sources relevant to delimitation in a number of countries were used and, although the criteria cited are self-explanatory, it is appropriate to comment on a few selected points. Sovereign states, defined as "states having absolute, unlimited power, and the right to make decisions, and accordingly to act" (Clark, 1995, 586), Brachya (1983) indicated that coastal zone boundaries can be based on either dominant natural landscape characteristics such as geology, topography and vegetation or the dominant land use, prominent among which are built-up areas and agriculture.

Problems in the delimitation of a coastal zone can be seen through the spatial limits of the bands which have been suggested for the coastal zone of Israel as follows: beach/foreshore 0 - 100 metres, immediate hinterland 10 - 200 metres, further hinterland 100 - 500 metres, (Brachya,1983). These dimensions indicate that an overlap of boundaries is possible. The littoral length was also subdivided into a number of units lengthwise (Brachya, 1983). On the other hand, Amir (1984) has defined the coastal zone of Israel as being the narrow belt lying between the fertile lands of the plains and the sea and including all the elements of the natural system. Hong, S-Y (1991) suggests for China a landward boundary using the existing administrative subdivisions such as cities and towns adjacent to coastal waters. In the case of the thirty-one coastal states of the continental US, it has been suggested that a 50-mile zone behind coastlines be called the 'Coastal Zone' (Edwards *et al*, 1997). However, this dimension has varied for a number of states as shown in Table 5.1. For the Italian peninsula, the zone was delimited by a belt running parallel to the coastline that includes the areas that are functionally interrelated with the marine zone. Although the width of this zone does not need to be uniform (Consiglio Nazzionale delle Ricerche (1985), a maximum limit of 5 km inland for Italy was suggested for the whole peninsula. Special areas that are often included within coastal zones are marshes and other coastal wet land habitats (Morgan, 1989). The importance of delimitation is highlighted by the fact that the coast is often a separate planning unit with its own specific problems (Public Works Department, 1990).

The difficulty in establishing a definite limit as to where the coastal zone ends on the landward side can be noted from a number of publications pertaining to different states, territories and islands of the USA. A postal survey addressed to central authorities running a CZM programme was conducted for the purposes of this thesis requesting information on the criteria used to delimit the landward coastal boundary. The replies to the questions varied significantly and helped in the compilation of Table 5.2.

Table 5.1 Coastal Zone Boundary delimitation for selected States

Country	Criteria for Land and Water Boundaries
Australia	100 m at least, or, extending 3 km inland or to the inner margin of recent estuarine sediments and coastal dunes where these extend more than 3 km inland. Source: Cullen, 1982, 184.
China	Using the existing administrative subdivisions such as cities and towns adjacent to coastal waters. Source: Hong, S -Y, 1991, 393.
Israel	Up to 500 m inland divided into: beach, 0 - 100 m; immediate hinterland, 10 - 200 m; further hinterland, 100 - 200 m. Source: Brachya, 1983, 512.

Sources: in table with relevant countries

Of importance to this thesis are the delimitations for islands in that the criteria established vary from encompassing the whole island (e.g. Guam, 549 km^2) to the limits established by different county councils (e.g. in Hawaii). Delimitation of the extent of the coastal zone can be useful for management purposes and may be necessary for administrative and legislative processes In general, coastal zone delimitations as shown in Tables 5.1 and 5.2 above, follow primarily political areas, with the zone's extent conditioned by the inland extent of counties that front the water's edge (e.g. Connecticut, Delaware, Florida, Maine and Maryland). Other delimitations use the degree of salt content in the water, such as in estuarine conditions (e.g. California), salt marshes and wetlands (e.g Alabama). In some cases more than one criterion was used such as for California, Connecticut and Massachusetts where multiple "tiers" were identified for denoting the coastal zone boundary. Effectively the boundary is, in general, influenced by the inland extent of the counties fronting the sea, and, in areas where sensitive ecosystems prevail, such as coastal wetlands and estuaries, an inland limit is taken that includes most of the particular ecosystem. Within these parameters the inland limit of the coastal zone boundary varies significantly for different states.

Table 5.2 Coastal Zone Boundary delimitation for selected states in the U S A

State	Dimensional Limits
Alabama	All coastal waters and adjacent shorelines within the 10th contour (the tenth line from a series of lines denoting heights above sea-level, the contours are spaced at 25-foot intervals). This includes transitional and intertidal areas, salt marshes, and wetlands as well as coastal island beaches located within the limit of the US territorial sea.
American Samoa	All of the land masses (except excluded federal Lands), the territorial waters, and submerged lands within the 3 mile limit.
California	CCA defines 'CZ' - the territorial sea, all off - shore islands and to extend inland generally 1000 yards from the sea's mean high tide line. In significant coastal estuarine, habitat, and recreational areas, the CZ extends inland to the first major ridgeline paralleling the sea or 5 miles from the MHTL of the sea, which ever is less, and in developed urban areas the CZ generally extends inland less than 1000 yards. The jurisdiction of the San Francisco Bay Conservation and Development Commission includes generally all areas of the Bay subject to tidal action and the first 100 feet of the shoreline.
Connecticut	Two tiered: Primary near shore tier: • seaward side by the limit of the State's jurisdiction in Long Island Sound. • landward side is bounded by a continuos line delineated by a 1000' linear setback measured from the inland boundary of State regulated tidal wetlands, or the continuous interior contour elevation of the 100-year frequency coastal storm - whichever is farthest inland. Secondary inland tier: includes all areas, except those in the primary tiers, within the inland boundary of the 36 coastal municipalities.
Delaware	The entire State, due to proximity of nearly all lands in the State to coastal waters.
Florida	The entire State, except that Federal consistency will only be applicable in coastal counties.
Maine	From territorial sea landward to the incorporated limits of all coastal towns and unorganised territories, 137 coastal towns and to unorganised townships.
Maryland	From its 3-mile jurisdiction in the Atlantic Ocean to the inland boundaries of the counties bordering the Atlantic Ocean, Chesapeake Bay and Potomac River to the District of Columbia.
Massachusetts	"Coastal frontage" - that the position of the land bordering the ocean to the point where the ocean waters are restricted to a closure of 300 feet by opposing banks; or in the case of large rivers mouths, where water flows under a bridge carrying a state road.
Mississippi	From territorial sea landward to include all areas within the three coastal counties.
Northern Mariana Islands	Islands of Saipan, Tinian, Rota, and all the remaining land and water areas of the Commonwealth.
Oregon	The territorial sea, extends from Pacific shoreline inland to the crest of the Coastal Mountain Range. This excludes Umpqua, Rouge and Columbia River basins that penetrate the coastal mountains but originate in the Cascades or interior lands.
Washington	All State's shorelines and associated wetlands, including, at a minimun, all upland area 200' from HWM; Non - SMA area within the 15 coastal counties which front on saltwater. SMA - all marine water areas of the State, to streams with a mean annual flow of 20 feet per sec or more, and to lakes larger than 20 acres. Applies also to adjacent land areas extending landward 200' from HWM and to all marshes, bogs, swamps, floodways, river deltas and floodplains associated with water bodies subject to the Act.

Source: personal communications from Coastal Management administrations of various States.

5.3 Establishing the study matrix for this thesis

Attempts to classify the Maltese coast in a number of segments/areas to introduce an element of sectoralisation in coastal uses have been made mainly on the basis of rock type (Bigeni, 1982, for Gozo), nature and shape of rock (Camilleri, 1977), coastal uses for walking and bathing (Torpiano, 1975), physical and man-made factors and predominantly touristic attractiveness (Farrugia, 1989).

In a publication by *Din l-Art Helwa* edited by Agius Muscat (1968) two authors made attempts at classifying parts of the coast. Lanfranco's classification was based on the predominant features of rock, soil and the dependent flora and fauna. Aguis Muscat himself based his classification on the geological strata that make up the island; Lower Coralline Limestone and Globigerina Limestone were treated separately but he only grouped together the three uppermost layers of Upper Coralline Limestone, Blue Clay and Greensand.

Haslam *et al* (1977) treat the coast from the floristic point of view and divide the coastal length into four categories: Coralline cliffs, sloping rocky shore, soil or clay slope, sandy bay and saltmarsh. The flora living on each separate substrate was given as a percentage of the total flora of the islands.

A few scientific publications have concentrated on geomorphological observations of the coasts of the Maltese Islands. These were discussed in detail by Paskoff and Sanlaville (1978), who maintained that the coastline is closely controlled by the geological structure and the limestone solution features, in that different rates of erosion of rocks produce different coastal features. Mechanical and chemical processes account for the configuration of the low limestone coasts, whilst the highland coasts are associated with mechanical and chemical processes. The authors have also produced a map of the Islands dividing the coast into fourteen geomorphological/topographical categories.

Effectively Paskoff and Sanlaville (1978) used both the geology as the base for their study and, through observation along the coastal margin, they interpreted the coastal features. Of the fourteen categories, five dealt with lithology. These were quaternary continental deposits, Upper Coralline Limestone, Globigerina Limestone, Clay slopes and beaches. These dealt with the effects of tectonic factors, namely faults, slickenslide and scree slopes (*rdumijiet*); four with topography, namely, low rocky coast, cliffs, high cliffs and high coast; and, two are associated with freshwater movement, namely, underground and karstic formations and the water drainage division. Another two factors shown were the highest altitudes and the built-up areas. Their cartographic representation along the coast is shown in Figures 2.3 and 2.4.

A Maltese coastal zone delimitation has never been seriously attempted. However for the purposes of this thesis, and more specifically for the development of the present argument, its spatial extent is inferred and quantified through a number of published sources. One of the most plausible estimates can be taken from the delimitation of the demographic census localities in the 1995 Census of Population and Housing Central Office of Statistics (1996). This publication, adapted for the purposes of this thesis, shows the spatial boundary limits of the demographic localities without considering the physical properties of the land. The map constructed is reproduced in Figure 5.1. It incorporates 63 per cent of the area of Malta, 92 per cent of Gozo and the whole of Comino. Another attempt at demarcating the coastal area was done by identifying the limits to which the land can be in view from the sea; a limit of about 20 per cent has been calculated. Figure 5.2 shows the results of this exercise as an increasing number of tourist brochures are advertising Malta's potential as viewed from the sea and an increasing number of tourist trips are organized around a ferry tour of the island. However, for the present study the criteria that have been used are the following. As physical parameters that essentially delimit the rural areas the identifying features that were used were key breaks of slope and the inland limit of *Inula Crithmoides* (Golden Samphire), a salt-tolerant plant that grows also under the influence of sea spray. The indicators used for the coastal urban areas were anthropogenic factors, such as tourist establishments, port and harbour works, coastal fortifications and residential areas. It was the distance from the water's edge to the façade of these establishments that incorporated the study matrix. The following sections elaborate on the criteria mentioned.

Figure 5.1 Area covered by Local Councils' administrative boundaries that are contiguous with the coast.
Source: Based on Census 1995 and developed by author.

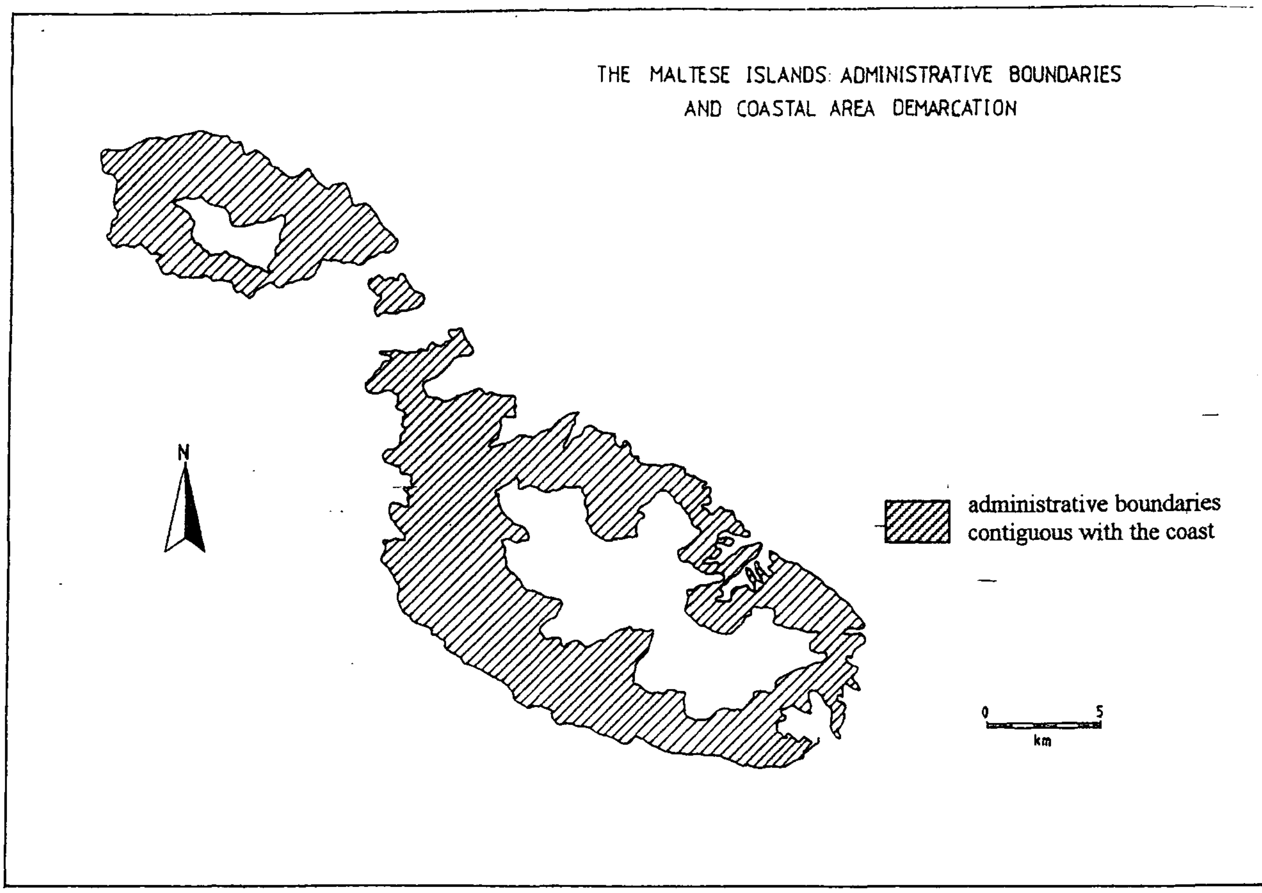
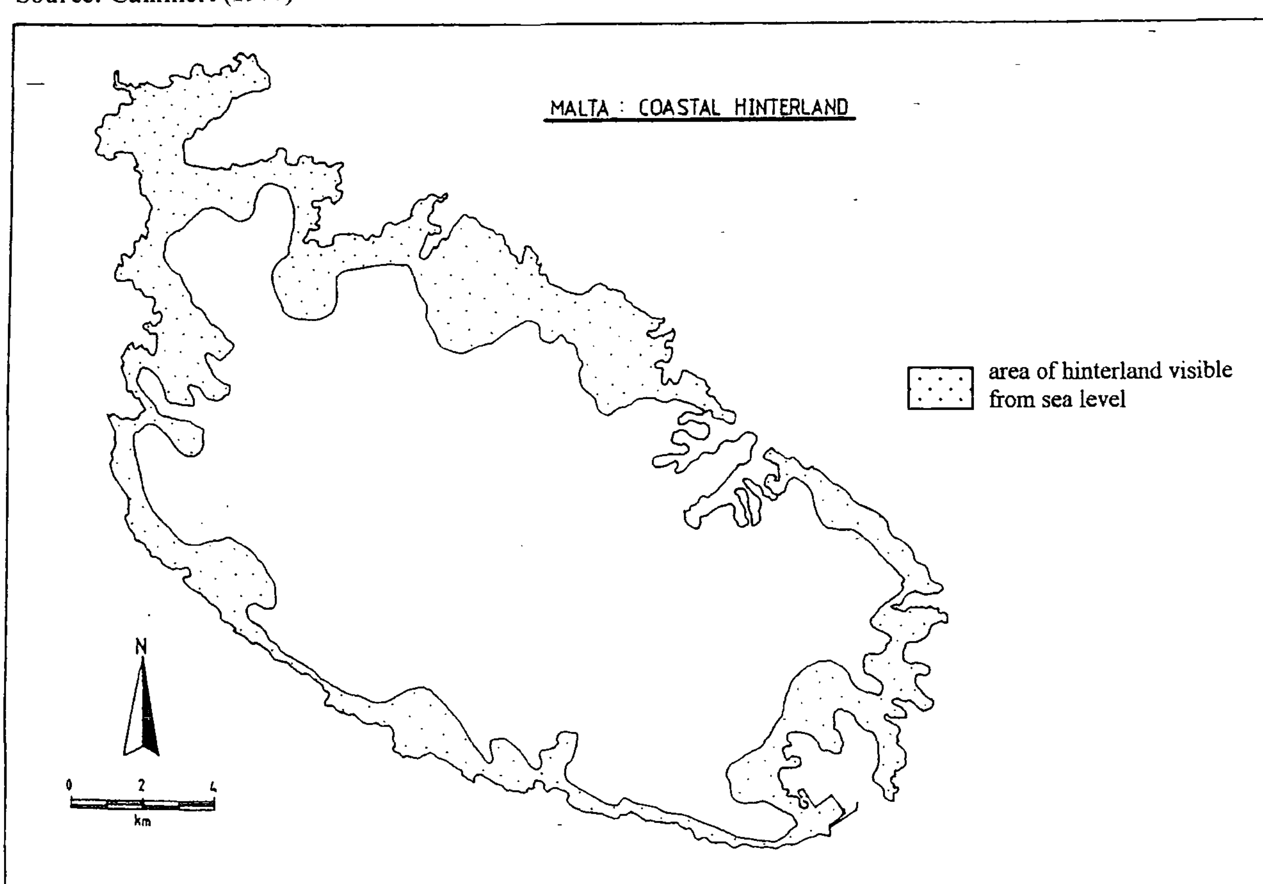


Figure 5.2 Malta: Extent of land seen from the sea
Source: Camilleri (1977)



5.4 The coastal "rural" areas

In identifying a practical boundary for the coastal "rural" areas the extent to which the first break of slope occurs was the prime consideration. In the absence of a notable 'break of slope' the limits of halophytic (salt tolerant) vegetation was considered. Sea spray conditions plant growth with halophytic vegetation growing up to limits influenced by these conditions, these being roughly parallel to the coast. *Inula crithmoides* (Golden Sapphire) is one of the best local indicators in that it marks the zone of sea spray influence inland. In many cases the limits of the "vegetation line" coincided with the limits of the first break of slope inland. However, where the *Inula Crithmoides* did not coincide with the first break of slope then the "topographic boundary" was drawn along the contour that marked the first break of slope from the shoreline. In general these areas were undeveloped areas and at times marked with rough terrain.

Although not used to demarcate the study matrix of this thesis other types of vegetation were taken into account: terrestrial coastal vegetation and maritime coastal vegetation. Essentially these were used to help in identifying selected land uses and it is felt proper to mention them here. Haslam *et al* (1977) gave a detailed account of the flora of the Maltese Islands they distinguished two broad types: the Perennials, that occur in habitats which are tolerable for land plants throughout the year, and the Annuals, which can only grow in places temporarily tolerable such as rocky shores, close enough to the sea to receive storm floods in winter. The study, besides including all the terrestrial flowering plants, also describes briefly the main maritime communities. For the purposes of this study the main emphasis lay on the latter. Appendices 2 and 3 list the most important vegetation with the species in Appendix 2 the most important of the two as they represent five terrestrial flowering plants. The table in Appendix 2, besides giving the scientific nomenclature, the English and Maltese names, gives also the main characteristics of each species together with the substrate properties (the main terrestrial habitat on which each plant lives is also given. Essentially the short list provides a spectrum of species that live on a variety of landscapes that are representative of the coast: sand dunes, estuarine conditions, deep soil, and moist rocky places. All the species are basically tolerant of salt spray.

Although all five species listed in Appendix 2 helped in delineating the landward boundary of the coastal zone as they all thrive in salt-tolerant conditions, two species were of particular importance in this part of the exercise. *Inula crithmoides* was practically used throughout, its inland limit being a function of a moist, rocky substrate. Theoretically this indicates that the plant should thrive all round the coast; and in practice this was confirmed. The two other species, *Phragmites Australis* were associated with areas that are either near to sandy beaches or where fresh water flows into the sea via the mouth of a valley. However all species are coastal zone markers because in the absence of other marker vegetation they help in the delineation of valleys within the sea-spray limit having a higher salt content in the soil.

The six main maritime species investigated are listed in Appendix 3. Their distribution along the coast was indicative of the presence or absence of pollutants. They were not used to demarcate the coastal zone but with a visual assessment of the type and spatial coverage on the sea bottom near the shore, an idea of the type and extent of pollution could be gained. Furthermore, the type of sea bottom prevalent in a bay was also indicated by the presence or otherwise of *Posidonia oceanica* banquettes along the shore. Strong sea currents and storm wave action combine to scrape the *Posidonia oceanica* from the sea bottom and deposit it on a beach or rocky shore.

5.5 The coastal "urban" areas

Delimiting the coastal zone in built-up areas has posed a major problem for the present survey. As vegetation and geomorphological factors could rarely be considered, a cultural parameter has been introduced. This problem was encountered mainly along the eastern lowland coastline in the part of the coast where recreational and industrial activity takes place. As the predominant location of these activities is along the shoreline, the first line of buildings along the littoral was taken as the primary marking point. This was also justified by the fact that it is the facade of these buildings as seen from the seaward side which provides the main aesthetic qualities for the built-up area along the coast.

The inland extent of the activity areas was also considered. This was governed mainly by a number of land uses: tourism-related, industry-relate residential and historic sites.

In the first type the tourism-related activity although most commercial establishments were located along the littoral, usually facing the sea, a number of shops and services were found further inland, normally a short distance (about 50m) from the seafront. These were considered to be within the coastal zone. The industry-related enterprises along the shore occupied a more inland location than the tourism - related ones. The main exception is the drydocks in the Grand Harbour where the inland spatial incursion was limited by the historic fortifications. Otherwise, for the Marsaxlokk container terminal, the whole industrial complex was included. In areas where residential zones predominated it was the distance between the shoreline and the building façade that was considered.

An interesting feature that linked the 'physical' markers with the anthropogenic ones occurred in some urban areas, with *Inula Crithmoides* found in patches at the foot of the buildings facing the sea. Thus the limit of the first facade of the first buildings lining the waterfront can be justified also using physical criteria and an "urban facade boundary" confirmed. These cultural factors were justified with the previous botanical criteria in that the main coastal zone vegetation marker, *Inula crithmoides*, a halophytic plant used in the first survey as an indicator of the coastal zone boundary, either did not have the ideal terrain in which to grow or the buildings on the facade precluded the necessary bioclimate for it to grow further inland. Furthermore there are instances in the Grand Harbour where the plant was seen to grow within crevices high upon the edge of the fortifications or even on the upper edges of dilapidated buildings. Thus even in the built-up areas the presence of *Inula crithmoides* was used to help in justifying the inland limit of the urban zone.

These physical criteria produced a line that, in general, ran parallel to the shoreline. Mapping was confined to this area only; this extended from the shoreline to the landward margin. For the purposes of data collection, establishing the land use inventory and analyzing the physical geographical factors which influence the land use, the boundary delimitation had to be a definite line.

5.6 Establishing coastal segments

To facilitate discussion, another type of boundary had to be introduced in the study. This entailed the division of the littoral margin of each separate island into a number of segments, following mainly large scale physical geographical and morphological criteria (Brachya, 1983). Essentially this was done to divide the littoral into a number of segments so that discussion can be easier and management policies explained better. In addition, the main analytical factor of this thesis lies in the grouping together of coastal areas having more or less the same cultural and/or physical properties. Figure 5.3 proposes that these subdivisions should be the end of one coastal unit and the beginning of another. Effectively the idea to identify segments resulted from consultation of various manuals on coastal management, such as Clark (1995) and Ellis (1978), the need to portray that the coast is essentially one that can be sectoralised through physical parameters and to present a regional dimension for the local coast irrespective of the boundaries established through Local Council criteria, Electoral Divisions or Parish Boundaries.

A number of criteria were considered to identify the segments that permitted the division of the littoral. Each segment had roughly homogeneous physical properties and fairly uniform anthropogenic influences. These were:

- compass orientation - the general direction that the part of the coast is facing;
- geology - the type of rock; slope angle at the land/water interface;
- large scale geomorphology, such as low sloping coastline, cliff face;
- slope angle; and,
- cultural features, mainly the predominant cultural development, e.g. industrial, touristic, agricultural or residential.

Table 5.3 shows the criteria used for demarcating different zones. Although cultural features can be left out of this exercise, and the segments be identified solely within the four physical criteria mentioned, their influence in determining the limits of the segments was minimal, as each one of the four physical parameters were, in turn, considered before the cultural criterion.

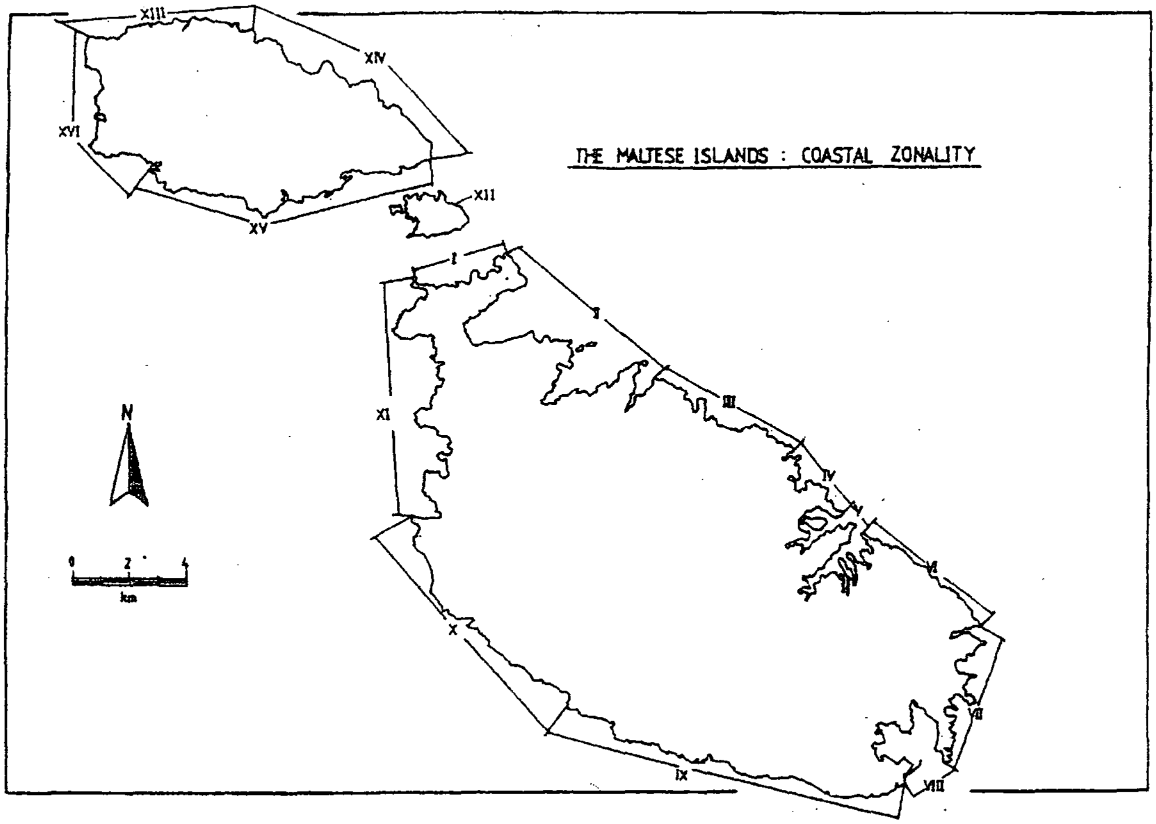


Figure 5.3 Subdivision of Coastal Segments

KEY

Segment I: Cirkewwa Point to il-Ponta ta' L-Ahrax
Segment II: Il-Ponta ta' l-Ahrax to il-Ponta ta' l-Ghallis
Segment III: Il-Ponta ta' l-Ghallis to il-Ponta ta' Dragunara
Segment IV: Il-Ponta ta' Dragunara to il-Ponta ta' Dragut
Segment V: Il-Ponta ta' Dragut to il-Ponta ta' Ricasoli
Segment VI: Il-Ponta ta' Ricasoli to il-Ponta taz- Zonqor
Segment VII: Il-Ponta taz-Zonqor to il-Gzira
Segment VIII: Il-Gzira to Il-Ponta ta' Delimara
Segment IX: Il-Ponta ta' Delimara to il-Ponta ta' Benghisa
Segment X: Il-Ponta ta' Benghisa to Ras ir-Raheb
Segment XI: Ras ir-Raheb to Cirkewwa Point
Segment XII: Comino
Segment XIII: Il-Ponta ta' San Dimitri to il-Ponta ta' Reqqa
Segment XIV: Il-Ponta ta' Reqqa to Ras il-Qala
Segment XV: Ras il-Qala to Ras il-Bajda
Segment XVI: Ras il-Bajda to il-Ponta ta' San Dimitri

Thus, to summarize, two sets of boundaries are proposed: the first running parallel to the shoreline, enclosing the area that was mapped and investigated in this thesis; another boundary, drawn with reference to the 1:25,000 scale maps published by the Oil Exploration Directorate (1992) for Geology and that published by the Works Department (1984a, 1984b, 1984c) for the large scale geomorphology, that divided the coastal perimeter into a number of segments. Other spatial units will be utilised. In general these are:

- The Maltese Islands: referring to the archipelago as a whole political entity;
- The separate islands of Malta, Gozo and Comino; and
- A 16 segment subdivision for the Maltese Islands mentioned below in Table 5.3.

Table 5.3 Main criteria used to identify the coastal segments

Segment	Compass Orientation	Geology	Large Scale Geomorphology	Slope Angle	Cultural Features
I	*	*	embayed zone		
II	*		embayed zone		
III	*	*	linear coastline	*	
IV	*	*	embayed zone		*
V	*	*	embayed zone		*
VI	*		linear coastline	*	
VII	*	*	embayed zone		
VIII	*	*	embayed zone		*
IX	*	*	linear coastline	*	
X	*	*	linear coastline	*	
XI	*	*	embayed zone	*	
XII		*	island		
XIII	*	*	linear coastline	*	
XIV	*	*	embayed zone		*
XV	*		linear coastline		
XVI	*		linear coastline		

* indicates presence of the feature shown
Source: developed by author from cartometric exercises

5.7 Establishing the length of the coastline

During the preliminary literature search and initial field exercises, the issue of coastal length was not a prominent factor. A number of reasons account for this. Coastal length has traditionally been a static dimension, which at best should be quoted together with other spatial dimensions, such as areal extent, of the state or country in question. The example of Malta is a case in point. In fact, the length of the coast of the Maltese Islands is quoted in official publications as 183 km, notwithstanding the changes affecting the littoral with the construction of jetties, breakwaters and other civil engineering structures. Even in publications pertaining to the European Union, where each state's spatial dimensions are given annually, and in which changes noted to the surface area of the states making up the Union are noted (Commission of the European Communities, Com. 92, 23 final Vol. III, 16), the littoral figures are not included. It is therefore not surprising that local figures for the littoral have remained unchanged for over 30 years (e.g. National Statistics Office, 2002).

In literature searches for this work, and especially sources pertaining to regional and country case studies, the issue of coastal length never arose beyond the empirical values. Most journals, articles and even books found in this bibliography do not assign much importance to this issue. However, through the personal communications sought from North American coastal agencies regarding the delimitation of the landward boundary of the coastal zone (cf. previous section), the need to know the precise length of a coast comes up, especially in technical literature.

Since this study focuses on a small island, the issue of the precise quantification of the coastal length is important. Larger states have a larger land area to coast ratio (cf. Tables 2.6 and 2.7) and therefore the coast may not exert an impact on larger states as important as it does on smaller states (Blake, 1984). The issue of coastal length emerged during the literature search where scientific papers appearing in the context of specialized studies on the coastal perimeter of Britain (Mandelbrot, 1967) and Australia (Galloway and Bahr, 1979) paved the way for an investigation into the local scene.

The importance of the issue of coastal length to coastal land use and coastal management will be dealt with here. Justification for examining coastal length within a land use exercise can be seen through a number of factors:

(a) By changes to land use types as the indentation changes along the coastal perimeter, with a higher indentation the more intense would be the land use; as natural protection from bad maritime weather conditions is given to coastal areas, with the result that sheltered areas tend to cluster dense populations and a range of land uses. A discussion on this issue is given in Chapter 8;

(b) The high land area to coastal length ratio (cf. Table 2.6); and

(c) A series of factors mentioned in the next chapter, such as, the high population density of the island, the sovereign state status of the archipelago and the recent quick pace of economic development that have put great pressures on coastal resources.

In part, this emphasis and linkage of coastal length to coastal management emerged as a result of the mapping exercise described later in sections 5.12-5.14. The issue of conflicting uses in heavily indented bays and inlets along the eastern coast of Malta gradually emerged and detailed observation followed.

Drawing from the theories proposed by Maling (1988) that the coastal length is a function of both the scale of map measured and the width of transects, a number of coastal lengths for the Islands at a variety of scales were drawn up. The study has a number of practical factors that aid in the management process, especially for areas that are heavily indented. Essentially it is the knowledge that, in whichever way the local coastline is measured the traditional length officially recognized is wrong. The areas that are prone to heavy land use pressures are the areas that need to be measured most accurately as they are the most indented. To begin with, the islands forming the Maltese archipelago are presented in a hierarchical order of both spatial and littoral dimensions starting with Malta through Gozo to Comino and the smaller rocks of Cominotto, Selmunette, Fungus Rock, and Filfla. Since this is a thesis dealing with the coast, it was felt that the actual length of coastline of the Maltese Islands must not be taken as read in secondary sources. Rather the need was felt to measure the coastal length using the same scale sheets as that used for the estimation of the land uses.

Deciding on the particular coastal length to be quoted in this work was the next cartometric exercise to be performed. A range of maps at various scales from 1:2,500 to 1:31,000 were used and consulted in the process of the compilation of this thesis. However, as the main land use mapping and measurements were done on the 1:2,500 scale sheets, it was thought appropriate to perform coastal length measurements using the same level of detail, ensuring a degree of uniformity.

At this stage the issue of the coastal length can be taken further to investigate a number of other factors. Coastal length measurements are tied to two main criteria, namely, the scale of the map used and the apparatus used for performing the actual measurement. The equipment and methodology for the latter are reviewed in detail by Maling (1988). Two main pieces of equipment were used in this instance, the opisometer and a pair of dividers. The former is a reliable piece of equipment for measuring the linear parts of the coastline. However, the apparatus was not as efficient for measuring in detail lengths of the indented portions of coast. Although the use of the opisometer gave very quick results, their reliability is questionable.

The pair of dividers, on the other hand, afforded greater accuracy especially in treating lengths of the indented and fragmented parts of the coast where boulder screes were prevalent. They gave scope to experiment with map scales and transect width. The latter factor opened up a new facet in the concept of fractals as developed by Mandelbrot (1967) and Galloway and Bahr (1979). It became immediately apparent that this issue has never been applied to the local scene and that the traditional dimensions given never mention map scale and/or transect width. To elaborate on this issue a cartometric exercise was performed. This involved calculating the length of coast as measured from the 1:25,000 scale maps using various transects, the results of which are shown in Table 5.4. A range of values was obtained, and the smaller transect the longer the coastal length turned out to be.

Table 5.4 Coastal length for the Maltese Islands at a scale of 1: 25,000 and various selected transects

Transect Length Metres	Malta East km	Malta West km	Malta km	Gozo km	Malta & Gozo km	Comino km	Maltese Islands km
500	68.630	54.195	122.825	38.310	161.135	7.340	168.475
400	71.890	54.680	126.570	38.510	165.080	7.450	172.530
300	75.250	57.150	132.400	39.700	172.100	7.100	180.200
200	78.400	57.320	135.720	42.390	178.110	8.560	186.670
100	84.400	64.645	149.045	42.500	191.545	8.975	200.520

Source: Author's calculations

5.8 Mapping scales

Owens (1992) defines scale as the degree of generalization of a landscape. Scale is controlled by two essential factors: the dimensions of the area that is to be studied and the level of accuracy that is required; as scale increases, the level of generalization decreases. Listed below is what is considered to be a spectrum of scales (Robinson *et. al.*, 1983) relevant to land use mapping:

i. large scale 1 : 1x 10^6 or ~~less~~ more - small scale

ii. medium scale 1 : 1x 10^5 to 1 : 1x 10^6

iii. small scale 1 : 50,000 to 1 : 1x 10^5 - Large scale

Perotte (1986) claimed that many coastal managers want mapping at 1:10,000 scale, while for Owens (1992) a scale of 1:5,000 institutes detailed mapping. It is therefore important to note that the local mapping of the Maltese coast at 1:2,500 was an exercise in detailed mapping.

Studies aimed specifically at coastal zone mapping are few and the number does not reflect the importance which this subject warrants. Ellis (1978), Owens (1992) and Perotte (1986) attempted to collate and investigate such mapping. Their studies were intended to be either primers to provide general information and guidance or overviews to be used as a starting point for coastal zone mapping. Their major concern was to try and initiate some form of uniformity in the thematic mapping of the coasts. The major problem stemmed from the wide spatial variability of the coastal character. Planners and managers need information that combines as many variables as possible in a small number of maps. Hence the diligent selection and compilation of a reliable base map should be the first goal. Small scales limit detailed studies and diminish the levels of detail. For small areas large scales are required. Coastal managers need a low level of generalization and hence large scale maps are the vital working tools.

Mapping the coastal area is essentially an exercise in identifying natural and cultural features. For the purposes of this thesis mapping basically entailed depicting land use. Ellis (1978) defines land use as comprising two components:- land use and land cover; land use being activity related, i.e., the way in which a parcel of land or water is used, whilst land cover refers to vegetation or artificial structures on the land. In the case of the Maltese Islands, the problem of land cover hardly emerged, as vegetation is generally sparse and artificial structures, where a cover or canopy is found, are restricted to shipbuilding facilities in the Grand Harbour or boat shelters which form a part of marine recreational facilities. Otherwise, all coastal land uses mapped were not covered up. The topographic details shown on the survey sheets were valuable in linking the topography to the land use elements being mapped, especially in undeveloped areas.

5.9 Cartographic materials used

Maps and sheets of the Maltese Islands are available at a number of scales. The British Government's Overseas Development Administration (Directorate of Overseas Surveys - DOS) produced and updated maps of Malta on a regular basis throughout the 20th century up to 1974. From these the most detailed maps available are the M8910 series at a scale of 1:2,500, published between 1971 and 1974, by which Malta is covered in 154 sheets. Gozo is covered in 42 sheets by a set published between 1964 and 1968, and Comino in two sheets which were published in 1963. Of these, 100 sheets covered the coastal zone area and were therefore used in the Coastal Surveys. Table 5.5 presents the lists pertaining to Malta subdivided by Segment.

Table 5.5 British Directorate of Overseas Surveys Series M 8910, 1971, Survey Sheets: Scale 1: 2500 used in Coastal Surveys

Segment I: 3882, 4082, 4083, 4283/ 4284.
Segment II: 4281/4282, 4081 (part of), 4280/4281, 4080 (part of), 4480, 4481 (part of), 4680, 4680, 4479, 4478, 4678, 4879/5029, 4879, 4677, 4678, 4878,4879/5079 (part of).
Segment III: 4878, 4879/5079 (part of), 5078, 5077, 5277, 5476 (part of).
Segment IV: 5476 (part of), 5275, 5475, 5474/5476 (part of), 5474/5674 (part of), 5673 (part of).
Segment V: 5473, 5474/5674 (part of), 5673 (part of), 5673 (part of), 5672, 5472, 5471, 5470, 5671, 5672 (part of).
Segment VI: 5872, 5871, 6070/6071, 6069 (part of).
Segment VII: 6069 (part of), 6068 (part of), 6068 (part of), 6067, 6066, 6065, 6064.
Segment VIII: 6065, 5964 (part of), 5964 (part of), 5865, 5866, 5665, 5664/5864, 5863 (part of), 5863 (part of), 5665,
Segment IX: 5762, 5562, 5463, 5263, 5064, 5065, 4864, 4665, 4666, 4466 (part of),
Segment X: 4466 (part of), 4467, 4468, 4268/4267, 4269, 4069, 4070, 4071, 4072, 3872, 3873.
Segment XI: 3874/4074, 3875, 4073, 4075, 4076, 4077, 3877/3878 (part of), 3877/3878 (part of), 4078, 4079, 4080 (part of), 4081 (part of), 3881/3860, 3883/3882,
Segment XII Comino
Segment XIII: 2692 (part of), 2893, 3093,
Segment XIV: 3292/3293 (part of), 3491/3492 (part of), 3691, 3690/3890, 3689, 3889.
Segment XV: 3888/4088, 3887/4087, 3887/4887 (part of), 3887/4887 (part of), 3687, 3686, 3486, 3286/3285, 3086, 2886/2887 (part of), 2886/2887 (part of), 2888,
Segment XVI: 2688, 2689, 2690, 2691 and 2692 (part of).

Source: compiled by author from the series of O.S. sheets.

"part of" means that only a part of the sheet was used in a particular segment, it usually follows that the next (adjacent) segment used the remaining part of the same sheet, hence another "part of".

The term 'part of' indicates that only part of (a section) of that sheet was used in the compilation of the sequence O.S. sheets that make up a segment. The parts were necessary as the O.S. sheets do not distinguish between one segment and another. As a result, some O.S. sheets had to be sectioned into different parts, this occurred mainly in those sheets that were located at the separation of two contiguous segments. These 'parts' were identified with the segment in which they appertained to. Therefore the same sheet number would appear more than once in different segments signifying that one sheet had more than one section of it falling in different segments. Figure 5.4 shows the distribution of the sheets along the coast. In addition, the coastal place names that occurred along the coast were identified from the 1:25,000 maps of Malta and Gozo and from the 1:2,500 survey sheets. These were compiled into Figure 5.5 and a key developed and shown on the reverse side of the same page. Combined together the Figure and Table provide a guide to sites and locations along the coast used in this thesis. In all 352 sites are identified.

The subdivision of the coast into 136 coastal units is an additional cartometric feature that has been introduced for this thesis. A number of units make up a segment. These units are primarily determined by the O.S. sequence of sheets as they appear along the coast, and secondly their size is determined by the area of land that each unit is represented on each sheet. However a number of minor adjustments were made to the size and extent of some units. Essentially this issue emerged during the compilation of the sequence of O. S. sheets for presentation in Appendix 1 and also in preparing the working document in Chapter 7 and sections of Chapter 8. Two tables were complied to elaborate on this issue. Table 5.6 lists the number of units present in each segment. Some segments are represented by a large number of units because they either have a long coastline (eg: rectilinear: Segments IX, X, XIV; embayed: Segments II, XI) and therefore consist of a large number of O.S. sheets. In the other segments where there are also a large number of units the reason is that there are sections of coast from opposite sides of the same narrow creek or bay represented on the same O.S. sheet and these sections are identified as separate units and listed in contiguous format as they appear on the coast. This sequence emerges in Chapter 7 and in Appendix 1.

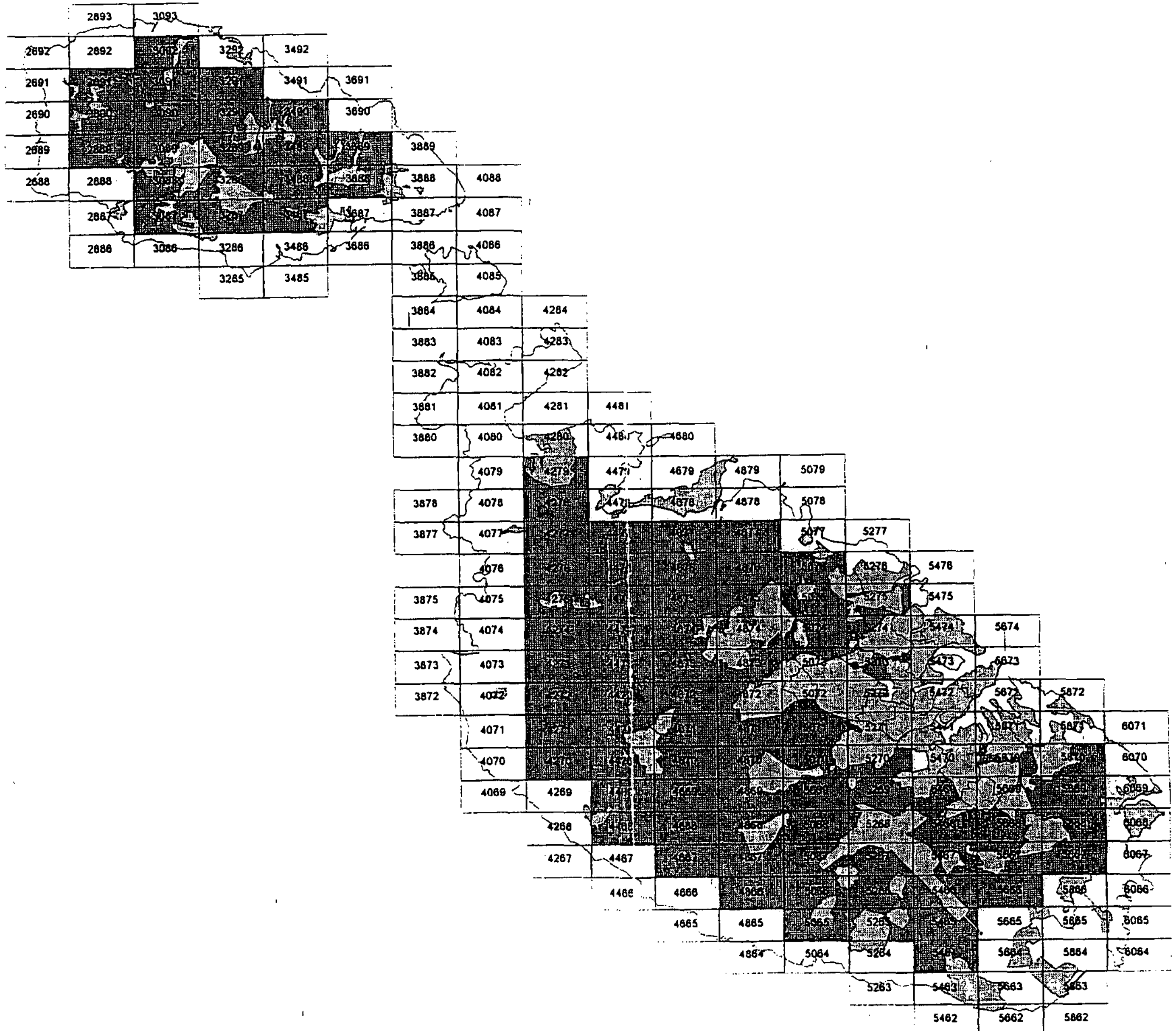


Figure 5.4 Map of the Maltese Islands showing location of O.S. sheets

Source: Compiled by author

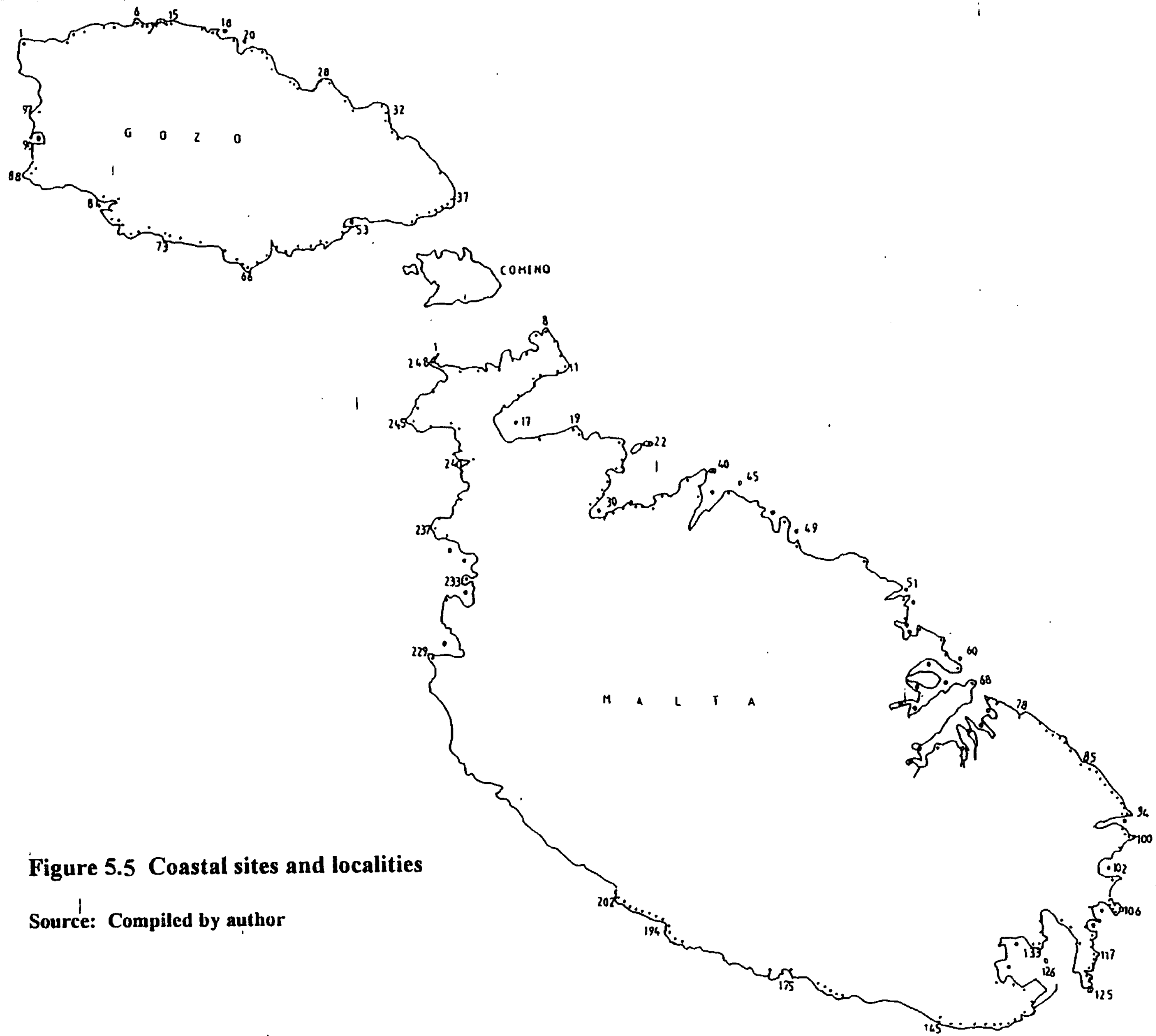


Figure 5.5 Coastal sites and localities

Source: Compiled by author

Sources: compiled by author from-
British Directorate of Overseas Surveys Series M 8910 (1971)
Works Department (1984 a); Works Department (1984 b);
Works Department (1984 c).

1. Ponta taċ-Ċirkewwa	46. Qalet Marku	91. Ghar id-Duhhan	136. It-Trunċiera tal-Hrieq	181. Denb il-Baghal	226. Il-Marġa	23. Ghajn Barrani	67. Ta' l-Ikbiex
2. Ir-Ramla ta' Wied Musa	47. Qrejten Point	92. Iż-Żellieqa	137. Ix-Xifer	182. Ras il-Hannija	227. Rdum tal-Vigarju	24. Rdum ta' Sekkek	68. Ghar Ilma
3. Ramla tal-Bir	48. Bahar iċ-Ċaghaq Bay	93. L-Ilsien	138. Benghisa Point	183. In-Neffiet	228. Il-Blata	25. Il-Geddum	69. Ta' Ċenċ
4. Ramla tal-Qortin	49. Il-Blata l-Bajda	94. Żonqor Point	139. St George's Bay	184. L-Ilsna	229. Ras ir-Raheb	26. Rdum ta' Sekkek	70. Tal-Hajt
5. Il-Bajja ta' l-Armier	50. Il-Ponta Irqieqa	95. Ghar ix-Xamn	140. Pretty Bay	185. Halq it-Tafal	230. Fomm ir-Rih Bay	27. Irdum tal-Marin	71. Iċ-Ċnus
6. Ramla tat-Torri	51. St George's Bay	96. Marsascala Bay	141. Wied ix-Xaqqa	186. Il-Mitqub	231. Ras il-Raheb	28. Rdum tar-Ramla	72. Il-Faqma
7. Dahlet ix-Xmajjar	52. Dragunara Point	97. Xifer iċ-Ċerna	142. Ghar Qirduna	187. Ghar Haxixa	232. Ġnejna Bay	29. Rdum ta' Venuta	73. Il-Pinnur
8. Ponta ta' l-Ahrax	53. Il-Qaliet	98. Il-Ponta ta' Barut	143. Ghar in-Naghaġ	188. Il-Maghlaq	233. Il-Qassaba	30. Irdum il-Kbir	74. Wied Marietta
9. Rdum l-Ahmar	54. Spinola Point	99. Il-Mitquba	144. Il-Mara	189. Ras Hanżir	234. Ghajn Tuffieha Bay	31. San Blas Bay	75. It-Toqba tal-Klieb
10. Rdum tal-Madonna	55. St Julian's Bay	100. Il-Gżira	145. Ghar Hasan	190. Ta' Bwieraq	235. Ramla tal-Mixquqa (Golden Bay)	31a Mistra Rocks	76. Wied tal-Kittienja
11. Dahlet ix-Xilep	56. Balluta Bay	101. Miġnuna Point	146. Blat il-Far	191. Ghar Lapsi	236. Rdum Majesa (Il-Mużżel tal-Majesa)	32. Ta' Ghajn Lembuba	77. Wied San Ġorġ
12. Il-Marbat	57. St Julian's Bay	102. St Thomas Bay	147. L-Antal	192. Ta' Bwieraq	237. Ras il-Wahx	33. Ghajn Berta	78. Il-Hotba
13. Rdum il-Hmar	58. Sliema Point	103. Il-Munxar	148. Minżel Spark	193. Hagra s-Sewda	238. Rdum Majesa	34 Irdum San Filep	79. Bajjada
14. Il-Parsott	59. Ghar id-Dud	104. Ponta tal-Griġal	149. Wied Żnuber	194. Bieb l-Gherien	239. Rdum id-Delli	35. Dahlet Qorrot	80. Tax-Xemx
15. Ta' l-Imgharraq	60. Il-Bajja ta' Ghar id-Dud	105. Ponta ta' fuq il-Maqjel	150. Il Blajta	195. Ix-Xaqqa	240. Il-Prajjet	36. Ghar Dorf	81. Id-Dawra ta' Sanap
16. Ghar Baqrat	61. Dragut Point	106. Xorb il-Ghaġin	151. Ta' Żghar	196. Is Sies L-Abjad	241. Ras in-Niexfa	37. Qala Point	82. Il-Kantra
17. Il-Bajja tal-Mellieha	62. Sliema Creek	107. Taht il-Maqjel	152. L-Arblu	197. Ix-Xaqqa	242. Iċ-Ċumnija	38. Ta' Bu Ghass	83. Ras il-Bajda
18. Ghajn Żejtuna	63. Lazzaretto Creek	108. Ponta tal-Hofra	153. L-Ghawejra	198. Ix Xwieki	243. Ġebel Imbark	39. Tal-Melh	84. Xlendi Bay
19. Ras il-Griebeġ	64. Msida Creek	109. It-Taqtiegha	154. L Iskolji	199. Ghar il Hamiem	244. Rdum il-Qammieh	40. Ġebel tal-Halfa	85. It-Tkiken
20. L-Imġiebah	65. Pietà Creek	110. Hofra l-Kbira	155. Wied Maqbol	200. Ghar it-Torkija	245. Qammieh Point	41. Iż-Żirka	86. Ghar ta' Santa Katarin
21. Blata l-Bajda	66. Marsamxett Harbour	111. Ras il-Fenek	156. L Iskoll ta' Sajjetta.	201. Miġra l Ilma	246. Rdum il-Qawwi	42. Tal-Blata	87. Ġebel Ben Ġorġ
22. Gżejjer Selmunett	67. Il-Fossa	112. Ras il-Fenek	157. Ghar it-Taraġ	202. Il Kullana	247. Ta' Qassisu (Rdum)	43. Il-Hnejja	88. Wardija Point
23. Rdum il-Bies	68. St Elmo Point	113. Hofra ż-Żghira	158. Ta' Melha	203. Rdum Hurrieqa	248. Ċirkewwa (Paradise Bay)	44. Tal-Ghassu	89. Id-Dejjaq
24. Ras il-Miġnuna	69. Il-Menqa (tal-Braken)	114. Ras il-Qala	159. Il-Hagra	204. Rdum Dikkiena	1. San Dimitri Point	45. Hondoq ir-Rummien Bay	90. Dwejra Bay
25. Il-Qala tal-Mistra	70. Marsa Creek	115. Kalanka tal-Qali	160. Wied Diegu	205. Rdum ta' Gidem	2. Tar-Rag	46. Barbaggiani Rock	91. Fungus Rock (Il-Ġebl. tal-Ġeneral
26. Rdum Rxawu	71. Ras Hanżir	116. Peter's Pool (Kalanka tat-Tumbell)	161. Ix-Xrajjek	206. Il-Hotba l-Bajda	3. Hekka Point	47. Ta' Bumbarin	92. Dwejra Point
27. Dahlet il-Fekruna	72. French Creek	117. Tumbell Point	162. Ta' Xordu	207. Rdum ta' Ghar Bittija	4. Ghar ix-Xih	48. Dahla taċ-Ċawl	1. Il-Bajja ta' San Niklaw
28 Rwawu Point	73. Dockyard Creek	118. Kalanka Fonda	163. Il-Borġ ta' Wied Fulija	208. Ghar Bittija	5. Pinu Point	49. Il-Ġebel taċ-Ċawl (taċ-Ċawl Rocks)	2. Il-Bajja ta' Santa Maria
29. Il-Bajja tal-Pwales	74. Kalkara Creek	119. Ghar Bella	164. Wied Fulija	209. Rdum Depiro	6. Forna Point	50. Ghar Minka	3. Iż-Żerżieqa
30. Rdum Stoppin	75. Rinella Creek (Bighi Bay)	120. Ponta tat-Tawwalija	165. Il-Kap ta' Wied Fulija	210. Rdum Dun Nazju	7. Ix-Xrick	51 .Il-Blata l-Bajda	4. Il-Hnejja
31. Tal-Kamp	76. Ricasoli Point	121. Il-Qala t-Tawwalija	166. Il-Minkba	211. Rdum ta' l-Ihfar	8. Is-Siġġu	52. Ramla taż-Żewwieqa	5. Il-Ponta l-Irqieqa
32. Ghajn Rasul	77. Wied Ghammieq	122. Ponta tal-Gidien	167. Il-Bajtra	212. Ta' Ġfien	9. Ghar ir-Rih	53. Mġarr Harbour	6. Il-Qala tal-Mazz
33. Ghar tal-Veċċja	78. Il-Kalanka tal-Patrijiet	123.Il-Kalanka tal-Gidien	168. Wied il-Bassasa	213. Tal-Gawwija	10. Ras iċ-Ċatta	54. Skoll ta' Ghasafar	7. Bejn il-Kmiemen
34. Ghajn Ghasfur	79. Tar-Ramel	124. Delimara Point	169. Ġebel Maqtugh	214. Rdum tal-Qaws	11. Ghar il-Qamh	55. Mellieha Point	8. Comminotto
35. Rdum tal-Mahruq	80. Taht il-Ġiebja	125. Taqtiegha ta' Delimara	170. Il-Hrejfa	215. Il-Qaws	12. Ras il-Kamun	56. Xatt l-Ahmar	1. Il-Bajja ta' San Niklaw
36. Qala ta' l-Ghażżellin	81. Ta' Talk	126. Marsaxlokk Bay	171. L-Ixmiex	216. Ix-Xaqlibi	13. Ghar il-Hdejda	57. Qala tal-Mikhal	2. Il-Bajja ta' Santa Marij:
37. Rdum l-Abjad	82. Tan-Nisa	127. Ras iċ-Ċaghaq	172. Id-Dahla	217. Ras id-Dawwara	14. Naghaġ il-Bahar	58. Ras il-Hobż	3. Iż-Żerżieqa
38. Ix-Xtajta ta' Buġibba	83. Tal-Qassisin	128. Taht it-Trunċiera	173. It-Trixija	218. Miġra Ferha	15. Reqqa Point	59. Ferrej Rock	4. Il-Hnejja
39. Ix-Xtajta tal-Qawra	84. Ras il-Ġebel	129. Ras it-Triq	174. Wied Babu	219. Ta' Hammud	16. Xineni Bay	60. Mġarr ix-Xini Bay	5. Il-Ponta l-Irqieqa
40. Il-Ponta tal-Qawra	85. Blata l-Bajda	130. Qrajten Point	175. Il-Hnejja (Blue Grotto)	220. Tal-Ferli	17. Qolla l-Bajda	61. Il-Ponta ta' l-Iskandlu	6. Il-Qala tal-Mazz
41. Ix-Xtajta tal-Qawra	86. Il-Golf tal-Blata l-Bajda	131. Il-Fossa	176. Wied Iż-Żurrieq	221. Ghar Dosan	18. Qbajjar Bay	62. Hagra s-Sewda	7. Bejn il-Kmiemen
42. Iċ-Ċens tal-Ġebel	87. Ġorf l-Abjad	132. Il-Ponta l-Kbira	177. Ras il-Bajjada	222. Miġra Ferha	19. Ponta ta' Santa Maria	63. Mġarr ix-Xini Bay	8. Cominotto
43. Port Bur-Marrad (Salina Bay)	88. Is-Swali	133. Tad-Debbra	178. Ghar ix-Xaghra	223. Il-Mina	20. Marsalforn Bay	64. Il-Kankra ta' Mġarr ix-Xini	
44. Ghallis Point	89. Il-Golf ta' Xuxetta	134. It-Trunċiera Ġewwenija	179. Ta' Bexxiexa	224. Rdum tas-Sarg	21. Ghar Qawqla	65. Ta' Bologna	
45. Ghallis Rocks	90. Sala Rock (L-iskoll ta' Sala)	135. Il-Hobra	180. Tal-Gawwija	225. Is-Sikka (tal-Frajna)	22. Rdum tas-Surgu	66. Ras in-Newwiela	

This situation is apparent in all three Harbours in Segments V and VIII and in areas where the bays and inlets were very narrow, such as St. Julian's Bay and Balluta (Segment IV). As the sequence of the coastal segments is a continuous one in that the end of a segment touches the beginning of the next one, so the sequence of coastal units forming each segment had to follow the same pattern. This subdivision was essentially a cartometric exercise where each coastal unit is presented as contiguous with the one preceding it and with the one following it irrespective of in which O.S. sheet the coastal unit was located. This problem would not have emerged had the level of the discussion stopped at Chapter 6, but with the requirements of the thesis and the felt need for detailed appraisal, the subdivision was thought to be ideal for the development of sections of Chapters 7 and 8.

To clarify this matter it entailed representing the O.S. sheet sequence in Appendix 1 as a series of four-digit figures some of which are duplicated. Table 5.6 gives a number of details pertaining to the coastal units in each segment. Adjacent units can have similar characteristics. In establishing the coastal units, the O.S. sequence was rigidly followed in areas where the coast shows rectilinear properties but in embayed zones this practice had to be occasionally modified. Table 5.7 presents these minor modifications and the criteria used in applying the changes. Essentially the need for this subdivision emerged only in the later part of this thesis. The identification numbers (1 to 136) of the coastal units with the O.S. numbering can be seen in the first two columns of Appendix 1. In addition, this numerical order for the identification of the coastal units was found convenient in the discussion in Chapter 8. Malta is covered in 112 coastal units, Gozo in 23 and Comino retained as one unit. Further detail is provided in Table 8.6 where data for the separate bays, harbours and inlets together with stretches of rectilinear coast are given. This table was found useful in comparing the general land use patterns between embayed and rectilinear parts of the coast.

The islands were also covered by three 1:25,000 sheets published in 1984. These maps are titled 'Malta East', 'Malta West' and a third covers 'Gozo' (Works Department, 1984a; 1984b; 1984c).The maps at 1: 25,000 were used to plot out my logistic strategy and the field mapping progress, and also to transfer data gathered from the larger scale maps. All of these editions were prepared by air photography in August 1968 by Hunting Surveys Ltd. with additional information supplied by the Office of the Public Works Department in Malta. Printing was done for the DOS by the Ordnance Survey. The choice of these maps was dictated by the level of detail presented in the maps. The 1968 series was superior to many of the versions published later. Further data was obtained from another set of 1: 2,500 sheets labeled as sketch

Table 5.6 Selected data for coastal units

Segment	Coastal Unit identification digits	Number of Coastal Units in segment	Per cent of total number of units
I	1-4	4	2.9
II	5-20	16	11.8
III	21-27	7	5.2
IV	28-36	7	6.6
V	37-56	20	14.7
VI	57-62	6	4.4
VII	63-68	6	4.4
VIII	69-77	9	6.6
IX	78-87	10	7.4
X	88-99	12	8.8
XI	100-112	13	9.6
XII	113	1	0.7
XIII	114-116	3	2.2
XIV	117-122	6	4.4
XV	123-131	9	6.6
XVI	132-136	5	3.7

Source: Compiled by author from Appendix 1

maps. These sketch maps highlight mainly the urban areas and also give street names, the extent of built-up areas, and also new road constructions and communication network changes. These maps are continuously being updated by the Drawing Office of the Department of Public Works and are readily available. These sketch maps were consulted throughout the survey, especially in areas where substantial changes were affected to the coastal area.

A key feature of the 1:2,500 scale sheets are the numbered lines along the horizontal and vertical axes showing northings and eastings. These were useful in estimating areas and measuring distances. Every sheet is overlain by a grid pattern of faint lines and each square corresponds to 10,000 m^2 (1 hectare) in area. The numbered grids were also used in fitting together adjacent quadrangles to form large continuous maps of the coastal areas.

The sheets also show geomorphological features such as steep slopes and cliffs. Contour intervals, at 2.5 metres, are represented in light brown and accentuated every 10 metres in a thicker and bolder maroon. These geomorphological features were ideal in correlating the type of land use to the slope of the coastal zone terrain, in fact the details presented on these sheets were of great help in identifying land uses in undeveloped areas. In addition, other coastal geomorphological details are represented accurately with boulder debris on scree slopes differentiated by size, position and shape. Coastal configuration is outlined precisely and this, together with large rocks, can be used for exact orientation in the field. A conversion table for metric to non-metric scale is included in the right hand margin. Other details of importance were found on the left hand corner of every map. These include the latitudinal and longitudinal degrees, seconds and minutes; buildings according to roof outline; and field boundaries were very accurately reproduced. The latter helped greatly in orientation in unbuilt areas. Representation ends at the shoreline.

The choice of maps for the field survey was conditioned by a number of factors that were in turn controlled by the cartographic options available. The features required to map out land uses accurately were well represented on the map: a clear shoreline margin, accurate contour identification and precise geomorphological representation were the main attributes; and field boundaries aided further the mapping exercise. Sheets with scales of 1:25,000 and 1: 2,500 scales were used. For the actual field mapping, the 1:2,500 scale maps were used with a second set used to transfer the detailed representation of the land uses. The 1:25,000 were used to compile, group and synthesize the detailed survey results. As the sheets used were dated, having been produced about 15 to 20 years previously, new built-up areas and any changes to the coastline from the construction of jetties, promenades to main rock falls or changes to sand beaches were marked to the base map.

Table 5.7: Cartometric adjustments to coastal survey sheet series

Coastal Segments	Coastal Units	Ordnance Sheet Survey Number	Locality	Criteria used
II	5	4283, 4282,4281	Mellieha Bay	same orientation facing south
II XI	6 109	4081 4081	Mellieha Bay Dahlet il-Prajjiet	same survey sheet covering the narrow neck of north Malta with bays facing opposing directions
II XI	7 109	4080 4080	Mellieha Bay Dahlet il-Prajjiet	same survey sheet covering the narrow neck of north Malta with bays facing opposing directions
II	9	4480,4680	Selmunette	to include St. Paul's islands in same coastal unit
II, III	16,19,20	4878	Coast Road	three separate units on same sheet which are not contiguous, separated with other units to obtain contiguity
III	22,23	5078	Qalet Marku	to isolate Qalet Marku peninsula
III IV	26 29	5276 5276	Dragonara peninsula St. George's Bay	survey sheet shows boundary between segments inner part of St. George's Bay
IV	28,31	5476	St. George's Bay	parts of same sheet used for different units due to embayment of coast, separated with other units to obtain contiguity
IV	33,35	5474	St. Julian's Bay	parts of same sheet used for different units due to embayment of coast, separated with other units to obtain contiguity
V	36-42 43-55	various sheets various sheets	Marsamxett Harbour. Grand Harbour	twenty units were identified, and the two harbours were separated. Details of the sheets and coastal units are in Appendix 1
VI	57,58	5872	Ricasoli Xaghajra	two units on same sheet to separate the two localities
VI,VII	62,63	6069	Zonqor Point	sheet falls at change of segments
VII, VIII	67,70	6065	Il-Kalanka tat-Tumbrell and ta' l-Inginier	two sites in opposing orientation and different segments
VII,VIII	68,69	6064	Delimara Point	same sheet at intersection of two segments, and drastic change in orientation
VIII	71,73	5865	Marsaxlokk Bay	parts of same sheet used for different units due to embayment of coast, separated with one other unit to obtain contiguity
VIII	76	5864, 5664	Container Terminal and Pretty Bay	included in same unit
IX	79	5662, 5462		a very small area in 5662 included with 5462
X	101	3874,4074	Fomm ir-Rih	a very small area in 3874 included with 4074
XI	102	4075, 3875	Gnejna Bay	peninsula and bay included in same unit for Bay
XI	105	3877, 3878	Ras il-Wahx	whole peninsula included in same unit
XII	113	3886, 4086	Comino	whole island included in same unit
XIV	118	3482, 3491	Marsalforn Bay	only change to Gozo coast, to include bay in one unit

Source: Compiled by author during cartometric estimates and from field experience

Areas where competing land uses were located over a small geographic space were initially field mapped at 1: 1,250 or even at 1: 675 scale. However the presentation of the results was done at the 1: 2,500, 1: 25,000 scale and, for a general overview picture where a map of the island of Malta fitted into an A3 size paper, the scale used was of the order of about 1: 120,000. Synoptic maps produced are shown in their relevant sections in the next chapter.

5.10 Geology maps

Other maps and charts were used to complement the main survey sheets. For geological information the map of the Geological Survey of the Maltese Islands produced by the British Petroleum Company Limited in 1954 at a scale of 1: 31,680 and the Geological Map of the Maltese Islands (Oil Exploration Directorate, 1992) at a scale of 1:25,000 suited the purposes well. The representation of the main rock types together with the precise position of discontinuities were of great help, even in areas where many different outcrops occurred in a limited area.

5.11 Pedology maps

Pedological information was important to the extent that soils washed down to the coastal area could be identified. However field reference to the Soil Map of Malta and Gozo, published by the Directorate of Overseas Surveys in 1960 and printed by the Ordnance Survey at a scale of 1: 31,680, was the only source that could be used. Reference to the soil type was only included in marginal field notes and did not feature in the report of survey or in this work. However Quaternary soil deposits found at three coastal locations in Malta were identified from the Geological map published in 1992 by the Oil Exploration Division.

5.12 The selection process of the land use categories and the mapping key

The spatial aim of this thesis has always been the appraisal of the whole littoral of the Maltese Islands. However, a number of studies were conducted over the study period with three main purposes in mind: (i) for the identification of the categories that would ultimately have to be the representatives of the land uses in the surveys; (ii) to develop a mapping symbolization key; and (iii) for experience to be gained in interpreting visually the coastal landscape. For the first purpose cited above the number of land uses that the author settled for were 16 that were used for the 1998 survey. However, for the purposes of this thesis, the sections that follow review the different surveys done to fine-tune these 16 land use categories. Therefore the chapter sections include the land uses identified for the pilot survey (Section 5.12.2 and Table 5.8), the land uses utilized for the 1989 summer survey (Section 5.12.3 and Tables 5.9 and 5.10), and the land uses deployed for this thesis (Section 5.12.4 and Table 5.11). The different number of land uses employed to map the coast reflect the on-going experimentation that was underway throughout this period.

5.12.1 Preliminary observations, winter 1988

The preliminary observations during the winter of 1988 took the form of coastal walks along the eastern Malta coastline as this was rather more accessible than other areas due to its low sloping nature. The cartographic results produced by the author from these initial exercises consisted of field sketches that mainly identified shoreline features using a broad brush approach with land use categories kept to a minimum. For example, no differentiation was made to separate the various elements making up the land that remained undeveloped. Human impact was mainly differentiated on the basis of the cultural uses (industrial, recreational, residential and historical) and undeveloped areas (agricultural and areas left in their natural state). An attempt was also made to define the extent inland to which mapping should take place. However a simple key to symbolize the land uses was also developed towards the end of the winter period as a result of the experience gained in looking at the coast. This key is shown in Appendix 5. The main problem with the symbols shown rested with the mapping scale and detail to which the land uses and other features were to be represented. For small scales and detailed identification of coastal features the key was confusing, as was to be realized later with the mapping at Bahar-ic-Caghaq (Figure 5.6). However, it was a healthy exercise in that the mapping scale was put into better perspective and confidence in the identification of most coastal features was gained. The number of land use categories utilized was not quantified.

5.12.2 The pilot study, Spring 1989

The second attempt at evaluating the coastal land use features was completed in the spring of 1989 where three days were devoted to mapping three different coastal environments. This exercise was done by Professor Ewan Anderson and myself primarily to organise sites, materials and mapping prior to the pilot study itself especially as the latter would involve a substantial amount of organization. Briefing a small team of mappers for the Coastal Zone Survey later on in the summer also required an element of experience to be passed on.

The cartographic results of the Pilot Survey are shown illustrated in Figures 5.6, 5.7 and 5.8. The sites mapped were:

I. Bahar ic-Caghaq area: selected so as to link with the work done a few months previously during the winter of 1988;
II. Pretty Bay, Birzebbugia: selected due to personal experience and the knowledge that as the area was slowly being influenced by the industrialization of a container terminal. Continuous monitoring of this site was planned to be a regular feature.
III. Rdum ta Gidem: selected due to its lack of accessibility: this presented a land use facet with agriculture and slope screes being the main categories ;

In addition to the land use, cartographic interpretation of three different sites was reproduced using different symbolization, including colour differentiation. Thus for Figure 5.6 of the Bahar-ic-Caghaq area, letter symbols formed the basis of the land use identification. However this method was very detailed, identifying very small patches of land use as small as $25m^2$. The system can be applied successfully to a small area, however it would not be advisable to map the whole coast of the Maltese Islands using this method. The clutter of symbols dotting the littoral is not aesthetic in the cartographic sense and can also be confusing. In addition, it is impossible to synthesize the material from the 1:2,500 to the 1:25,000 scale. The end result of this was that a different set of symbols were developed to help in the identification and symbolization of small parcels of land uses that were clustered into small areas. This system is reproduced in Appendix 5.

Figure 5.7 for the Birzebbugia area was an exercise in differentiating land uses by colour. Here again costs for producing the whole coast of the Maltese Islands by this method was inhibiting. However, the end result was one that produced a very neat map and in all probability was crucial in the award of the contract for the Coastal Land Use Survey. The Department of Geography at the University of Durham was of valuable assistance in producing the final maps.

In the Rdum ta Gidem area a method of map overlays was proposed. In Figure 5.8 the results of the overlayed maps are reproduced as one figure. This method had a basic aim of including a number of physical features on which the anthropogenic (human induced) ones were superimposed. Again, as with Figure 5.6, this method was good for small areas, but the costs of producing the overlayed cartography for the whole coastline would have been very expensive to produce and the expertise was not available locally.

The three areas mapped covered most of the land use elements of the coast and as only one method had to be used for the field mapping exercise of the Coastal Land Use Survey the pilot study was the basis used in the discussions that helped evolve the mapping system. Although the aim of the Pilot Survey was to produce detailed maps of the main variables for about 10 per cent of the coastline of Malta, it was more an exercise in testing the methodology and the identification of any mapping problems. The main approach was by observation, collection of material and discussion. Orientation and slope angles were measured by field compass and clinometer. The main element that emerged from this brief was that a number of land use categories and a number of sub-categories were proposed. In general, a fairly good idea of the nature of the coast was obtained.

Although the survey did not cover the full extent of the coast, more categories were added to the ones observed on the three sites, partly on the basis of the Winter Survey and on the further experience gained. These are listed in Table 5.8 and include ten main land use categories, having in total 46 attributes. The attributes were essentially the land use features that make up the coastal resources in the ten main categories listed. The main categories were spatially larger in area than the sub-categories.

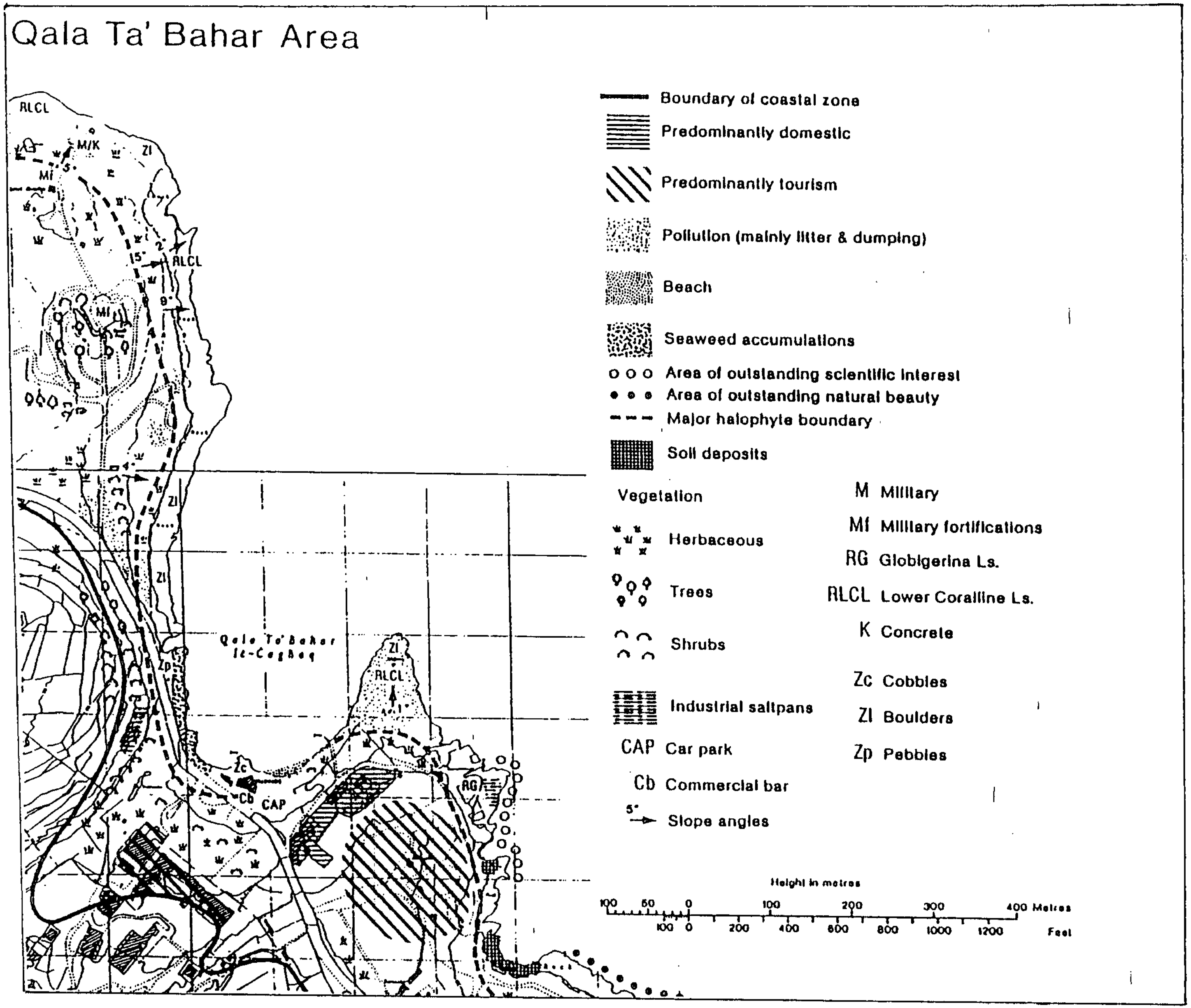


Figure 5.3 Baħar iċ-Ċagħaq

Source: Anderson and Schembri, J.A (1989)

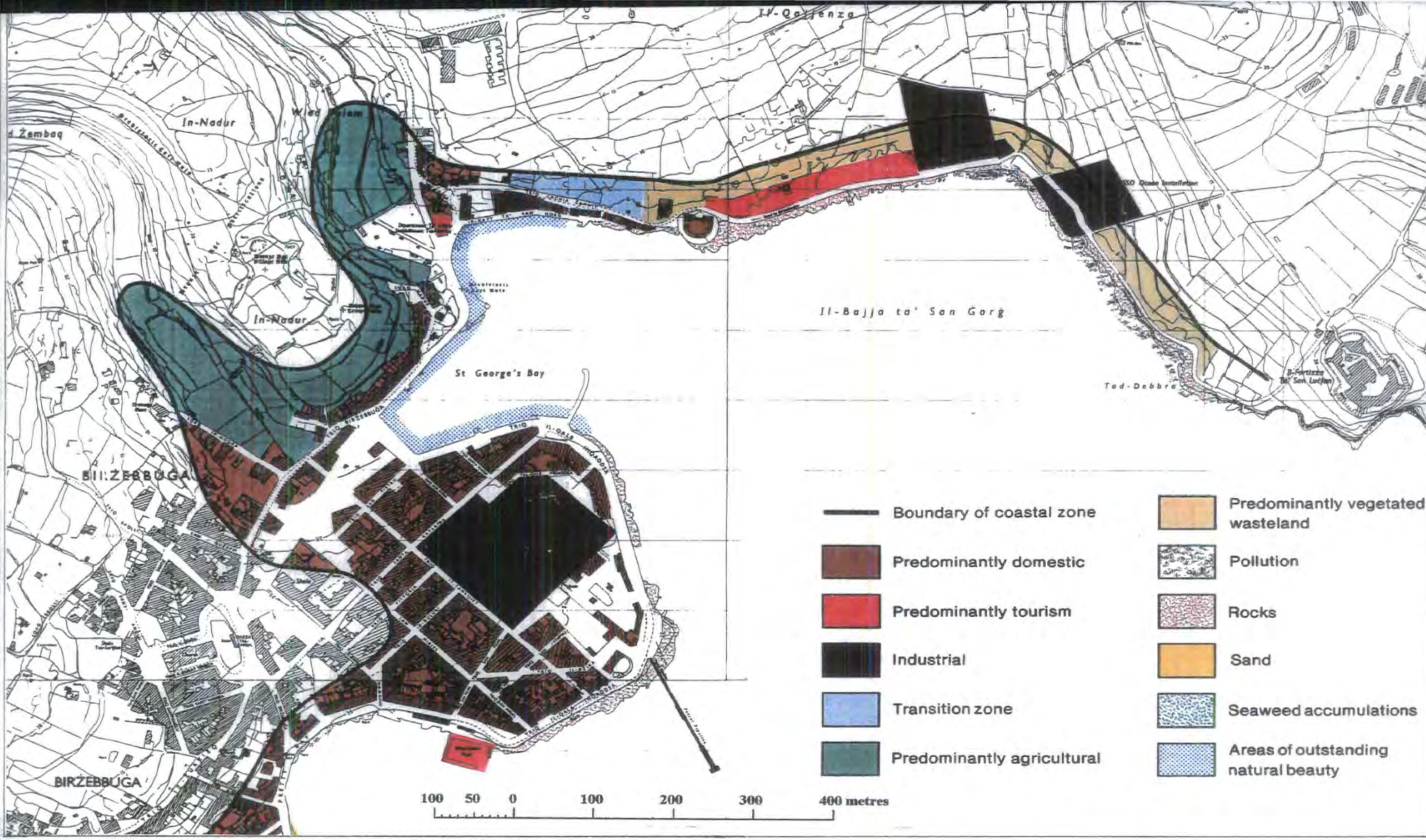


Figure 5.7 Malta, Birżebbuġa: representation of landuses by colour coding

Source: Anderson and Schembri, J.A (1989)

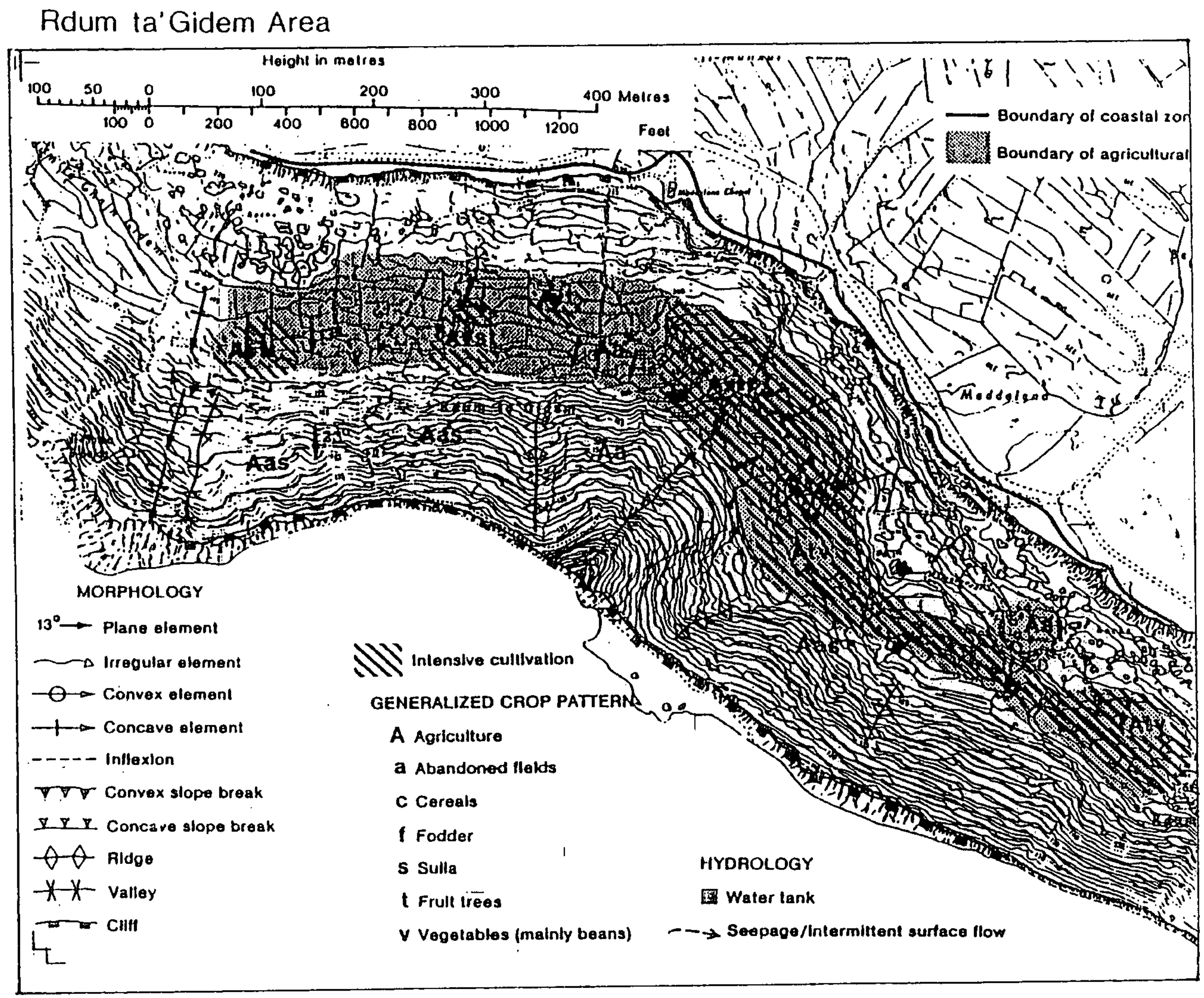


Figure 5.8 Rdum ta' Gidem Area

Source: Anderson and Schembri, J.A (1989)

5.12.3 The Coastal Zone Survey, summer 1989

The end result of the spring survey was that a brief was compiled to be distributed to the participants of the summer land use survey. The list of participants is detailed in Figure 1.1 and included the Director of the Survey, Professor (then Dr.) Ewan Anderson, myself, Professor (then Dr.) Gerald Blake, eight University students, four from Malta and four from Durham, essentially these eleven geographers formed the mapping team. Professor (then Dr.) Patrick Schembri and Edwin Lanfranco as consultants from the University of Malta and a number of administrative assistants from the Town Planning Department (as the Malta Environment and Planning Authority was known then). Further changes were made to the main key to be used for the Coastal Zone Survey of the summer of 1989. In all eight main land use categories and 28 sub-categories were provided in the brief. These are summarized in Table 5.9. As the list of categories was shortened, an overlap of land uses emerged. In these cases the predominant use was selected. The criteria used in identification of the land uses is reviewed in this chapter but the main cartographic identifying features were hatching and colour-coding (Table 5.10).

Site selection for the summer 1989 survey posed no problems as the whole littoral length of the Islands was to be mapped. However, the extent to be mapped inland was a feature that emerged in the follow-up discussions to the pilot survey. In section 1.3 of the thesis this issue is discussed but the emerging problem was that the whole littoral would not have a standard fixed cut-off line that is distance-related from the coast but a line that winds its way along physical or anthropogenic features. This line in general is one that is parallel to the shoreline. This situation is similar to studies carried out in a number of countries and shown in Tables 5.1 and 5.2. As a result, the main output was the production of 100 colour-coded maps (cf. Section 1.1) at a scale of 1:2,500, now held by the Planning Authority. Table 5.10 gives the list of categories the identifying features for each category and the colour coding used in the final mapping that was presented. In addition, twelve synoptic charts were also produced. These were drawn at a scale of 1:25,000, six representing Malta and six showing Gozo. These dealt with tourism, accessibility, vegetation, pollution, industry, economic and historical features.

Mapping and identifying coastal features is an exercise that calls for effective cartographic representation. The major land use categories that include within them all of the coastal elements have to be properly distinguished from one another. Colour was therefore important in presenting the data effectively. Besides enhancing the display, colour adds visual interest, increases contrast and may evoke a stimulus or response in the map reader (Robinson *et. al*, 1984). As the maps drawn are later to be used by coastal planners and managers, attention was paid to create combinations that did not mislead the data interpretation, make unnecessary contrasts or highlight unimportant features. Thus it was thought to be important to create a continuous graphic communication between the cartographer and map reader by enhancing visual interest. As each land use category utilized one specific colour it was important to first identify the aesthetic reactions aroused by different colours, reactions which connote concepts (Robinson *et. al*, 1984). For example vegetation was coloured green and maritime functions in blue. The hues employed in demarcating one category from another tallied with the Robinson *et al* (1984, 163) classification as follows:

- Red for tourism - being an important dimension in coastal development all tourists facilities have to be marked as important;
- blue for maritime functions - conventional use;
- green for vegetated areas - conventional use;
- yellow - paucity of vegetation - shore;
- orange - open land;
- brown - agriculture;
- black - pollution;
- mauve - services;
- purple - industry
- purple with dot pattern - historical.

Furthermore, domestic buildings were left uncoloured as the thin black lines marking them did not in any way interfere with the colours used. In addition, to broaden the colour spectrum the colours described above were also enhanced with a line or dot pattern to represent each of the 26 land use elements individually. These details are given in Tables 5.9 and 5.10.

An exercise of these dimensions, mapping land use on a scale of 1: 2,500 covering an area of about 19 km^2, could not have been performed single-handed for a number of reasons. A "snapshot" of the coastal situation was needed as a good base for the study *per se* and to provide a strong basis for future updates; and, the time span for mapping had to be short and the survey performed during the peak-use season. The reason is that a number of mobile kiosks and other features associated with the swimming season occupy the coast. A summer survey was also necessary as it is during this season that a high degree of use was made of the coast and it was important to assess as many coastal land use variables as possible. In addition, the involvement of Geography student groups from Durham and Malta Universities constrained the survey period to the summer vacation. Geography undergraduates from Durham had to be made familiar with the local environment. This was facilitated by the Durham Geography Department's 15-day field class in Malta the previous April.

On the other hand, the preliminary development of methodology can be performed either singly or in a team of two. The latter brings out on-site discussions and is probably the most important component in the exercise. Only the main land use exercise of 1989 utilized more than two people at the same time.

The main problems that emerged as a result of the successive mapping stages was that a uniform mapping key and symbols were not developed, consequently land use measurement and interpretation suffered. Therefore this lack of uniformity was ironed out with the production of three maps for Malta and three for Gozo and Comino giving a synoptic view of coastal land uses. These are shown in Chapter 1. They were used to produce a paper to mark the completion of the survey and to highlight the problems faced at the coast in Malta (Anderson and Schembri, 1990).

Table 5.8 Land use categories identified in the Pilot Survey

1. Residential permanent temporary 2. Commercial Services retail office hotel mobile kiosk bar 3. Industrial light heavy under construction extractive 4. Land-based transportation car parks roads promenades bus terminus bus stop 5. Institutional religious educational entertainment military	6. Sea-based Transport boathouses hangers slipways boatways marinas jetty port 7. Communications and utilities electrical power broadcasting water supply sewage pipeline 8. Recreational swimming fishing entertainment boating hunting trapping camping sites clubs 9. Special interest historical scenic ecological agricultural 10. Undeveloped land bare rock scree slopes shore platforms

Source: compiled from results of 1989 Pilot Survey

Table 5.9 Land Use Categories identified in the summer 1989 survey

RECREATION 1. Tourist buildings 2. Transient tourism 3. Areas of tourist use 4. Boathouses 5. Maritime activities 6. Services/Recreation	UNDEVELOPED AREAS 1. Unvegetated coastal rock 2. Coastal rock platform 3. Open land : garrigue - steppe maritime vegetation 4. Open land : rupestral - rdum vegetation
VEGETATION 1. Vegetation	AGRICULTURE 1. Land in use 2. Land abandoned
LAND UNDER DEVELOPMENT 1. Urban wasteland 2. Transitional land 3. New construction 4. Dumping: building rubble 5. Dumping: domestic 6. Oil pollution	INDUSTRY 1. Industry: primary 2. Industry: secondary and tertiary
RESIDENTIAL 1. Domestic buildings 2. Retail/Commercial: non-tourist 3. Military/Historical/Archaeological	OTHER USES 1. Beach: sand/silt 2. Beach: shingle 3. Widien 4. Soil deposits

Source: Compiled by E.W. Anderson and author from 1989 Pilot survey and for use in the main1989 survey

Table 5.10: Main details from 1:2,500 scale maps for Malta and Gozo

Land Use Categories	Identifying Factors	Colour Code
Tourism	Tourist buildings (hotels, guest houses, bars, cafe, multi-use building with a tourist component) - striped pattern; transient tourism (caravan and camping sites) - dot pattern; areas of tourist use (car parks) - coloured in	Red
Maritime Functions	Boathouses (buildings with large predominant front doors and usually no windows - striped pattern Maritime activities (jetties, slipways, harbours and boat houses) - no particular pattern, colour enhancement of straight coastline	Blue
Vegetated Areas	Vegetated patches of landscape significance (trees, shrubs or plants of similar size which remain green throughout the year) - striped pattern	Green
Accessible Shore	Beach: sand/silt – coloured in Beach: shingle – dot pattern Unvegetated coastal rock - line pattern Coastal rock platform - cross-form pattern	Yellow
Open Land	Natural landscape: Garrigue: steppe maritime vegetation - dot pattern Rupestral Rdum vegetation (depending upon soil and shelter) - double dot pattern Valleys - arrow in direction of water flow Man-made landscape: Urban wasteland - striped pattern Transitional land - coloured in	Orange
Agriculture	currently in use- striped pattern abandoned - dot pattern soil deposits - coloured in	Brown
Pollution	rubble dumping - dot pattern domestic dumping - striped pattern new constructions - dot and line pattern oil pollution - coloured in seaweed banquettes - striped pattern (angular)	Black
Services	retail and commercial - striped pattern recreation - coloured in	Mauve
Industry	primary (quarries, salt pans0 - striped pattern secondary (manufacturing, ship repair) - cross form pattern	Purple
Historical	Historical (military, historical or archaeological) placed in some category as they occur in apparently small discreet areas except in Grand Harbour, but distinguished on the maps - dot pattern	Purple with dot pattern
Domestic	Domestic buildings were left unimproved on the base maps	unimproved

Source: developed by author based on mapping results of the 1989 Coastal Zone Survey

5.12.4 The 1998 coastal survey

The 1998 mapping for this thesis involved using a monochrome copy of the 1989 mapping as a guide during the survey and modifying the mapping using the 16 land use categories but retaining the same coastal zone boundary. The land use mapping was done with a charcoal pencil using the lower case lettering (a-p) throughout (refer to Table 5.11). The main changes observed were in the urban coastal areas. The introduction of the dilapidated areas category helped to smooth out problems in distinguishing between transitional, waste land and new building construction. Recreational areas were also grouped into two instead of six categories as tourist buildings, the services associated with the tourism industry and recreational areas having maritime activities are all generally found near one another serving the same needs of recreation, thus separate identification was not needed. The identification of the land uses in the undeveloped areas category was greatly helped with the contour pattern on the O.S. sheets with the density and spacing between the contour lines being an indicative factor and the geomorphological representation of cliffs and scree slopes indicated in the key to the O.S. sheets. A dense contour pattern generally identified abandoned agricultural land as some slopes were rather steep to retain soil, and in other cases field sizes were generally very small to permit a viable harvest, the introduction of machinery and the transport of products to the market. All the changes made were primarily done to cut down on the number of land uses that were mapped separately and whose final linear dimensions in the 1989 survey were rather small and had little bearing on the overall results. In addition, representing minute features on the synoptic maps in this thesis would have been impossible. Effectively the changes made provided a smoother representation of the land uses both cartographically and in the data presented in the tables. However, one main change was that the land use results obtained were represented in a spatial format (hectares) rather than in linear units and attention was paid to avoid giving figures with overlapping land uses and probably mislead the reader of this thesis, as is evident from Table 1.1.

In addition, a modified key with different symbols and changes to the land use variables was developed for the 1998 Coastal Land Use Survey. This is shown in Table 5.11. Thus, problems of uniformity in interpretation of the coastal land uses were eliminated and a new set of measurements was developed. However it must be stressed that, were it not for the experience gained in the successive mapping exercises and surveys, the final result would not have been so succinct. In the final presentation of the results in this thesis, and including the changes affected as a result of the land use changes, the land use categories were kept to a maximum of sixteen for the sake of an efficient presentation of the discussion. These are summarized in Table 5.11 and include the cartographic key to the symbols given and which form the basis of the discussion in the next section.

In addition, between April and May 2003, an assessment of changes to selected coastal localities was made by the author. These included mainly changes to the coastal urban areas made since the 1998 survey and took into consideration the proposals made by the MEPA in the various Draft Local Plans for Public Consultation, Reports of Survey and Local Plans. Various issues from the Times [of Malta] helped to identify particular sites where changes were occurring or proposals for development were being made, and in some cases also provided a literary source to substantiate field observations. The results of these changes are developed in the conclusion to Chapter 7.

5.13 Cartometric method

Cartometry, has been defined by the International Cartographic Association as the measurement and calculation of numerical values from maps. Maling (1988) identifies measurements of distance, area, direction, and counting the numbers of objects shown on maps as the four basic kinds of techniques in cartometry. Although a number of sophisticated methods for the actual estimation of areas are available, the method proposed by Sauvain (1990) was used for the purposes of this thesis, using a transparent copy of millimetric graph paper where 1cm = 10 divisions and $1cm^2$ = 100 divisions, superimposed on the 1:2,500 scale maps where each cm^2 (100 divisions) represented $625m^2$ one small square ($1mm^2$) equalled $6.25m^2$. The method used in estimating the land use for each of the 16 categories on every sheet was by adding up the results of a, b and c below:

a) the number of complete centimetre squares under the transparent grid;

b) the number of complete millimetric squares;

c) the number of incomplete small (m) squares to the nearest 0.75, 0.50 or 0.25.

The results were entered into a matrix denoting the sixteen land use categories on the horizontal line and sheet numbers on the vertical line. Thus the complete quantitative land use situation was identified. The values were then converted into hectares. Each value represented the cumulative total for that particular land use found on one coastal unit on one O.S. sheet. In addition, cumulative totals for each land use in each segment and the total area of all the land uses in each unit are also given, together with the cumulative value of the total area of coastal zone for each segment. All the results are shown in Appendix 1.

5.14 Data reduction

The data gathered from the field was calculated in square metres, resulting in an unwieldy data base. So as to achieve an efficient discussion, the data gathered from the field was modified by a process known as "data reduction". This consists of a number of steps to compact the data and, in the first place, make it easier to be followed. In fact, data reduction is one of the preliminary methods suggested by Ehenberg (1982) and O'Brien (1992) as a method to be followed prior to analysis. Essentially this involved two stages:

(a) the 100 survey sheets were organized into 16 coastal segments; and

(b) the area for each land use category was converted into hectares (cf. Appendix 1)

This data reduction gave the opportunity to reduce the data further through successive stages and provide areal measurements for compacting the 16 land use categories into eight and successively into data for each island (Malta, Gozo and Comino separately) and finally into data representing the Maltese Islands as a whole group. In fact the discussion in the next chapter follows the results obtained through the data reduction method where the data is examined through a sequence of spatial scales starting from that of the Maltese Islands, then tackling each island separately before the analysis of each segment.

Table 5.11 Main land use categories, sub-categories and principal features and utilities used in the identification of the land uses, with respective symbols. 1998 coastal survey

Symbol (Upper case)	Main category land uses	Symbol (lower case)	Sub-category land uses	Principal features and utilities used to identify the main and sub-category land uses
A	Recreational areas	a	tourism	hotels, holiday flats, beach concessions, catering establishments
		b	marine servicing areas	jetties, breakwaters, slipways, boathouses, ferry and cruise liner facilities, yacht marinas, boat parking facilities
B	Residential areas, roads and historical sites	c	residential areas	buildings for residential use
		d	public utilities (Roads, promenades)	roads, promenades (walkways), pedestrian zones, pavements, vehicle parking facilities and other infrastructure facilities evident at ground level
		e	historical sites	notably coastal defences (towers, forts, bastions, batteries, redoubts, pill boxes), sites with archaeological remains and buildings of historical importance
C	Extractive and industrial areas	f	extractive Industries	reverse osmosis plants, salt producing areas.
		g	industrial areas	marine servicing industries, power stations, fuel storage and distribution depots
D	Depositional environments	h	depositional environments	sand beaches, sand dunes, salt marshes, fresh water springs, areas of ecological importance.
E	Afforestation areas	i	afforested areas	trees and vegetation planted by men
F	Arable land	j	agriculture areas: in use	agricultural areas under cultivation or identified as temporarily fallow
		k	agricultural areas: abandoned	abandoned agricultural areas
G	Undeveloped land	l	shore platforms	predominantly Globigerina limestone shoreline with smooth surface, unvegetated
		m	low sloping rock	predominantly Coralline limestone shoreline with pitted surface, sparse garigue vegetation
		n	cliffs and steep slopes	steep rock faces and cliffs
		o	scree slope areas 'rdum'	boulder fields, rupestral vegetation
H	Dilapidated areas	p	dilapidated areas	rubbish dumps, spoil from building industry, on-going infrastructure works, unused urban areas

Source: Compiled by author

In order to interpret the different number of land uses identified for each survey (Pilot, 1989 and 1998) and group the information present in Tables 5.9 and 5.11, Table 5.12 was compiled. This shows how the number of land uses was rationalized so as to simplify mapping and interpretation. Thus, the recreational areas in the third column represents tourism and marine servicing areas in column two and the six land uses in column 1 i.e., tourist buildings, transient tourism, areas of tourist use, boathouses, maritime activity and services/recreation. The same process applies for the other rows.

Table 5.12: Scheme showing grouping of land uses

Land Use Categories (28) identified in the summer 1989 survey (cf. Table 5.9) used in Section 5.12.3 only	**Land use categories (16) identified in 1998 Survey (cf. Table 5.11 Columns 2 and 3) Used in Sections 6.3 to 6.15**	**Synoptic grouping of the land uses into eight land use categories. Used in Section 6.2 only**
Tourist buildings Transient tourism Areas of tourist use Boathouses Maritime activity Services/recreation	Tourism (a) Marine servicing areas (b)	Recreational areas (A)
Domestic buildings Retail/commercial Military/historical/archaeological	Residential areas (c) Public utilities (d) Historical sites (e)	Residential areas, roads and historical sites (B)
Industrial areas: Light Heavy Under construction Extractive	Extractive industries (f) Industrial areas (g)	Extractive and industrial areas (C)
Beach: sand/silt Beach: shingle Widien Soil deposits	Depositional Environments (h)	Depositional Environments (D)
Vegetation	Afforested areas (i)	Afforested areas (E)
Agriculture: land in use Agriculture: land abandoned	Agriculture: land in use (j) Agriculture: land abandoned (k)	Arable Land (F)
Unvegetated coastal rock Coastal rock platform Open land;garrigue, steppe maritime vegetation Open land: rupestral *rdum* vegetation	Shore platform (l) Low sloping rock (m) Cliffs and steep slopes (n) Scree slopes (*rdum*) (o)	Undeveloped land (G)
Urban wasteland Transitional land New constructions Dumping;building material Dumping:domestic Oil pollution	Dilapidated areas (p)	Dilapidated areas (H)

Source: compiled by author from Tables 5.9 and 5.11

Key (a) indicates lower-case land use symbol
(A) indicates upper-case land use symbol

5.16 Conclusion

The methodological and cartographic techniques employed and the refinements made to the mapping key over successive exercises were the result of experience gained over a number of years of teaching at the University of Malta, conducting field sessions for local and foreign students (students from the University of Durham included), and coastal field sessions to the International Ocean Institute's Coastal Zone Management Programme. All of the above gave me extensive experience on the terrestrial side of the coastal zone of the Maltese Islands. Thus mapping and the necessary cartometric measurements could be performed with a fair degree of accuracy. The discussion that follows in Chapter 6 is the result of extensive field studies, detailed mapping, accurate cartographic representation and precise cartometric measurements. These led to the values presented being based completely on raw data. The new set of calculations was based on the areal unit of the hectare, and each land use category was identified separately from the rest with no over-lapping between land uses. Again, measurements were made to suit the researcher and the needs of this thesis.

Chapter 6 Coastal land uses: description and discussion

6.1 Introduction

The data reduction exercise described in the previous chapter enables the presentation of the data in this chapter in increasing detail both for the land uses (categories), and locations (segments). The reason behind this method puts a strong base for the discussion and analysis and does justice to the detailed surveying, mapping and cartometric measurements made. This method of analysis first gives an overview of the coastal land use distribution in the Maltese Islands as a complete archipelago, to give a general view of the archipelago, secondly to show the differences in the coastal land use between the separate islands from the aspect of each individual island, namely, Malta, Gozo, and Comino separately, and finally land use is examined for each of the 16 segments individually so as to provide a strong base for the discussion and analysis and to do justice to the detailed surveying, mapping and cartometric measurements made. This ensures that the coastal land use in the Maltese Islands is examined in detail. In addition Appendix 1 shows the further subdivision of each segment into a number of coastal units, adding to the detail of the coastal land uses. The 16 segments are divided into 136 coastal units, these are discussed in Chapter 7. The coast of the Maltese Islands features on 100 of the 172 Ordnance Survey sheets that make up the whole archipelago: 73 for Malta, 23 for Gozo and two for Comino. The data as presented in the thesis, follows the sequence of the segments as given by the sheets in the Ordnance Survey series.

In this thesis on land use in the coastal zone of the Maltese Islands the discussion and analysis are based on the data gathered from the field, with the main data-base presented in hectares. Elaboration of this data is given as a ratio in the form of percentage values where particular land uses need to be put into the perspective of a wider geographical setting. Thus most of the data is presented consistently in the same format throughout this chapter and it is made up of two sets: the raw values in hectares, and the corresponding ratios in percentages. Two main elements are represented: the quantitative, which is the raw data as presented in hectares and, secondly, the qualitative, which is represented by the different land use categories. There are three broad sections in this chapter:

(a) introduction to the Maltese Islands, where a general view of the coastal land uses is provided;

(b) description and discussion of each land use category as distributed in the Segments making up the coastal zone. There are nine sections in this part of the chapter, with each of the first eight sections consisting of seven parts each. The particular land use is described in the first four parts along the following lines: introduction, background information, justification of the study, and the fourth part providing definitions of the particular land-use category. The final three parts in each section provides a framework for discussion of the raw land use data in the ensuing pattern: presentation of the data, discussion and analysis and the conclusion. The final (ninth) section is concerned with presenting a conclusion and also to provide a platform for further analysis in the subsequent chapters; and

(c) synoptic map is presented with each section. Each map of the Maltese Islands includes the land uses pertaining to each section. The localities for each map can be identified from Figure 5.5 and its accompanying key found on the back part of the same page.

Discussion starts with an examination of three tables that subdivide the coastal area into eight main land uses. The data presented in this chapter is the result of data reduction methods explained in Section 5.14.

6.2 A synoptic analysis of coastal land uses: areal measurements

The data presented in this chapter is the result of three exercises: field surveying, mapping, and cartometric measurements and the data reduction techniques used. The methodology for compiling this data has been described in Chapter 5. A synoptic view of the land uses of the coastal zone is presented to give the distribution of the eight main land use categories as found on Malta, Gozo and Comino separately (Table 5.11). This data is summarized in Tables 6.1, 6.2 and 6.3. These tables give the distribution of the eight main land-use categories that are the main focus of this chapter. A consistent format is presented for each table. The main 8x4 matrix, representing the eight main land use categories on the vertical axis and the separate islands of Malta, Gozo and Comino and data for the Maltese Islands as a whole are represented on the horizontal axis. Each table is therefore made up of 32 cells. Table

6.1 is the main table giving the raw data for each major land use category for each island separately and for the Maltese Islands as a whole. The data in the two other Tables 6.2 and 6.3 represent ratios to the raw data of Table 6.1 and give the ratios for each land use as represented in each separate island and for the Maltese Islands.

The coastal zone of the Maltese Islands, as defined for the purposes of this thesis, is approximately 18.5 km^2; this includes 14.5 km^2 for Malta, 3.5 km^2 for Gozo and the rest for Comino (Table 6.1). The uneven division in the coastal zone area between the three islands of Malta, Gozo and Comino with 78.6, 18.9 and 2.5 per cent respectively is immediately apparent. Malta has the largest coastal zone dimensions for a number of reasons:

(a) it is the largest island of the archipelago;

(b) it has the longest coastline of the three islands;

(c) the indentation of the coastline on the east and south of the island gives it a high proportion of coastal margin to land area when compared to the other two islands; and

(d) the low sloping topography along a substantial part of the Malta coastline gives it a wide coastal zone boundary (cf. section 2.3.1).

The largest of these values is for the undeveloped areas, with almost 40 per cent of the whole littoral area. This, together with arable land, constitutes two-thirds of the whole coastal area. Within each individual island the highest ratio for one particular land use is given by the undeveloped areas category for Comino with 83.6 per cent. Gozo has almost one-half of its coastal zone identified under this category and almost 87 per cent of its coastal zone grouped between the arable and the undeveloped land categories together. Malta has more than one-half of its coastal zone identified under these land uses. For Malta residential and recreational areas make up most of the remaining land uses, with 291.2 ha, or 15.7 per cent of the area under study. Almost 20 per cent of the Malta coastal zone is occupied by recreational and residential land uses.

The three values for the recreational areas, residential areas and industry, are clustered at around 150 ha of area each for Malta (around 10 per cent for each category), whilst for Gozo the figures are smaller, ranging from 10.2 - 3.5 ha (0.5 to 0.1 per cent), indicating that Gozo's coastal zone is less "urban" than that of Malta. For the coastal zone of Comino the fact that the recreational area consists only of a hotel is reflected in the high proportion of 14.4 per cent for this land use category. In addition, the coastal zone boundary for Comino is more evenly distributed around the coastal margin than for Malta and Gozo mainly because of the absence of significant indented coastal areas, giving a generally rectilinear coastline and a coastal zone boundary running parallel along the shoreline. In addition, the marked absence of significant terraced agricultural areas and valleys help to maintain a rather uniformly narrow coastal zone. In fact Table 8.2 has details pertaining to the mean width of the coastal zone for each segment. Those segments that possess scree slopes and agricultural areas (Segments X and XIV) or a low sloping profile (Segment III) have wide coastal zones, whilst the opposite situation exists for segments where cliffs are present (Segments IX and XIII). Furthermore, the lack of marked coastal indentations presents a coastline that is not amenable to development due to the absence of sheltered areas. The smallness of the island and the relative isolation from the other parts of the archipelago may also be significant contributors to this land-use pattern.

It should be noted that the coastal zone boundary, although being in general essentially a line running parallel to the shoreline, does not give uniform areal dimensions for all segments. This is due to a number of factors explained in sections 5.2 - 5.6 and Table 5.3 in the previous chapter where the study matrix of this thesis was put forward through the criteria used in establishing a coastal zone. These criteria considered the extent of halophytic vegetation, whether the area was urban or rural, and the overall physical properties of the coast. Therefore each segment has different coastal zone dimensions and Table 8.2 gives details for each segment.

The highest values are for those land uses having undeveloped land and arable land. In fact, the Maltese Islands possess 65.8 per cent of these land uses along their littoral, Malta has 60 per cent of its coastal zone area occupied by arable and undeveloped land, Gozo 87.9 per cent and Comino 83.8 per cent. Of the other land use categories the residential and recreational land uses are the locations where intensive human interaction and impact prevail, and in general, referred to in this thesis as the coastal

Table 6.1 Maltese Islands: Areal distribution of coastal land uses (ha)

Land Use	Malta	Gozo	Comino	Maltese Islands
Recreational Areas	140.4	3.9	6.5	150.8
Residential Areas	150.8	3.5	0.6	154.9
Industrial Areas	139.3	10.2	-	149.5
Areas with depositional environments	9.5	3.0	*	12.5
Afforested Areas	66.0	19,9	0.2	86.1
Arable Land	350.9	133.2	0.1	484.2
Undeveloped areas	523.9	175.1	37.7	736.7
Dilapidated areas	78.2	2.0	-	80.2
Total	**1459.0**	**350.8**	**45.1**	**1854.9**

Source: Estimated by author from Appendix 1

* Area < 0.1 ha

Table 6.2 Maltese Islands: Percentage distribution of main land uses for Malta, Gozo and Comino. Data given for each separate island by rank order

Land Use	Maltese Islands	Malta	Gozo	Comino
Recreational Areas (A)	8.1	9.6	1.1	14.4
Residential Areas (B)	8.4	10.3	1.0	1.3
Dilapidated Areas (H)	4.3	5.4	0.6	-
Industrial Areas (C)	8.1	9.6	2.9	-
Areas with depositional environments (D)	0.7	0.6	0.8	*
Afforested Areas (E)	4.6	4.5	5.7	0.5
Arable Land (F)	26.1	24.1	38.0	0.2
Undeveloped Areas (G)	39.7	35.9	49.9	83.6
Total	**100**	**100**	**100**	**100**

Source: Estimated by author from Table 6.1

Upper case lettering denotes key symbol for the land use as presented in Table 5.11

* Area < 0.1 ha

Table 6.3 Maltese Islands: Percentage distribution of each land use category for Malta, Gozo and Comino by rank order.

Land Use	Malta	Gozo	Comino	Total
Recreational Areas	93.1	2.6	4.4	**100**
Residential Areas	97.4	2.2	0.4	**100**
Dilapidated Areas	97.5	2.5	-	**100**
Industrial Areas	93.2	6.8	-	**100**
Areas with depositional environments	76.0	24.0	*	**100**
Afforested Areas	76.7	23.1	0.2	**100**
Arable Land	72.4	27.5	0.1	**100**
Undeveloped Areas	71.1	23.8	5.1	**100**

Source: Estimated from Table 6.1

* Area < 0.1 per cent

urban areas. Table 6.2 shows that Malta, having 29.9 per cent of its coast devoted to these activities, is by far the leading island of the archipelago in this respect. Gozo at 2.1 per cent is well behind. The case of Comino at 15.7 is due to the fact that the only hotel on the island occupies a substantial part of its coastal zone. For the dilapidated type of land use, the total area of 80.2 ha (Table 6.1) represents 4.3 per cent of the coastal zone for all the islands.(Table 6.2).

Other general considerations noted include the following:

(a) Within the whole complex of the archipelago, 8.4 per cent of coastal land use is taken up by residential areas. The difference between the three islands is manifested here with about 97.4 per cent of this land use category found on Malta (Table 6.3).

(b) the remaining areas within the urban complex present a similar situation with over 90 per cent of these located on Malta.

However, the distribution of the areas that are associated with the paved (covered with an artificial surface) areas is much smaller for Gozo and Comino than they are for Malta.

Differences are also to be found in the land uses identifying the smaller values: depositional environments, afforested areas and dilapidated areas. These represent a total of 9.6 per cent (Table 6.2) of the coastal zone for the Maltese Islands. Spatially this amounts to 178.8 ha, of which 86 percent is found on Malta. The main reasons for this are that more sand beaches are located on Malta, and more afforested areas are to be found on the larger island along the coast. In addition, data for dilapidated areas is very high for Malta and accounts for 97.5 per cent (Table 6.3) of the values given for the Maltese Islands as a whole. The higher population density, and the concentration of development and infrastructural works occurring on Malta make the larger island more prone to accumulating unwanted and discarded building material and rubbish dumps. In addition, there are more pockets of unbuilt areas in urban zones in Malta than on Gozo and they are larger in size.

This part of the discussion can be elaborated upon with the help of Table 6.3 and section 6.4 that follows. Both sets of data help in the assessment of selected proportional values between Malta and Gozo. The areal ratios between Malta and Gozo/Comino are 78:22, meaning that for every 78 km^2 area for Malta, Gozo and Comino have 22 km^2, the ratios for coastal length are 73:27 (cf. Table 8.2), and those for the coastal zone area are 79:21 (Table 8.2). From Table 6.3 it is apparent that only the ratios dealing with coastal rural environment conform to the ratios for the Maltese Islands as a whole whereas the ratios for the coastal urban environment are heavily represented for Malta. The range of values here is 97.4 - 93.1 for Malta and 7.0 - 2.2 for Gozo and Comino together. However, the unique nature of Comino is apparent with its 14.4 per cent devoted to recreational land use and 83.6 per cent (Table 6.2) of undeveloped land. The reason for this is that the only hotel on Comino occupies a substantial part of the coastal zone.

The data presented and discussed have provided an insight into the coastal land use fabric of the Maltese Islands, showed up the main differences between the coastal land use set-up of the separate islands of the Maltese archipelago and helped to identify the land uses that generally appertain to the urban and rural fabric. Thus the terms "urban" and "rural" will be used throughout the thesis to indicate both land uses and geographic locations, whether the spatial unit being discussed is the coastal segment or the coastal unit.

In order to conclude this section it is important to show that these observations indicate that a simple classification of coastal land uses can be used to subdivide the coastal zone into three main sections. First are the land uses associated with the coastal urban core areas, this would include most residential (A) and recreational land uses (B). Industrial areas (C) are also included in this category as in Malta most are located within the urban zones, such as at Grand Harbour and Marsaxlokk Bay. Dilapidated areas (H) are also included with this category as most of them are found within the urban sprawl. Secondly, areas with arable land (F) and undeveloped areas (G) can be considered as having a rural character and very different from the urban areas, in fact they constitute part of the rural environment. Thirdly, the remaining two land use categories of afforested areas (E) and depositional environments (D) lie between the urban-rural spectrum both by their genetic nature and location placed at the interface of the two to act as buffers and also at times lie on the periphery of both urban and rural coastal environments. In addition, the important nature and high utility value of both afforestation areas (practically all planted by humans to embellish the coastal environment) and sandy beaches which although limited in size and extent (only 2 per cent of the coast has sandy beaches) form the backbone of the tourist industry in Malta. In fact the sandy beach at Birzebbugia (Segment VIII) lies within the urban environment and the beaches at Ghajn Tuffieha, and Golden Bay (Segment XI) are to be found in the rural environment. Table 6.4 gives the percentage value for each island and for the Maltese Islands. The high percentage of coastal urban land uses for Malta is evident from the Table. The analysis that follows will examine the land uses extant over sectors of the coastline to identify the land use fabric of the different segments that make up the coastal zone of the Maltese Islands.

Table 6.4 Percentage distribution of coastal land-use categories for the Maltese Islands, Malta, Gozo and Comino classified by "urban" and "rural" categories.

Land uses	Maltese Islands	Malta	Gozo	Comino	
ABC H	28.9	34.9	5.6	15.7	**Urban**
DE	5.3	5.1	6.5	0.5	**Others**
FG	65.8	60.0	87.9	83.8	**Rural**
Total	100	100	100	100	**Total**

Source: Estimated by author from Table 6.2

The discussion that follows focuses on the 16 category land use classification (Table 5.11) and utilizes the two main matrices presented as Tables 6.5 and 6.6. A 256-cell matrix is given for each table. Table 6.5 gives the distribution for each separate land use for each segment. Thus the 15.8 ha for cell Ia is the area covered by recreational activities in segment I. On the other hand, from Table 6.6 this figure represents 12.78 per cent for the recreational land use category for Segment I as a ratio for the Maltese Islands (Segments I to XVI) for this category, it is shown in cell Ia in Table 6.6. Ideally the Tables should be read along the vertical axis if the need is to assess the land use categories along the coast, and read across the horizontal axis if the need is to assess the distribution of the land uses within particular coastal segments.

6.3 Coastal urban land uses

As discussed above, the distribution of the coastal land uses along the littoral is unevenly distributed between the main islands because land uses associated with the urban fabric are most strongly represented on Malta's littoral. Land uses associated with the rural fabric (agriculture and undeveloped areas) are characteristic of the Gozitan littoral and some parts of the Malta coast. Tables 6.5 and 6.6 provide further evidence for this and help to identify better the distribution of these land uses along the coast. Within the urban fabric identified above, coastal segments I to V provide about three-quarters of the area devoted to coastal urban activities, the only exception being the area in cell VIII g, where the industrial zone of Marsaxlokk Bay is located, together with a high proportion of the residential areas for the whole coastal littoral. This data shows that within Malta the industrial areas are highly represented within the urban zones. The major maritime industrial areas of Grand Harbour and Marsaxlokk Bay together with their associated residential areas account for these high urban land uses.

Segments II, III, IV and V all show a high value for recreational land uses, with the 'urban' categories. Segment III is represented by four isolated recreational establishments in an otherwise rural environment (one hotel, one marine recreational park and boathouses and a holiday complex). In addition, from the data presented, coastal industrial land uses (g) have a highly selective location, being represented in only four contiguous segments, V to VIII. The extent of the urban fabric in the coastal zone can also be assessed from the values given for the land uses a to g (as given in Table 5.11) and from Segments I to VIII as provided in Table 6.7. This table shows the percentage value of the land uses that make up the separate "urban" land uses in Segments I to VIII. Thus 87.21 per cent of all the recreational areas in the Maltese Islands are found in segments I to VIII. The same applies for the other categories represented in the table.

All values are high with the exception for salt production sites ('f'), which account for the extractive industries, all of which are located in coastal rural areas. Examples are Reverse Osmosis plants and salt panning activities, which both require siting away from urban areas. Dilapidated areas also have a strong coastal urban orientation in that

Table 6.5 Distribution in hectares of the main coastal land use categories in the Maltese Islands.

Segment	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p
I	15.8	1.4	0	2.1	0.7	0	0	2.0	1.4	22.8	0	0	9.4	26.0	1.7	6.1
II	19.6	2.3	1.7	20.5	1.2	8.2	0	2.6	21.6	30.0	28.5	10.8	13.4	29.3	34.8	18.4
III	35.6	0.3	0	5.3	0.1	0.5	0	0.1	4.3	3.6	4.8	11.3	2.9	33.6	0	13.3
IV	17.9	0.3	5.1	5.3	1.1	2.5	0	0.1	2.1	0	0	2.5	6.4	2.1	0	2.8
V	11.2	13.6	4.1	26.6	29.1	0.6	79.0	0.1	7.1	5.0	0	2.7	2.2	0	0	12.1
VI	2.2	0	0	0.8	0	1.8	3.4	0	0.1	1.2	7.6	3.0	1.7	7.1	0	9.2
VII	3.2	2.7	2.2	5.8	0.2	2.3	0.1	0.1	6.9	14.6	7.1	4.2	5.8	10.3	0	3.6
VIII	2.3	2.5	4.4	9.1	2.9	0	33.9	1.9	6.9	13.1	2.4	0.8	2.0	5.6	0	9.1
IX	2.1	0.6	0	0.2	10.1	6.9	0	0	2.0	13.3	14.8	0.4	0.8	49.8	0	0.5
X	0	0	0	0	0.1	0	0	0.4	7.1	99.7	60.0	0	4.3	16.7	69.6	0.1
XI	6.2	0.7	0	1.1	0.2	0.1	0	2.2	6.5	11.1	11.3	2.4	2.7	26.4	120.9	3.0
XII	3.9	0	0	0	0.6	0	0	0	0.2	0.1	0	3.6	0.9	33.2	0	0
XIII	0	0	0	0	0	5.5	0	0	1.8	1.5	6.6	10.9	0	17.4	0	1.5
XIV	0.3	0.6	1.1	0.7	0	1.4	0	2.9	11.2	10.7	31.4	1.6	3.4	9.5	39.8	0.3
XV	3.3	0.7	0	1.6	0.1	2.7	0	0.1	6.7	33.0	22.3	5.4	1.3	61.9	3.0	0.2
XVI	0	1.6	0	0	0	0.6	0	0	0.2	0.9	26.8	3.8	1.6	15.5	0	0
Total	123.6	27.2	18.6	79.1	28.3	33.1	116.4	12.5	86.1	260.6	223.6	63.4	58.8	344.4	269.8	80.2

Source: Compiled from Appendix 1

Key: a - recreational areas; b - marine servicing areas; c - residential areas; d - public utilities; e - historic sites; f - extractive industries; g - industrial areas; h - depositional environments; i - afforested areas; j - arable land; k - abandoned arable land; l - shore platforms; m - low sloping rock; n - cliffs; o - scree slopes; p - dilapidated areas.

Table 6.6 Percentage distribution of the main coastal land use categories in the Maltese Islands

Segment	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p
I	12.78	5.15	0	2.65	1.22	0	0	16.00	1.63	8.75	0	0	15.99	7.55	0.63	7.61
II	15.86	8.46	9.14	25.92	20.98	24.77	0	20.80	25.09	11.51	12.75	17.03	22.79	8.51	12.90	22.94
III	28.80	1.10	0	6.70	0.17	1.51	0	0.80	4.99	1.38	2.15	17.82	4.93	9.76	0	16.58
IV	14.48	1.10	27.42	6.70	1.92	7.55	0	0.80	2.44	0	0	3.94	10.88	0.61	0	3.49
V	9.06	49.63	22.04	33.63	50.87	1.81	67.87	0.80	8.25	1.92	0	4.26	3.74	0	0	15.09
VI	1.78	0	0	1.01	0	5.44	2.92	0	0.12	0.46	3.40	4.73	2.89	2.06	0	11.47
VII	2.59	9.93	11.83	7.33	0.35	6.95	0.09	0.80	8.01	5.60	3.18	6.62	9.86	2.99	0	4.49
VIII	1.86	9.19	23.66	11.50	5.07	0	29.12	15.20	8.01	5.03	1.07	1.26	3.40	1.63	0	11.35
IX	1.70	2.21	0	0.25	17.66	20.85	0	0	2.32	5.10	6.62	0.63	1.36	14.46	0	0.62
X	0	0	0	0	0.17	0	0	3.20	8.25	38.26	26.83	0	7.31	4.85	25.80	0.12
XI	5.02	2.57	0	1.39	0.35	0.30	0	17.60	7.55	4.26	5.05	3.79	4.59	7.67	44.81	3.74
XII	3.16	0	0	0	1.05	0	0	0	0.23	0.04	0	5.68	1.53	9.64	0	0
XIII	0	0	0	0	0	16.62	0	0	2.09	0.58	2.95	17.19	0	5.05	0	1.87
XIV	0.24	2.21	5.91	0.88	0	4.23	0	23.20	13.01	4.11	14.04	2.52	5.78	2.76	14.75	0.37
XV	2.67	2.57	0	2.02	0.17	8.16	0	0.80	7.78	12.66	9.97	8.52	2.21	17.97	1.11	0.25
XVI	0	5.88	0	0	0	1.81	0	0	0.23	0.35	11.99	5.99	2.72	4.50	0	0
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Source: Compiled from Appendix 1

Key: a - recreational areas; b - marine servicing areas; c - residential areas; d - public utilities; e - historic sites; f - extractive industries; g - industrial areas; h - depositional environments; i - afforested areas; j - arable land; k - abandoned arable land; l - shore platforms; m - low sloping rock; n - cliffs; o - scree slopes; p - dilapidated areas.

they account for 93.02 percent within the "urban" segments, although a closer examination of the localities where they occur show that road construction makes a fairly large contribution.

Table 6.7: Area of selected urban land use categories in Segments I to VIII as a percentage of the total area in each category

Land use symbol	Per cent	Main urban land uses
a	87.21	Recreation areas
b	84.56	Marine facilities
c	94.09	Residential areas
d	95.44	Roads
e	80.58	Historic sites
f	48.03	Salt production sites
g	100.00	Industrial areas
p	93.02	Dilapidated areas

Source: Estimated from Table 6.6

6.4 Coastal rural land uses

The rural land use indicators mainly consist of two types: arable land and undeveloped areas. Arable land exhibits areas where agriculture is practiced or was the main land use activity until the land in question was abandoned. Undeveloped areas consist mainly of one of four main geomorphological features: shore platforms, low sloping rock, cliffs and steep slopes, and scree slopes. The land uses designated as "rural" in the coastal segments IX to XVI are presented for these segments in Table 6.8. All values are above three-quarters of the total land uses for each segment, with the value for Malta (Segments IX, X and XI) having a higher mean at 88.3 per cent than those for Gozo (Segments XIII to XVI) at 86.5. Further examination of the raw data presented shows arable land identified with land uses (j and k) constituting the larger

Table 6.8: Area of selected land use categories in Segments IX to XVI as a percentage of the total area in each category

Segment	Arable Land	Undeveloped Areas	Total Per cent	Segment	Arable Land	Undeveloped Areas	Total Per cent
IX	27.7	50.6	78.3	XIII	17.9	62.5	80.4
X	61.9	35.1	97.0	XIV	36.6	47.2	83.8
XI	11.3	78.3	89.6	XV	38.9	47.6	86.5
XII	0.2	88.7	88.9	XVI	54.3	41.0	95.3

Source: Estimated from Table 6.5

proportion of the rural land uses in Segments X for Malta and XVI for Gozo. In all other segments undeveloped land features prominently. Examining the other segments where the "rural" element is present within the essentially "urban-designated" segments, Table 6.9 is proposed. This shows that the segments in question all have a substantial amount of their coastal zone made up of rural land use indicators, with mean values 17.5 per cent for arable land and 35.65 per cent for undeveloped land.

Table 6.9: Percentage distribution of arable and undeveloped land use categories for "urban" segments

Segment	Arable	Undeveloped	Total
I	25.5	41.5	67.0
II	23.0	34.8	57.8
III	7.2	41.2	48.4
VI	25.1	31.0	56.1
VII	31.3	29.4	60.7
Mean	17.5	35.65	58.0

Source: Estimated from Table 6.5

Thus the land use categories indicating "urban" and "rural" characteristics of separate segments underline the fact that most segments, are more rural than urban in character if the cumulative totals for each land use category are taken into account by using as an indicator the 50 per cent mark as the cut-off point between urban and rural sectors. The figures given in the Tables 6.7-6.11 are the percentage values of the total for the Maltese Islands in that category, whether the figures quoted are for urban, rural land uses or for the segments. Further details emerge upon examining the "rural" land uses in segments IX to XVI from the data presented in Table 6.10 giving the percentage distribution for each land use category (j to o).

The two land uses that fall below the 50 per cent value are for shore platforms and low sloping rock. The reasons for this are the following:

a) These two rock types provide the main accessible areas of this coastline;

b) They are prevalent in zones where the "urban" character of the coastal zone is prominent. The high values linked to the other four land use types ('j', 'k', 'n' and 'o') are due to the fact that the land uses are in themselves indicators of a rural coastal environment.

Table 6.10: Area of selected rural land use categories in Segments IX to XVI as a percentage of the total area in each category

Land use	Symbol	Per cent
arable: in use	j	65.36
arable: abandoned	k	77.45
shore platforms	l	44.32
low slop rock	m	25.50
Cliff	n	66.90
Scree slopes	o	86.47

Source: Estimated from Table 6.6

Examining the "urban" land use category values in the matrices provided in Tables 6.5 and 6.6, the figures tend to be rather low for the urban land use categories column in Table 6.11 when compared to the data examined above for both the predominantly "urban" areas and "rural" areas. Table 6.11 gives percentage data for the segments whose land uses were not discussed above in Tables 6.7-6.10. Keeping to the "urban" and "rural" labels discussed above, Segments IX to XVI show a consistently small percentage value for the urban land uses whilst segments I to VIII do not exhibit the same consistency in values. The reasons that only segments IV, V and VIII show a predominant urban character are because the industrial base for segments V and VIII is very highly represented, and segment IV is almost completely made up of urban land uses. For segments II, III, VI and VII a more even spread of urban and rural characteristics is prevalent.

It can therefore be concluded that the segments that possess a predominant urban-industrial land use typology are IV, V and VIII. Segments VII, IX, X and XI have a predominantly rural environment, while segments I, II, III and VI have a predominance of rural land uses but also some marked urban activities. A discussion using Appendix 1would reveal the exact details within each segment. In addition, a more even spread of urban and rural land uses is seen in segments II, III, VI and VII. Thus, notwithstanding the urban/rural classification label placed on selected land use categories and the identification of some segments according to this method, variations occur. These will form part of the basis of the following sections.

Table 6.11: Cumulative percentage distribution of "urban" land uses in segments IX to XVI and "rural" land uses in Segments I to VIII

Segment	'Urban' land uses (a, b, c, d, e, f, g, p)	Segment	'Rural' land uses (j,k,l,m,n,o)
IX	20.0	I	67.0
X	0.2	II	57.8
XI	5.9	III	48.4
XII	10.5	IV	22.9
XIII	15.5	V	5.1
XIV	3.9	VI	56.1
XV	2.1	VII	60.7
XVI	4.3	VIII	24.7

Source: Estimated from Table 6.5

6.5 Presentation of each section

Following the processes of data collection and of data reduction (Chapter 5), the main focus of this chapter is to describe and analyse the land use data. Eight sections follow (6.6-6.13), each representing a group of coastal land use categories and deals with each group separately. All sections, with the exception of depositional environments, afforested areas and dilapidated areas, group a number of land uses. The breakdown and identification of the land use categories follows that given in Chapter 5, in Table 5.11 and is used throughout this thesis. Table 6.19 gives the list of sections with their respective title and the land uses that fall within each section.

Each section is analysed, following a sequence as follows:

(a) Introduction to the main land use category by presenting the land use study matrix;

(b) Background information pertaining to the land-use under discussion, including all of the sub-categories as they have developed over the years and as affecting the Maltese islands' land use in general;

(c) Justification for study gives the reasons for including the particular land use in the discussion and as a consequence outlines the importance of the particular land-use category to the thesis;

(d) Definition of the land use categories to be discussed follows the definitions as presented in Olsen and Seavy (1990), the Coastal zone survey report for 1989, and as finally developed for this thesis and presented in Table 5.11;

(e) Presentation of the coastal land use data for the particular coastal land-use category as given for each of the 16 coastal segments and as sub-totals for Malta, Gozo and Comino and the Maltese Islands. The tables are presented in two main data sets: areal, in hectares, and as ratios (percentages);

(f) Discussion and analysis of the data presented in the main Table and in the synoptic map provided; and

(g) Conclusion.

The figures presented and the discussion that follows are in hectares (ha) and percentages. This is done for a number of reasons:

a) As a quantity, one hectare is large enough at 10,000m^2, that cartometric errors are minimized whilst at the same time the hectare within the scale of the Maltese Islands' littoral is a fairly small area. This affords good comparability between different land uses, knowing that the total area under investigation is about 19,000 ha; and

b) As figures are presented to one decimal point, this brings down the minimum area for discussion to the 1,000m^2 level, approximately 32m x 32m. This makes up a fairly small area on the 1:2,500 scale map and a minute one on the 1:25,000 scale. As an attempt at using the appropriate level of precision for the description of coastal land use, a range of scales is used between one hectare and one-tenth of a hectare. This is broad enough to accommodate land use variations even within areas that possess a variety of land uses in a small area.

In addition, any element of subjectivity or any human error in the estimation of areas and in presenting the figures was smoothed out and corrected by the fact that all measurements were done initially in square metres, on a scale of 1:2,500, and later converted into hectares. Thus all the figures present a fair element of cartometric precision. However, when appropriate, and when areas are rather small, measurements are given in m^2 in the discussion.

The discussion centres around the tables presented with each section. Each deals with the land use categories as listed in Table 5.11. The order of discussion used is one where the "urban" land use categories are placed first in the table and are also the first to be discussed. "Rural" land uses are then discussed, followed by the dilapidated areas at the end. This last category has been left to the end as it largely represents the areas that were undergoing change at the time of the survey and the general conclusion of the chapter deals especially with change. Although the prevalence of the elements that make up this land-use category are linked more with the "urban" land uses than with any other, as it is made up of elements that are essentially associated with areas where dumping of building material, industrial and domestic waste prevail.

In order to highlight the association between coastal land uses and demonstrate the distribution of coastal functions two types of maps have been included with each section. The first type shows the distribution along the coast of the Maltese Islands of the land uses being discussed in each particular section and Table 6.12 gives the list of sections which are to be followed in this chapter based on broad land use categories (eg. Figure 6.3). The second type of map shows details pertaining to land uses in a section of the coast (eg. Figure 6.1) The latter generally serves to pinpoint a recurring example that is found in various parts of the coast and the key identifying the land uses is common throughout the chapter and found with Figure 6.19.

Table 6.12 List of the eight main sections in this chapter

Section 6.6 - Recreational Areas: tourism, marine servicing areas
Section 6.7 - Residential Areas: residential areas, public utilities, roads
Section 6.8 - Extractive Industry and Industrial Areas: extractive industries, industrial areas
Section 6.9 - Depositional environments
Section 6.10 - Afforested Areas
Section 6.11 - Arable Land: agriculture areas in use , abandoned agricultural land
Section 6.12 - Undeveloped Areas: shore platforms, low sloping rock, cliffs and steep slopes, scree slope areas (*rdum*)
Section 6.13 - Dilapidated areas

Source: developed from Table 5.11

The first three categories to be discussed form the basis for the urban and economic environments. These are made up of recreational areas, residential areas and industrial areas. These areas collectively make up the "urban" land use categories. The second set of four categories is mainly linked to the natural environment. These are the areas that are not built upon and do not have the urban qualities such as buildings and other engineering structures as for the urban land uses. These include areas with depositonal environments, afforested areas, arable land and undeveloped areas. These are essentially land uses that provide the "rural" base to the coast. A final category is the dilapidated land uses.

Further details regarding the definition of each land use category are given with the relevant section in this chapter. However, one point needs clarification. Although the land uses under discussion have been broadly labeled as "urban" and "rural" types, there are instances where these are found in close proximity to one another. An area may also be traditionally associated with the urban environment but also has land uses associated with the "rural" category. In part these situations reflect two factors: the marked variations in the patchwork of coastal land uses that make up the local littoral, and the detailed mapping that was done in the field.

6.6 Recreational Areas

6.6.1 Introduction

The land uses that form the coastal urban fabric have been separated into two categories largely incorporating two main coastal urban uses: recreational areas reviewed in this section of this thesis and residential areas presented in section 6.7. These are tackled together with their associated infrastructural facilities of marine servicing areas for the recreational areas land use category, and roads and public utilities for the residential areas category. Historic sites have been arbitrarily included with the latter. This separation of the urban land uses into two main sections was necessarily due to the presence and importance that the tourist sector (represented by the recreational area) has on the economy in general and on the coastal fabric in particular, that it warranted a separate treatment.

Recreational areas along the coast, for the purposes of this thesis, are closely linked to tourism and the shoreline services that cater for boating facilities. They form part of the coastal urban environment as most hotels and catering establishments are located within the densely built-up areas of the coast. The elements that identified this land-use category are given in Table 5.11.

6.6.2 Background Information

As an economic activity, tourism has experienced continuous growth over the last 40 years. Data compiled according to tourist arrivals shows a steady increase of visiting tourists from 12,583 in 1959 to 1,215,713 in 2000 (National Statistics Office, 2001a) with the estimated financial values of Lm 765,000 to Lm 270 million in the same period. The workforce in full and part-time employment in tourism including those employed in the hotels and restaurants increased from 505 to 12,004 (National Statistics Office, 2001c) of which 9033 are in full-time employment (Employment and Training Corporation, 2002). The increase in the number of hotels was from 25 to 133 and the number of beds including all types of accommodation including guest houses, hostels, tourist villages, aparthotels, self catering establishment and hotels increased from 1218 in 1959 to 46,432 in 1998 (Mangion and Vella, 2000). Cruise passengers also increased from 8399 in 1959 to 144,064 in 1998. Tourism's contribution to the economy taking the multiplier effect into consideration is estimated to be around Lm 255 million and about 19 per cent of the GDP (National Statistics Office, 2001b) which is proportional to 27 per cent of Government income (Mangion and Vella, 2000). Although part-time employment in the sector is significant and moonlighting rampant it is estimated that employment in the sector is equivalent to 17 per cent of the national full-time compliment (Mangion and Vella, 2000). In addition, a considerable part of the construction industry is geared to service the tourist sector in the building of new establishments, the upkeep of the older tourist venues and sites used for recreational purposes and other associated activities. Estimated projections at an increase of 5 per cent as a result of further coastal development are envisaged.

Increases in tourist arrivals have been registered throughout the last 3 decades from 100,000 in the 1960s (Schembri and Magri, 1995) to about 1.2 million in 1998 National Statistics Office, 2001b). The use of land for this industry has also increased substantially and large parts of the coastal areas are dotted with hotels and restaurants. In fact, according to estimates calculated by the author from a brochure published by the Ministry of Tourism (National Tourism Organization, 1995) about two-thirds of the hotel and catering establishments in the Maltese Islands are located on the coast. The spatial distribution of this land use category is seen from Figure 1.1 and a general prevalence of tourist activity along the north-east Malta coast is apparent. Further details of the spatial distribution of recreational areas are presented in Table 6.13. Plates 6.1(a) and (b) show the development of a popular tourist resort in Malta.

Tourism in Malta has generated a substantial amount of literature. The main initial focus of many papers generally start by giving a brief overview of the development of tourism in Malta as a main fulcrum in the changing economic base of the islands, however with a heavy dependence on the British tourist market. Lockhart and Ashton (1991) used the results of a survey conducted in the late 1980s on tourist accommodation and concluded that the temporal distribution of visitors was dominated by the prevalence of "the package-holiday" (p.28). The few sandy beaches, lack of attention to the upkeep of roads and the general bad state of the environment, especially in summer in the tourist congested areas, were the main complaints aired by the respondents. Notwithstanding the generally negative view that the new buildings disrupted the old architectural style, the coast was spared from the "continuous ribbon development" (p.31). Lockhart (1997 a) proposed that only with the introduction of environmental legislation and the enforcement of a land use structure plan, was it possible to control haphazard coastal development and curtail the use of scenic sites by bird trappers and hunters. The efforts by successive administrations to increase the bed capacity and diversify from the British dependence together with the impact of high seasonality (summer) of domestic tourism were the central themes in Lockhart (1997b). The author concluded that the emergence of long-haul tourist destinations was also affecting tourism in Malta as it was in other Mediterranean destinations.
Ioannides and Holcomb (2001) maintain that although high-income tourists are the ideal niche to attract, they generally cost more to cater for and have greater environmental awareness. The latter is definitely not in Malta's favour. In addition, the authors doubt whether promoting eco-tourism is wise on Malta's part as there are few "unspoiled" areas left and the place is littered with plastic containers, household refuse and debris from the building industry. Both Lockhart (1997) and Ioannides and Holcomb (2001) compare Malta and Cyprus. Common trends include their location in

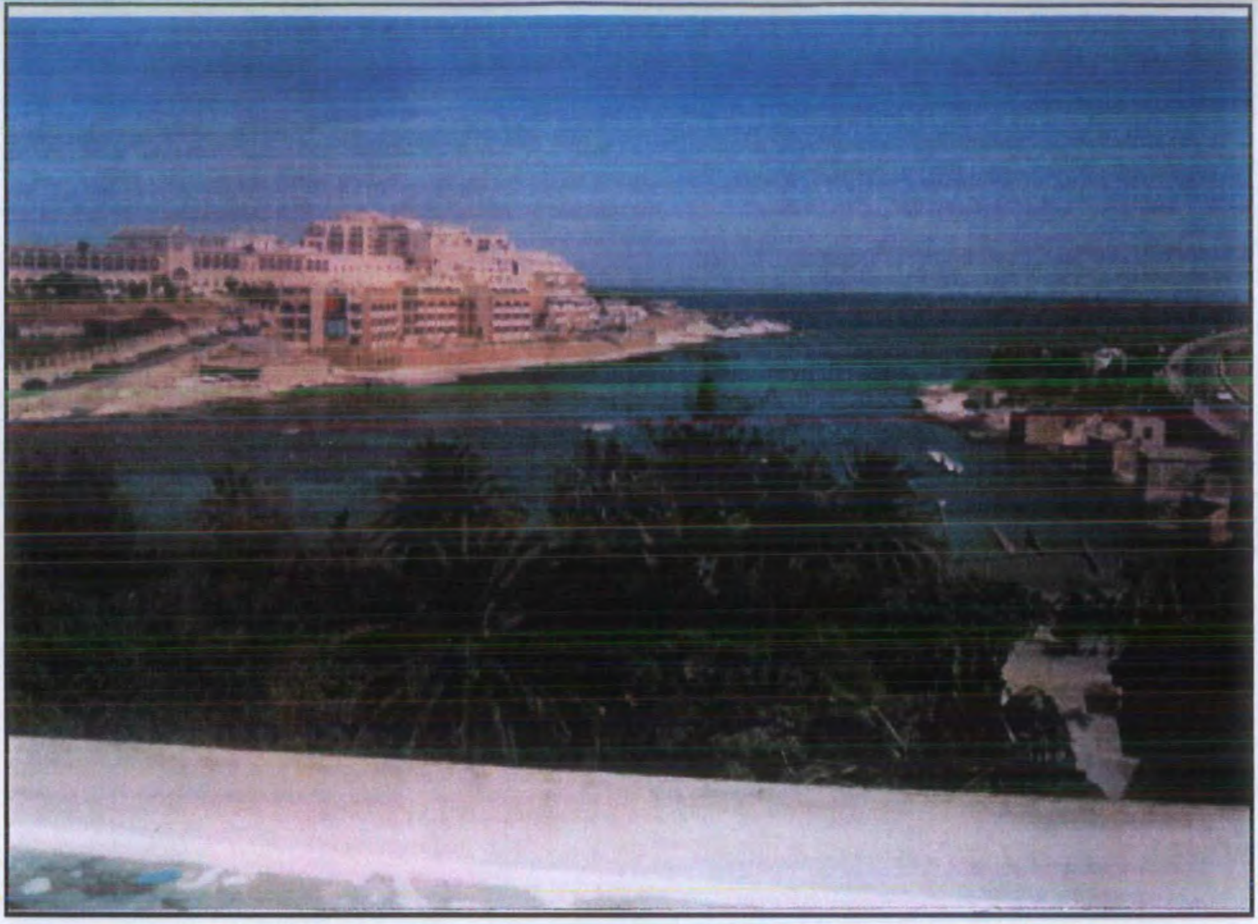


Plate 6.1a Malta, St George's Bay Paceville: Contemporary coastal resort development on north side of bay facing 19th century boathouses. The afforestation setting in the foreground is the open space of another tourist resort developed on a fertile valley floor. Source: The author

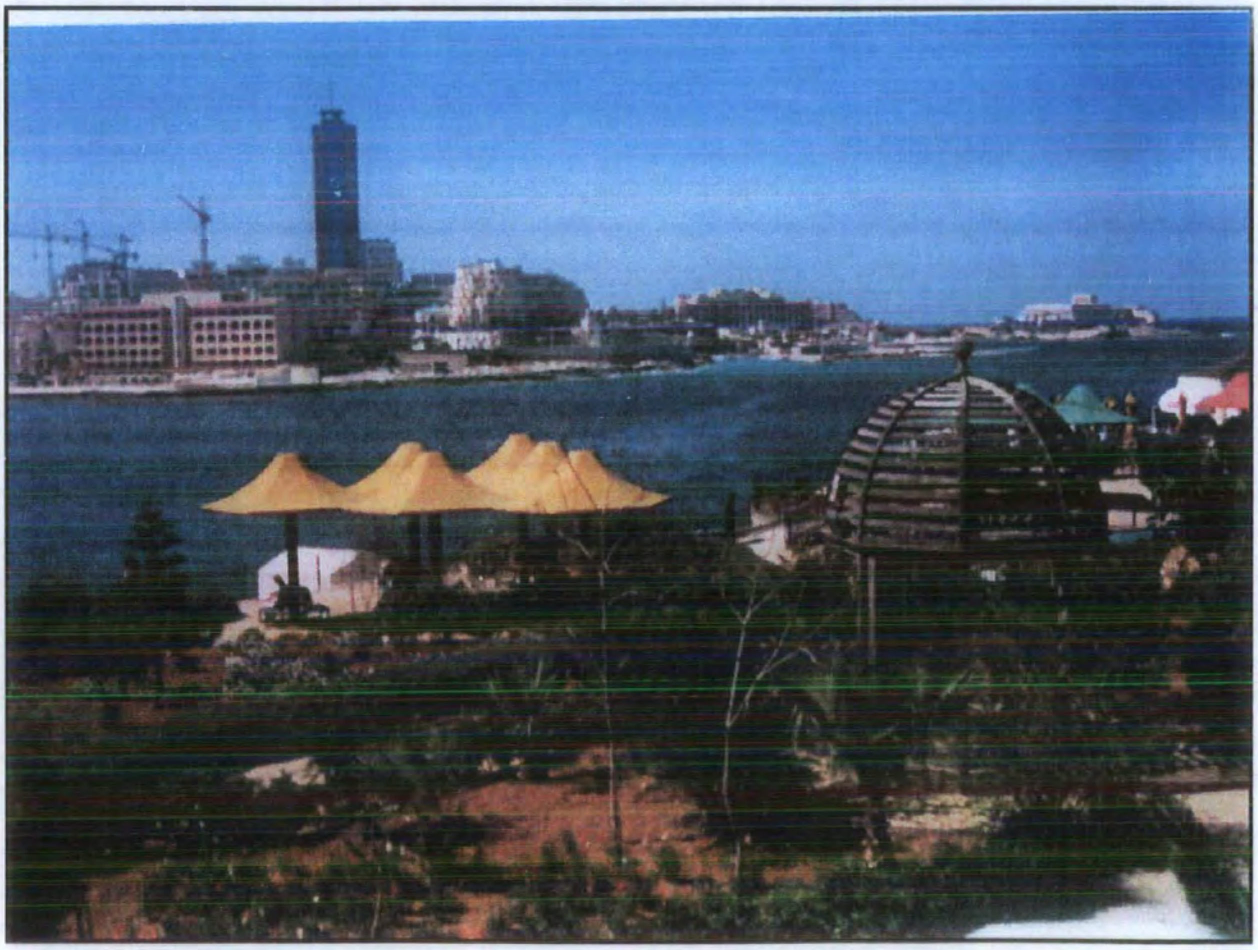


Plate 6.1b Malta, St. Julian's Bay: the Hilton project in the background and a landscaped public garden in the foreground. Source: The author

the Mediterranean, common historical links with Britain and the attraction of a high number of British tourists. The emphasis on cultural tourism, increase in five-star accommodation and the failure of the two islands' administrations to combine tourism strategies with the development of a strong economic base and sound land use strategy are parallel aspects of the general tourism plans and pitfalls of both islands (Ioannides and Holcomb, 2001). Lockhart (1997 a) cites the failure to enforce planning regulations and sustainable forms of tourism have little attention in both islands' planning processes, the dependence on a few markets and the strong hand of politics in shaping policy are also detrimental factors.

6.6.3 Justification for study

Land used for the recreational purposes mentioned above is one of the main features of the coast of the Maltese Islands. This is partly due to the development of coastal tourism and the maritime-oriented recreational activities. A number of coastal areas have been developed into areas with hotels, guest houses, restaurants and commercial outlets servicing this recreational industry. As a consequence, land speculation is high and infrastructure activities have complemented this development with the construction of promenades, slipways, jetties and marinas. Many of these areas coincide with high population concentrations and have therefore become nodal areas used as major activity centres accommodating multiple activities and as a result generating a high economic value.

6.6.4 Definitions and criteria used for field identification

Two variables have been identified as making up the land use category of recreation:

(a) areas with facilities for tourism, identified with attributes such as hotels, holiday flats, beach concessions, and catering establishments; and

(b) marine facilities, identified with attributes such as jetties, breakwaters, slipways ferry and cruise liner facilities, yacht marinas, boat-parking facilities, boathouses, and caravan and camping sites.

Two sources for defining the categories are utilized. One is taken from a coastal zone management manual (Olsen and Seavy, 1990) and the second is from the actual land use field mapping exercises. The first definition is reproduced in full:

"Recreational boating facilities include marinas, launching ramps, residential boating facilities, recreational wharves, piers and slips, floats or floating docks, and recreational mooring areas.

1. Marina: any dock, pier, wharf, float, floating business, or combination of such facilities that service five or more recreational boats as a commercial enterprise or in association with a club.
2. Launching ramp: a man-made or natural facility used for the launching and retrieval of boats.
3. Residential boating facility: a dock, pier, wharf, or float, or combination of such facilities, contiguous to a private residence, condominium, cooperative or other home owners' association properties that may accommodate up to four boats.
4. Recreational mooring area: any designated area managed by a commercial enterprise, a club, city, or town where five or more recreational craft are kept at moorings"

Source: Olsen and Seavey 1990, 71

Recreational land use along the coastal zone was classified into two broad elements. These are described separately.

(a) Tourism

This was by far the major element. Table 5.11 gives the elements associated with this land use and includes tourist buildings such as hotels, guest houses, bars, cafes and multi-use buildings with a tourist component. Further related elements of other amenities such as car parks linked to particular hotels were also included in this category. Essentially, in mapping the features associated with these recreational establishments, elements that formed part of the residential land use category were integrated with them. These therefore called for a degree of attention in the mapping of the urban landscape, as there were problems in the identification of some of the buildings used for holiday flats as separate from the residential ones. Figure 6.1 shows the integration of recreational areas along Sliema promenade, in this case restaurants and hotels within the residential environment. Two historical sites are also identified, in perspective these are dwarfed by the contemporary building development. In coastal rural areas, zones used for recreational purposes normally stood out clearly and no similar problems were encountered regarding identification. Figure 6.2 shows a typical example taken from Comino and identifies the site of a secluded beach with associated hotel amid undeveloped surroundings. In general these areas catered for the international tourist market. The presence of caravans along the coast, which collectively may sometimes constitute a camping site, were also noted and included with this land use category, even though their physical presence was limited solely to the summer months. However, the final section of this chapter deals with areas where multiple uses occur, and caravan sites are one of these areas. The key to the detailed land use maps similar to those found in Figures 6.1 and 6.2 is to be found on the flap with the Figure on page 253.

(b) Marine Servicing Areas

These included infrastructural elements that enhanced both the aesthetic and the functional value of areas where many activities were taking place. Table 5.11 gives the elements that constituted this land use variable. These variables are generally located in areas where there is a high degree of accessibility between land and sea. Although the spatial extent of these areas is normally small, they are generally noted for the high degree of activity associated with recreational activities and a concentration of retail outlets. Engineering works such as jetties and breakwaters form part of this land use variable. The main purposes of three of these amenities are the following:

- concrete platforms which normally help to improve sea/shore accessibility;
- slipways, which have a good physical access from the roads and enhance boat access between land and sea ; and
- jetties, normally used to protect the coastal environment from sea swell and which also increase the serviceable area of sea/shore.

Boathouses are also included with these variables as they constitute an amenity that caters for recreational purposes. Essentially boathouses are one-roomed garage-type buildings whose function is mainly for the provision of shelter for one boat. Most of these rooms are permanent structures. They are usually located in sheltered coastal areas that lack the facilities normally associated with storm protective structures such as breakwaters. The distance to the nearest habitable area is normally substantial, hence the purpose of these boathouses. In effect, many boathouses in Malta actually serve as summer residences for whole families. Many are equipped as summer houses, with electricity, water and sanitary facilities. Nonetheless buildings with large prominent front doors and without windows can be considered as boathouses. In the

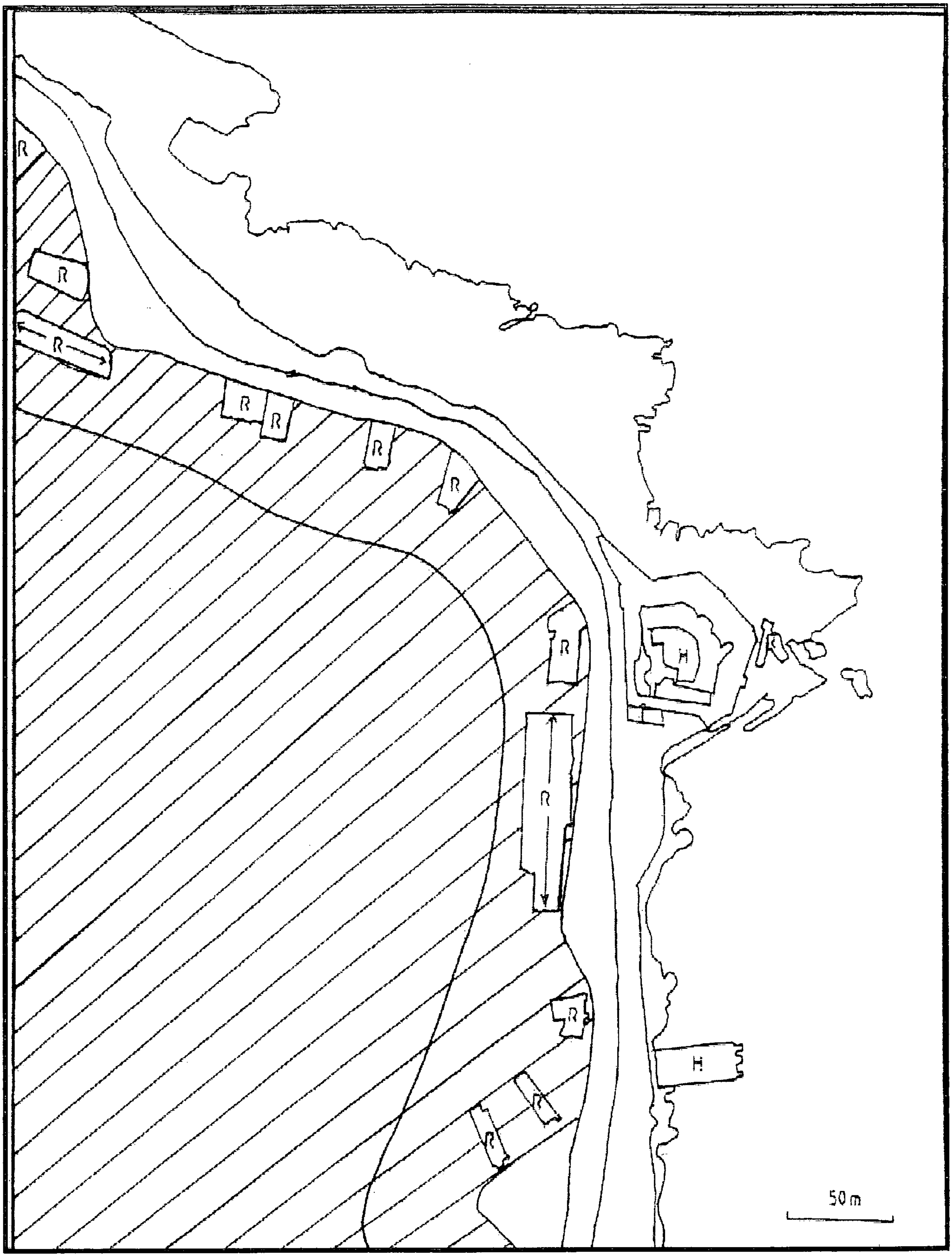


Figure 6.1 Sliema: Typical plan view of urban coastal area with recreational establishments in residential zone and road parallel to shoreline. A historical tower (H) marks the strategic importance of the site in coastal defence network of pre-19th Century Malta

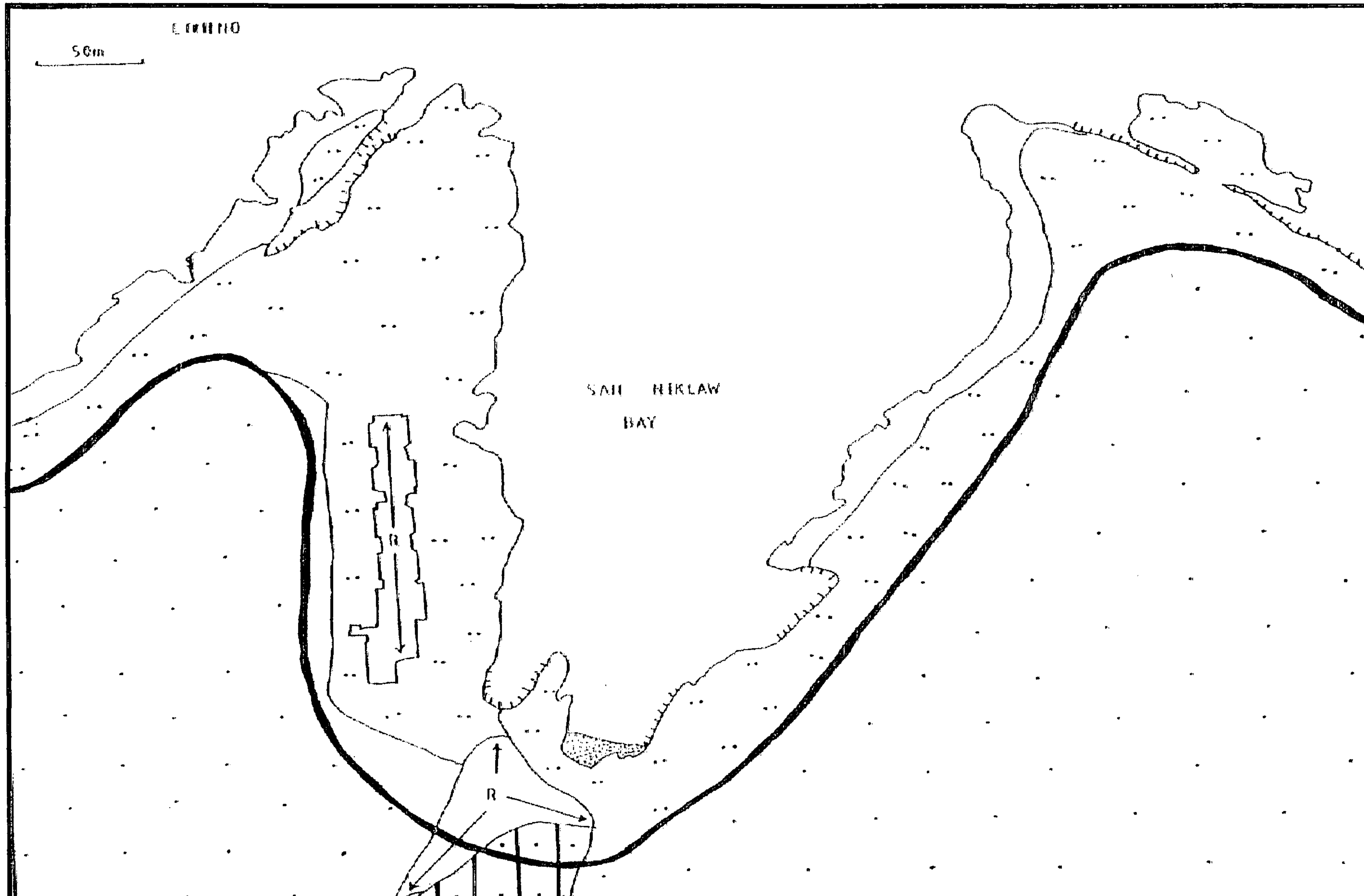


Figure 6.2 Comino: typical plan view of recreational development land in rural area with hotel development near sand beach

6.6.5 Presentation of data

Table 6.13: RECREATIONAL AREAS. Land use distribution for Malta, Gozo, Comino and the Maltese Islands.

	Hectares			Per cent		
Segments	**Tourism**	**Marine Servicing Areas**	**Total**	**Tourism**	**Marine Servicing Areas**	**Total**
I	15.8	1.4	17.2	10.5	0.9	9.1
II	19.6	2.3	21.9	13.0	1.5	12.5
III	35.6	0.3	35.9	23.6	0.2	19.0
IV	17.9	0.3	18.2	9.5	0.2	12.4
V	11.2	13.5	24.7	7.4	9.0	15.2
VI	2.2	-	2.2	1.5	-	11.6
VII	3.2	2.7	5.9	2.1	1.8	4.3
VIII	2.3	2.5	4.8	1.5	1.7	4.8
IX	2.1	0.6	2.7	1.4	0.3	1.4
X	-	-	-	-	-	-
XI	6.2	0.7	6.9	4.1	0.5	3.6
TM	116.1	24.3	140.4	74.6	16.1	93.9
XII	3.9	-	3.9	2.6	-	2.1
TC	3.9	-	3.9	2.6	-	2.1
XIII	-	-	-	-	-	-
XIV	0.3	0.6	0.9	0.2	0.4	1.1
XV	3.3	0.7	4.0	2.9	0.5	2.1
XVI	-	1.6	1.6	-	1.1	0.8
TG	3.6	2.9	6.5	3.1	2.0	4.0
GT	123.6	27.2	150.8	80.3	18.1	100

Source: Estimated by author from field data and cartometric measurements

Key
I to XVI - coastal segments (rows)
TM - Total of values for Malta
TC - Total value for Comino
TG - Total of values for Gozo
GT - Total of values for the Maltese Islands

Grand Harbour and some other areas boathouse ownership is perceived as being an honourable part of a family's inheritance. The legal status of some boathouses has been contested for some time, leading the Planning Authority to enforce the demolition of parts of what became a shanty town along the north coast of Malta. Residents protested as the action deprived them of a second home just before summer, and disrupted the vacation community spirit in the area (The Times [of Malta] 6 August, 2001).

6.6.6 Discussion and analysis

Table 6.13 presents the land use elements for the recreational areas category. Its spatial extent for the Maltese Islands is 150.8 ha, about 8 per cent of the total area for the coastal zone. A synoptic map for their occurrence along the coast of the Maltese Islands is shown in Figure 6.3. The emphasis attached to this economic activity in the different islands is seen from the fact that 90 per cent of it is located on the Malta coast, with the rest on Gozo and Comino. Along the Malta littoral the distribution is heavily biased towards the northern and northeastern shoreline, where a high concentration of recreational land uses is apparent along Segments I to V; these account for 117.9 ha or 78 per cent of the total for the Maltese Islands.

Further concentration of recreational land uses is evident, with just over one-half clustered in segments II and V. This indicates that the concentration of recreational activities is grouped along selected areas of the coast. A low sloping accessible coastline is partly the reason for this concentration. In a number of cases the land use category is not present along all parts of the littoral in segment V, with the concentration of recreational activities located along the Marsamxett Harbour littoral. A number of reasons account for this:

- the harbour's littoral is highly accessible along most of its length;
- the high concentration of population living around the littoral;
- the area has extensive yacht marina development;
- the various marinas are linked by a pedestrian promenade that follows the coastal margin along most of its length; and
- the touristic development along the littoral further encourages the development of marine recreational areas.

The other major concentration is for Segment II from Ahrax Point to Ghallis Point. Recreational development occurs mainly in the bays and inlets and evidence is absent along the rectilinear parts of the coast. This area includes Mellieha Bay, St. Paul's Bay and Salini Bay (Segment II). Table 6.14 gives the spatial distribution of the recreational activities in this segment.

Table 6.14 Spatial distribution of Recreational Areas in Segment II

Locality	Area (ha)
Ponta ta' l-Ahrax to Rdum tal-Madonna	0.4
Mellieha Bay	8.5
Mgiebah	5.3
St. Paul's Bay	5.9
Salini Bay	4.3
Total	24.4

Source: author's fieldwork and cartometric measurements

In Segment V the area under the recreational land use is 15.9 ha along Marsamxett Harbour and 8.8 ha for the Grand Harbour area. Whilst for the Marsamxett Harbour recreational areas are located along most of its 10 km land/sea periphery, for the Grand Harbour area recreational areas are found mostly along part of the Valletta/Floriana coastline and at the inner areas of Ricasoli Bay, Senglea Creek and French Creek. The contribution of the other east coast segments, i.e., VI to VIII, that include the Marsascala area to Benghisa, constitutes about one-tenth of the total recreational activity. This is mainly due to the summer vacation resorts of Marsascala (Segment VII) and Birzebbugia (Segment VIII). These resorts attract mainly locals from the southern and south eastern parts of Malta. In the south western region areas of maritime recreational value are confined to the sand beaches from Ras ir-Raheb to Qammieh (Segment XI) and to the rocky creek of Wied iz-Zurrieq and Ghar Lapsi (Segment IX). Ghar Lapsi and Migra Ferha (Segment X) are essentially vantage viewing points on the southern cliff edge about one hundred metres above sea level. Segments X and XIII are noted for the absence for any recreational infrastructure. These areas make up the stretches from Wied iz-Zurrieq to Ras ir-Raheb for Segment X in Malta and the north east coast of Gozo. High cliffs are the main physical feature of these areas, with direct access to and from the coast being rather difficult.

6.6.7 Conclusion

Although recreational areas are widely spread along the littoral of the Maltese Islands, a link with the low sloping accessible areas is evident together with areas where a high concentration of population lives. The following section reinforces this argument by reviewing the residential areas.

6.7 Residential Areas, Roads, and Historic Sites

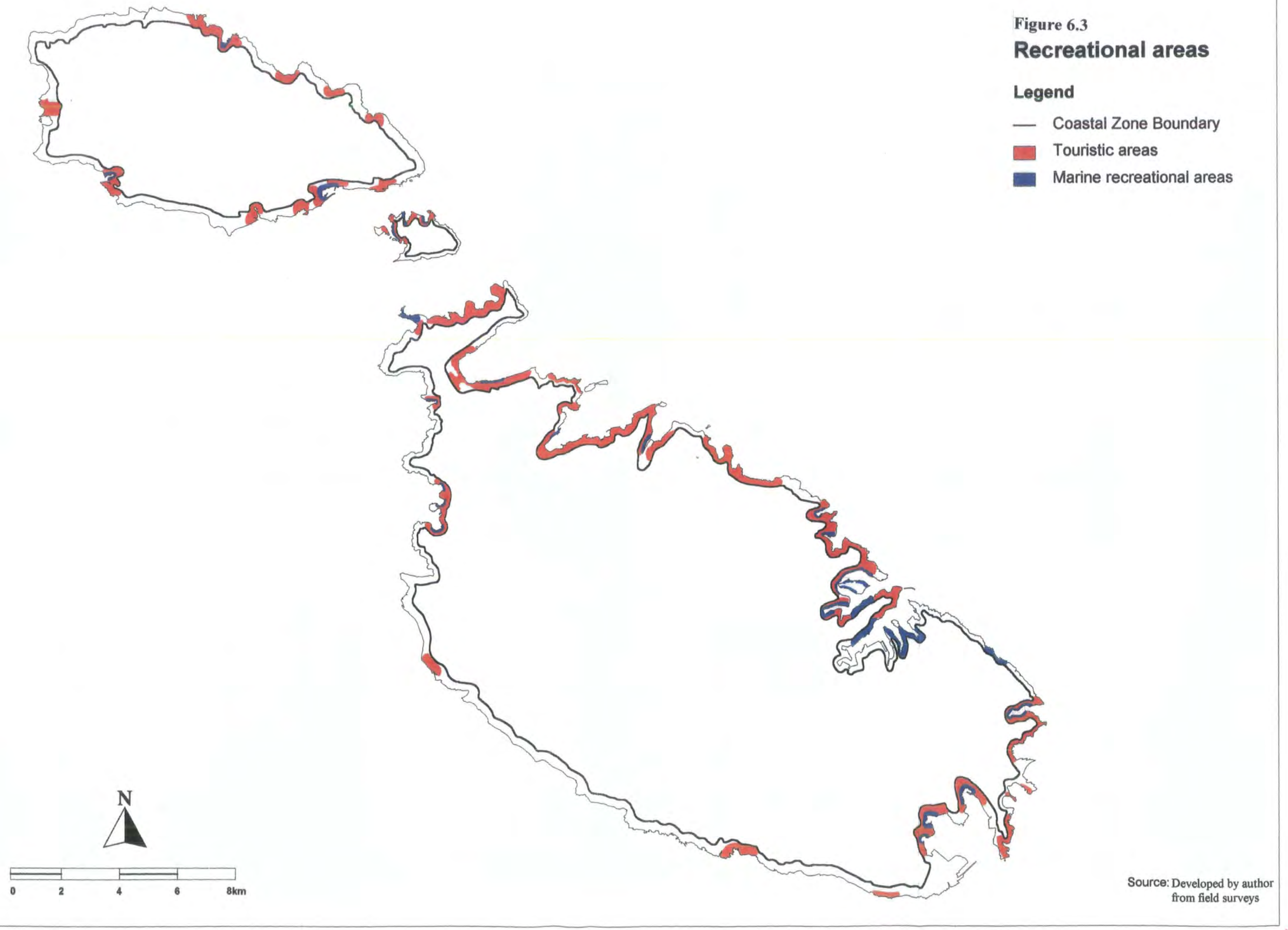
6.7.1 Introduction

The grouping of these three land-use variables into one category was due to the fact that they are all related to the urban fabric. Residential areas in themselves constitute a considerable area of the urban fabric, especially when they are present in clusters. The definition of an urban area varies considerably from one country to. For the Maltese Islands it is a locality that constitutes a population of more than 2000 inhabitants (cf. United Nations Department of Economic and Social Affairs (2001)).

Although roads are present even in rural areas, the large proportion of the road network is found mainly in the urban areas. In addition, most coastal areas have a road along a large part of the littoral, generally located between the foreshore and the backshore area, irrespective of whether these areas are urban or rural in character. Figure 6.1 shows an example of a coastal urban area, with the coastal road located between the foreshore area and the built-up hinterland. In fact, only three coastal Segments, IX, XIII, and XVI do not respect this model and do not have a coastal road skirting the whole length of their littoral.

Historic sites are mainly found in areas that are highly accessible from the sea. The very purpose of many of these sites along the coast was for defense and therefore they are today found in areas where many coastal activities are concentrated. In addition, many of these sites have become part of the built environment with the expansion of the urban area next to them. Historical sites are being influenced by the three major land use categories reviewed in this chapter, namely, residential areas, recreational areas and industrial areas. Figures 4.2 – 4.5 (in Chapter 4) show this process for the built-up areas for the 19th and 20th centuries.

Figure 6.3
Recreational areas



This section deals with the residential areas as a main land-use category. Together with the recreational areas reviewed in the previous section, these areas form the bulk of the urban environment along the coast. Three land use categories are presented in this section: residential areas, the areas occupied by roads and historical sites.

6.7.2 Background information

Residential areas form the bulk of the urban land uses in the Maltese Islands in that their spatial extent has increased from 5.5 per cent of the surface area of the Maltese Islands in 1955 to 16.5 per cent in 1990 (Cilia, 1995). In essence, this increase has reflected the socio-economic changes of the country and also the population increase to 367,000 in 1994 (Central Office of Statistics, 1996). The local debate regarding the provision of residential areas centres on two facets: land surface occupied and housing affordability (Chamber of Architects and Civil Engineers, 1999). Housing affordability to lower income groups is made possible with state help in Malta with the provision of residences at subsidized rents (Lockhart, 1987). However none of these residential units are located within the coastal zone boundary of this thesis. The salient features of the historical background to the Maltese Islands was presented in Chapter 4, however only a relatively small part of the coast is covered with historical artifacts, notwithstanding the strategic importance of the fortifications in the coastal defense.

The road network is a more prominent feature. In fact, 1500 km of roads cover the land surface of the islands, of which 99 per cent are bitmac surfaced (Central Office of Statistics, 1999). This puts the Islands as the leading country in the world, with 4.7 km length of road surface per km^2 of area. In addition, the historical development of the road network saw an increase of 100 per cent from 800 km in the 1930s to the present figure (Central Office of Statistics, 1999).

6.7.3 Justification for study

Including residential areas, roads and historic sites these land use categories within the study is partly justified by the built-up areas being used as indicators to mark the coastal zone limits by taking house facades facing the sea (section 1.3.). In most cases in urban areas these facades had roads in front of them and in many cases the historical sites identified were located within the urban built-up areas.

6.7.4 Definitions and criteria used for field identification

(a) Residential areas

These areas can be defined as comprising terraced houses, flats and villas. In general, a ribbon-type distribution prevails (Carter, 1995) along the coast. Identification was simple and mapping was rather straightforward as the residential areas were left in their original hue on the map, and new additions were drawn in. Data regarding the areas occupied by each category were then estimated.

(b) Public utilities

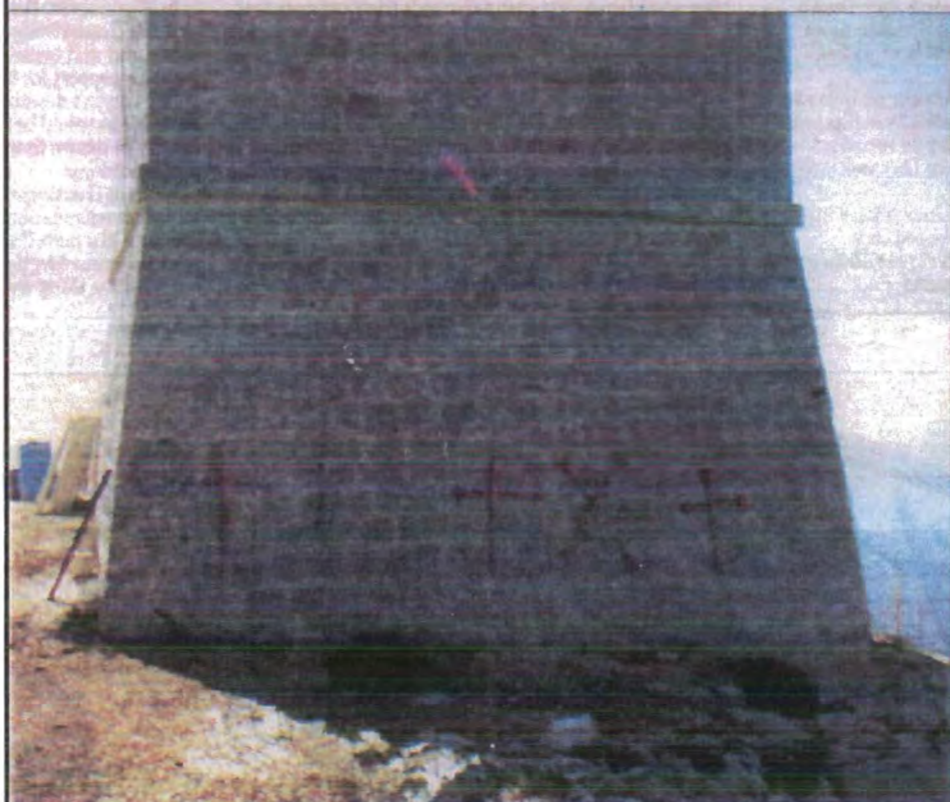
Road construction and upkeep can also be viewed with this land use category in that the coastal accessibility for residential and other purposes is conditioned by the presence or otherwise of roads. Easily identifiable in plan and on site, roads were probably the easiest of all the land uses to map and to quantify spatially as their columnar features when seen in plan on the maps helped the areal measurements.

(c) Historic sites

Historic sites have been included with this land use category as they are essentially sites that in many cases form a continuous unit with the urban fabric. These comprise a rather wide range of fortifications, varying in scale from the massive defensive walls and bastions of the Harbours (Plate 6.2) to the coastal watch towers. Archaeological sites located in the coastal zone are also included within this category. A problem was, however, posed for areal quantification in that coastal watch towers, redoubts and batteries have very small areas, normally less that 0.1 ha each, but a greater significance in the coastal land use fabric. The isolated and relatively remote situation of some historical artifacts also draws vandal attention (Plate 6.3). When giving land use values for complete segments, it was the cumulative measurements of each land use category that was finally shown, because some historical buildings are not large enough even when their individual cumulative areas are summed. As a result, an asterisk is placed in the cell in Table 6.22 where this situation occurs.

Plate 6.2 Malta Valletta: Fortifications enclose the peninsula, with typical high urban density, that separates Marsamxett Harbour from Grand Harbour to the north and south respectively.
Source: Undated promotional material, Malta Tourism Authority.

Qrendi tower daubed with paint



Herman Grech

The 17th century *Torri tal-Hamrija* in Qrendi is the latest historical gem to fall victim to the work of vandals, who daubed it with spray-paint some time on Monday.

Unknown individuals ventured into the area near Haġar Qim and Mnajdra and sprayed obscene words and crosses on three walls of the tower with blue and red paint.

When contacted, Museums Department director Anthony Pace said it was still too soon to give the extent of the damage, since the paint had not yet been analysed.

The tower has been undergoing the finishing touches of a Lm24,000 restoration job.

The tower, built on two storeys, was one of 13 built by Grand Master de Redin in 1658 to watch over the Maltese coastline and warn of

(Continued on page 12)

Plate 6.3 Malta, limits of Wied iz-Zurrieq: Vandalism on 17th century coastal watchtower built as part of the defence of the coastal rural areas. Source: The Times [of Malta] 15 August 2001

6.7.5 Presentation of data

Table 6.15 RESIDENTIAL AREAS, ROADS AND HISTIORIC SITES. Land use distribution for Malta, Gozo, Comino and the Maltese Islands.

	Hectares				Per cent			
Segment	**residential areas**	**public utilities**	**historical sites**	**Total**	**Resid ential areas**	**public utilities**	**historical sites**	**Total**
I	-	2.1	0.7	2.8	-	1.4	0.5	1.9
II	1.7	20.5	120	34.2	1.1	13.2	7.7	22.0
III	-	5.3	0.1	5.9	-	3.4	0.1	3.5
IV	5.1	5.3	1.1	11.5	3.3	3.4	0.7	7.4
V	4.1	26.6	29.1	59.8	2.6	17.2	18.8	38.6
VI	-	0.8	*	0.8	-	0.5	-	0.5
VII	2.2	5.8	0.2	8.2	1.4	3.8	0.1	5.3
VIII	4.4	9.1	2.9	16.4	2.8	5.9	1.9	10.6
IX	-	0.2	10.1	10.3	-	0.1	6.5	6.6
X	-	-	0.1	0.1	-	-	0.1	0.1
XI	-	1.1	0.2	1.3	-	0.7	0.1	0.8
TM	17.5	76.8	56.5	150.8	11.3	49.7	36.5	97.3
XII	-	-	0.6	0.6	-	-	0.4	0.4
TC	-	-	0.6	0.6	-	-	0.4	0.4
XIII	-	-	-	-	-	-	-	-
XIV	1.1	0.7	-	1.8	0.7	0.5	0.1	1.2
XV	-	1.6	0.1	1.7	-	1.0	-	1.1
XVI	-	-	-	-	-	-	-	-
TG	1.1	2.3	1.1	3.5	0.7	1.5	0.1	2.3
GT	18.6	79.1	28.3	154.9	7.0	51.2	36.9	100

Source: Estimated by author from field data and cartometric measurements

Key
I to XVI - coastal segments (rows)
TM - Total of values for Malta
TC - Total value for Comino
TG - Total of values for Gozo
GT - Total of values for the Maltese Islands
* - less than 0.1 ha

6.7.6 Discussion and analysis

The main factor that distinguishes this land use category is the fact that, out of the total area of 154.9 ha, about one-half is taken up by roads. There are many reasons for this:

- roads parallel to the coastline are to be found along most of the littoral length of the coast;
- in urban or built-up areas the road is the main line of communication between the coastal zone and its hinterland;
- essentially it is areas that have a good accessibility along their littoral that have had roads constructed all along their coastal perimeter.

The apparently limited area (18.6 ha) occupied by the residential areas land use category is conditioned by the coastal zone limit extending only up to the first line of buildings and therefore the full extent of the residential areas is not included in the figures. The distribution of residential areas is best examined from the figures presented in Table 6.22, with the main concentration of these land uses being in the urban coastal areas. Figure 6.4 shows the distribution of the land uses under discussion in this section. The highest figures are for segments IV, V and VII, the continuous belt from St. Julians (Segment IV) to Kalkara (Segment V) in the Harbour areas and around Marsaxlokk Bay (Segment VIII). For the other areas of the coast smaller values occur in segments VI, with the cluster of houses at Xghajra, and Marsalforn in Gozo in Segment XV.

As the limit of the coastal zone for urban areas extends only to the line of first buildings the area occupied by roads along the urban coastal areas is high with over three-quarters of the area forming the bulk for this category. Practically all coastal segments are represented, with the exception of segments I, VII and XI. All segments in Gozo are sparsely represented due to the fact that access roads from the hinterland to the coastal areas are not parallel to the coast but perpendicular to it. This is basically due to topography, with access roads running along valley bottoms to the shoreline as a solitary line of communication. The V-shaped valley system in north west Malta and in Gozo precludes a coastal road network.

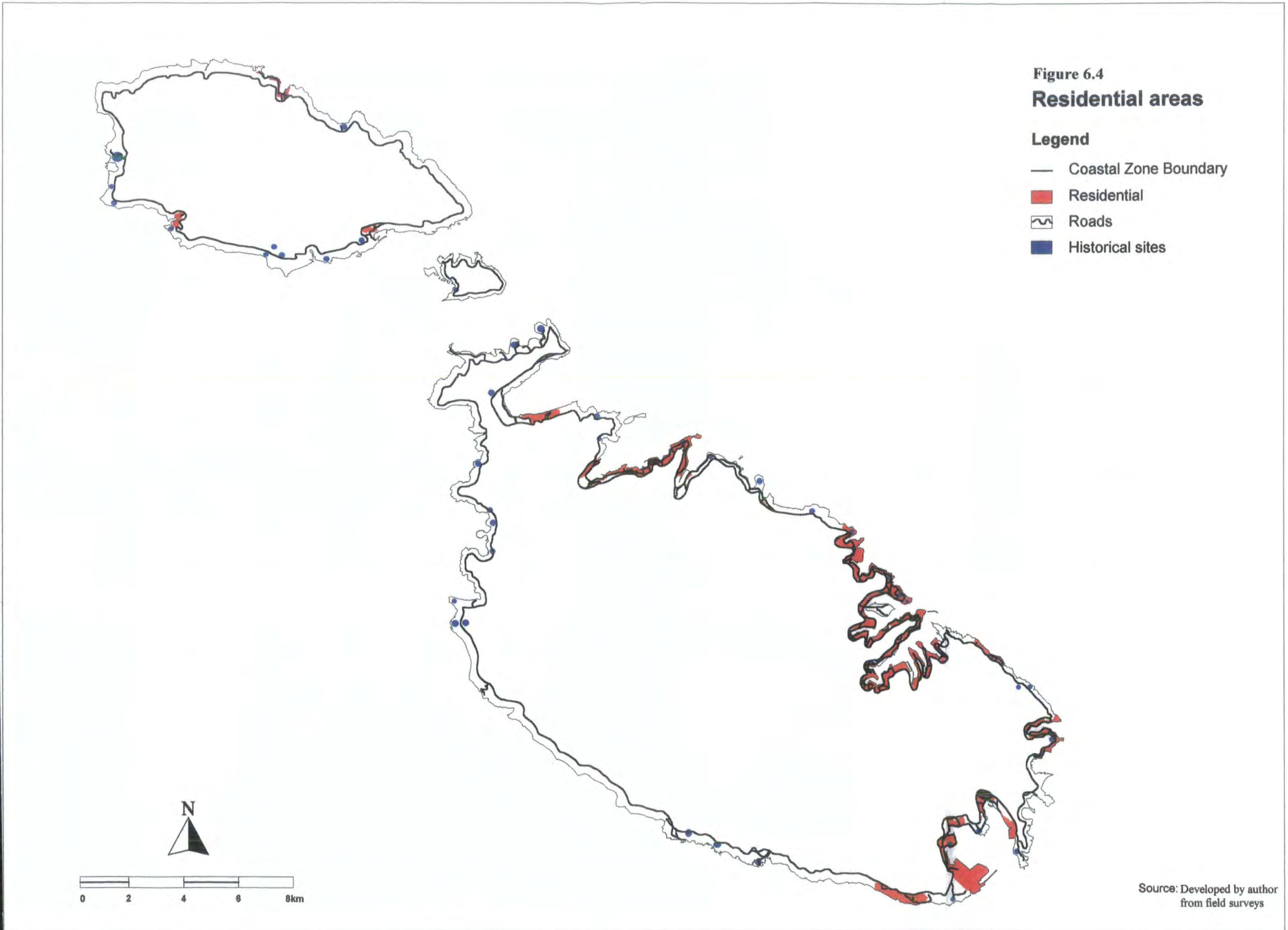


Figure 6.4
Residential areas
Legend
Coastal Zone Boundary
Residential
Roads
Historical sites
N
0
2
4
6
8km
Source: Developed by author from field surveys

The high figure for segment V at 26.6 ha and contributing 33.63 per cent of the total is accounted for by the following for the Grand Harbour and *Marsamxett* Harbour littorals:

a) both have indented stretches of coastline in the islands, with a combined length of about 25km; and
b) the length is skirted by a shore platform or low-sloping rocks throughout. This has provided access to and along the shoreline, with the result that the natural rock outcrop has slowly been replaced by roads, promenades and other facilities all round the littoral for the establishment of services along the land/sea interface.

The other notable figures in segments II, IV and VIII all represent road areas for urban waterfronts, with roads running parallel to the water's edge. The case of segment III at 5.3 ha is accounted for by the fact that a purposely built scenic road along a rural coastal area, known as "The Coast Road," is located between Ghallis Point through Bahar ic-Caghaq and almost up to St. George's Bay.

The analysis of these roads in conjunction with the general topography of the coast shows up a number of negative points, since the roads were constructed with little planning forethought, especially where located near to the shoreline with a buttressing wall. Thus a number of problems have been identified:

a) Storms make roads impassable at times and damage is caused to retaining walls and coastal furniture such as lamp posts and benches;
b) A limited area of shore platform is available for recreational and other purposes; and
c) The presence of a sea wall a few metres behind some sand beaches has been cited as one of the reasons for the depletion of the sand beaches in basic textbooks on physical geography (eg. Strahler and Strahler, 1984). Beaches at Balluta Bay, St. George's Bay, St. Paul's Bay and St. George's Bay at Birzebbugia have practically disappeared because the natural conditions that maintain sand on the foreshore have been altered.

The figures presented show that Malta has 97.3 per cent of the area of historic sites found on the littoral of the islands as a whole. This is mainly due to:

a) the extensive network of fortifications in the Grand Harbour area; and,
b) the fact that the long accessible coastline of Malta needed defensive works that could deter any invaders. As shown in Chapter 4 these fortifications were developed mainly by the Knights and later the British.

The figures presented show a total area of 58.3 ha of monuments, of which one-half is located around the Grand Harbour. The high priority of coastal defence is demonstrated by their presence along most of the littoral. Only in areas where the sea to land accessibility is low are coastal fortifications not represented. However, small watch towers built by the Knights and pill boxes built by the British in the defense of the islands during the Second World War are not quantified because the area they cover is very small.

The data in Table 6.15 indicate a 2.9 ha for segment VIII, and 10.1ha for segment IX. This represents the fortresses built by the British in response to improvements in the technology of warfare. In all two cases the forts were built in areas highly inaccessible from the sea at Delimara and Benghisa (both in Segment V). In addition, a number of Knights' fortifications were upgraded by the British and in a few cases their spatial extent increased, such as at Fort St. Lucian at Marsaxlokk Bay (Segment VIII). The British also superimposed a number of pill boxes on top of Knights' fortifications around the Grand Harbour area (Segment V), although these additions did not influence the spatial extent of the fortifications. As a general trend, coastal fortifications built by the Knights' protected mainly the highly accessible areas, whilst the British built theirs in areas where sea/land accessibility was poor.

The coastal defensive historical sites have a unique spatial distribution that largely repeats itself in most of the inlets and larger bases along the coast of Malta. Their distribution in the 16th and 17th centuries followed a pattern of having watch towers at the outer precincts of peninsulas enclosing bays and fortifications with fire power at the inner areas of the same bay. The latter included redoubts, batteries and also the occasional *fougasse*, a circular man-made hole in the rock that when filled with explosives and sharpnel is ignited on the approach of the enemy (Hughes, 1993). In areas where accessibility was difficult, the system of watch towers was the only means of defensive works utilized as at the coastal area from Wied iz-Zurrieq to Marfa (Segments IX to XI) on the western coast of Malta. In areas where the littoral zone was mainly one with a predominantly linear coastal pattern and few inlets of note, but also highly accessible from the seaward side, entrenchments and low defensive walls were constructed such as along the north Malta coast between Marfa and il-Ponta ta' l-Ahrax. During the British period the geography of coastal defences was concentrated on the building of large forts such as at Delimara, Benghisa, Madliena and San Leonardo. In the Second World War in addition to the pill boxes, rows of barbed wire and iron stakes screened the whole coastal littoral.

6.7.7 Conclusion

The general impression given of the first two land-use categories is one where the urban element is highly represented. This is seen from the fact that, in the subsequent sections dealing with the other land-use categories, the urban land uses are not prominent. However, the next land use to be discussed is the industrial areas, where again the coastal urban fabric is the focal point of the discussion.

6.8 Extractive Industries and Maritime Industrial Development Areas (Industry)

6.8.1 Introduction

In an attempt to limit the number of major land use categories and to help in the process of data reduction (cf. Section 5.14), all "industrial" activities that were within the coastal zone boundary were grouped together. However, two main types of industrial activities have been identified:

(a) the extractive group: salt-panning, quarrying and reverse osmosis (R.O.) plants; and

(b) the maritime-related servicing industries located exclusively within Grand Harbour and Marsaxlokk Bay group: Malta Drydocks, the Tank Cleaning Farm; the Power Stations in both sites; the Grain Silo Storage facilities; the Container Terminal; all fuel storage depots.

However, some distinctions can be made within the "extractive" group. The location of salt panning areas and the Reverse Osmosis (R.O.) plants are totally dependent on proximity to the sea, whilst stone quarrying is just an extension of an inland activity and a number of sites just happen to be on the and within the Coastal Zone boundaries. The distribution of these land use categories in this segment is shown in Figure 6.5.

6.8.2 Background Information

The industrialisation of the Maltese islands has experienced a marked increase in tempo in the last thirty years. The gainfully occupied population amounts to 137,387, 38.3 per cent of the population with a Gross National product per head of Lm 3092 in 1998 - an increase from Lm2112 in 1991 (Central Office of Statistics, 1993). Only 4 per cent of the working population is engaged in the construction industry, with only 1.4 per cent of workers employed directly in quarrying (National Statistics Office, 2002). The efficiency of new machinery and advances in the technology of building equipment has permitted a decrease in the employment of workers in quarries from 618 in 1965 (Balm, 1996) to 318 in 1997 (Central Office of Statistics, 1999). The emphasis of industrialization has been has been predominantly two-fold: first, on light industry based mainly inland around the harbour conurbation manufacturing textiles, footwear and electronic components accounting for 43.3 per cent of the work force in about 2600 establishments (National Statistics Office, 2001c), and, secondly, on heavy and servicing industry based on the coast especially in Grand Harbour and lately also in Marsaxlokk Bay. As for the primary industry, the extractive industries of salt production, desalination and quarrying are the main components. Together with tourism, industrialization has been one of Malta's main foci for economic development.

The main economic efforts have centred around shifting an economy based on servicing the British military base to one of economic sustainability based on a strong infrastructure and on the twin pillars of tourism and industrial output. The latter can be conveniently divided into the light industrial sector that produces textiles, leather and microchip components and the heavy industrial sector that is concerned with ship servicing and repairing. Whilst the former has a relatively recent history, spanning the last 40 years, the latter has its origins dating to the Knights of St. John, when the area around Grand Harbour was turned into a ship building and repairing port. This tradition was retained by the British, who maintained the harbour as the main base of their Mediterranean Fleet. The post-independence period saw the addition of further developments along the harbour littoral. These were mainly concentrated on the provision of cruise liner and yacht marina facilities. The most recent issue to emerge in the coastal zone development of the Grand Harbour concerns the changes to the waterfront of the Cottonera littoral, as a result of a project for the rehabilitation of the area. In this project part of the Drydocks will be turned into a yacht marina-hotel-artisanal workshop facility. The project was first proposed by the present author in November 1993 at a workshop (Schembri and Borg, 1997). In their review the conveners of the workshop and authors of the proceedings (Fsadni, C. and Selwyn T., 1997) commented that here "a future is imagined in which tourism acts as a catalyst that can anchor the local population to its ancestral links and at the same time earn them a living" and they labelled this plan as "enlightened intervention in the Maltese walled cities" (page 10).

The land uses extant in the coastal zone of the Harbours are partly a reflection of this development spanning centuries of effort. The industrial base of Malta is spread further inland and includes a manufacturing sector made up of 1632 establishments and employing about 28,000 persons. These include 12 industrial estates, 11 of which are in Malta (National Statistics Office, 2002), and all located beyond the coastal zone delimitation used for this thesis. As for the building of the infrastructure necessary for this economic diversification, the primary products of stone and spall were obtained as a result of the development of the extractive industry. These quarries of open-cast extraction of natural rock are mainly located inland but are represented on the coast by a small number of derelict sites.

Reverse Osmosis (R.O.) Plants are used to convert sea water into potable water. The first Plant was introduced to Malta in 1982 at Ghar Lapsi on the south coast of Malta (Segment IX). Since then four other plants have been set up. These are located at Cirkewwa (North coast), Pembroke (East coast), Marsa (Grand Harbour) and Tigne (Marsamxett Harbour). Plans are in hand to commission another plant on the South east coast. The main idea behind these Plants is to combat water shortage for domestic, industrial and other needs associated with tourism and other forms of recreation. The production of water from these Reverse Osmosis plants is in the region of 112 million m^3 per year (1999/2000 estimates by the National Statistics Office (2002)). These are added to the water extracted from underground sources, which is 19.2 million m^3 per year, in addition to 0.4 million m^3 of distilled water from the Marsa plant per year (National Statistics Office, 2002). The latter is used mainly for the Power Station augmented by R.O. Plant water production to a total of about 185,000 m^3 per day. In addition the storage capacity of all surface reservoirs totals 0.5 million m^3. Reverse Osmosis (R.O.) plants have been the modern answer to combat water shortage in the island of Malta. As with land use type, they have been included within the extractive elements in that they make full use of drawing sea water and converting it into potable water, pumping out residue water with a higher salt content. The locations of the five R.O. plants near the shoreline fall within the coastal zone boundaries of this study. The construction of each consists of a pipe network that leads to a filtering station. In essence it is the station itself that takes up the space and not the pipe networks leading to and from the sea. For security purposes each RO plant has controlled access and is fenced off, thus demarcating precisely the land use limits and helping to identify easily the area occupied.

Another facet of water production in the Islands deals with the production of water for irrigation. A Sewage Treatment Plant situated at Sant Antnin limits of Marsascala (Segment VII) has increased its production capacity from 372 million litres in 1984 to 1562 million litres in 1993. This plant produces second class water which is used to irrigate fields in the south east of Malta (Malta National Report, 2002), and the agricultural production of this region has been enhanced. The problem of water shortage is rather acute during the summer and the R.O. Plants have provided a practical answer to the water shortage problems in Malta.

Quarrying is another important economic activity, not only as it yields one of the few natural resources of the Maltese Islands, i.e. stone for building purposes, but also because it provides employment for around 845 persons in 70 establishments and an associated 6429 persons in the construction industry (National Statistics Office, 2001b).

6.8.3 Justification for study

Each type of land use has its own justifiable reasons for inclusion in the land use study. Salt panning is largely compatible with the environment, having a low-profile, though a fairly long littoral spread on the low sloping Lower Globigerina promontories along the eastern seaboard of Malta and on the northern and southern shores of Gozo. Salt-pans are one-metre square rectangular 10-cm deep pools etched into the rock surface. The Globigerina rock surface is the only rock type in Malta and Gozo that possesses the "soft" lithological qualities permitting the construction of these pools. Sea water placed in the pools evaporates, leaving salt sediment to be harvested. Three harvests are produced between May and October. However, the presence of these pools precludes alternative or overlapping land uses, especially during the spring and summer harvesting season when trespassing is unwelcome.

The extensive and highly commercialised industry at Salini Bay is also included within this land use sub-category, although the salt manufacturing network is much larger. The method of production utilizes the shallow, narrow and sheltered inlet of Salini Bay and the trapping of sea water in the inner recesses of the bay by means of a system of dykes facilitates the production of the salt through evaporation. Access on to the working surface is made by a system of fixed wooden pontoons.

The benefits of the presence of R.O. plants at Cirkewwa, Ghar Lapsi and Pembroke are debateable. The first two are located in areas where they interfere with the generally low profile of the coast. At Pembroke the noise generated by the plant is inconvenient to the residents. The RO at Tigne is less conspicuous both within the built aesthetic form and its audibility from nearby built-up areas. The remaining structure at Marsa will be considered separately along with the whole Grand Harbour industrial complex.

In justifying the inclusion of quarrying within the coastal extractive industries one may cite a number of points regarding the four locations investigated, two in Malta and two in Gozo. Quarries are the most striking feature in a "reworked" landscape in the Maltese Islands (Balm, 1996). The Maltese attachment to stone has been around since prehistoric times and the numerous archaeological sites with large Megalithic temples bear witness to "sacred island" status. The military fortifications surrounding Grand Harbour and other sites (Hughes, 1993), and the large Baroque churches in all towns and villages bear witness that the Maltese have used local stone for all buildings from residential and worship purposes to the needs for defence of the territory. Although the use of local quarried stone decreased by 50 per cent between 1988 and 1993 and the use of the concrete block and cement increased at the same time, the pressure on extending the quarries is great. Although quarrying is an essentially inland function that utilizes the Globigerina and Upper and Lower Coralline Limestone, there are four cases where it is located within the coastal zone. In all cases the quarries also break through the coastline. Aesthetically it is probably the most negative of all coastal industrial activities. The management of quarries, and their proper utilization, is a challenge that needs to be taken up seriously.

6.8.4 Definitions and criteria used in field identification

Citing the sources used previously for the other land-use categories for definitions pertaining to this section, a problem arises with defining those structures that protect and service shoreline facilities, as the same structures are also classified under the recreational areas category. So as to eliminate the problem, the same definition will be used for both recreational and industrial servicing facilities. A distinction will be made according to the type of sea-use associated with the littoral area under discussion. The definition is reproduced in full.

1. "Shorelines protection facilities include breakwaters, groynns, bulkheads, jetties, and other structures, the purpose or effect of which is to control, or prevent, the erosion of coastal features.
2. Riprap is a foundation or sustaining wall of stones placed together without mortar.
3. A revetment is a structure built to armour a sloping shoreline face composed of one or more layers of stone or concrete rip-rap. A revetment blankets, and generally conforms to, the contours of a coastal feature.
4. A groin is a structure built of rock, steel, timber, or concrete that extends from a beach into tidal waters and is used to entrap sand; groins are generally perpendicular to the shoreline's coastal trend.
5. Breakwaters and jetties are fixed or floating structures that protect a shore, harbour, anchorage, or basin by intercepting waves.
6. A bulkhead is a structure or partition built to retain or prevent sliding of the land and protect the inland area against damage from waves.
7. A seawall is a massive bulkhead with a vertical, curved, or stepped face designed to withstand the direct onslaught of ocean waves (Olsen and Seavey, 1990, 84).

(a) Maritime-related industrial activities.

The areas have specific functions:

a) shipbuilding;

b) ship repairing;

c) grain silo site;

d) tank cleaning farm;

e) power stations;

f) container terminal; and

g) hydrocarbon strategic facilities.

Identification is straightforward. These areas, besides having the industrial equipment that identifies each one, have a littoral made up of concrete platforms, jetties, wharves, slipways, servicing rooms, offices and other buildings associated with their functioning. The only mapping I used for these was in the identification of their limits and boundaries.

(b) Extractive Industries

Extractive Industries are of three kinds:

(a) those associated with quarrying where open pit systems are used to exploit the natural resource of Upper and Lower Coralline and Globigerina Limestone for building purposes and also for the construction of roads, coastal land reclamation, and the production of concrete;

(b) those associated with the utilisation of the sea water for the production of potable water through Reverse Osmosis (RO) plants; and

(c) those associated with salt production (Plate 6.4, p201).

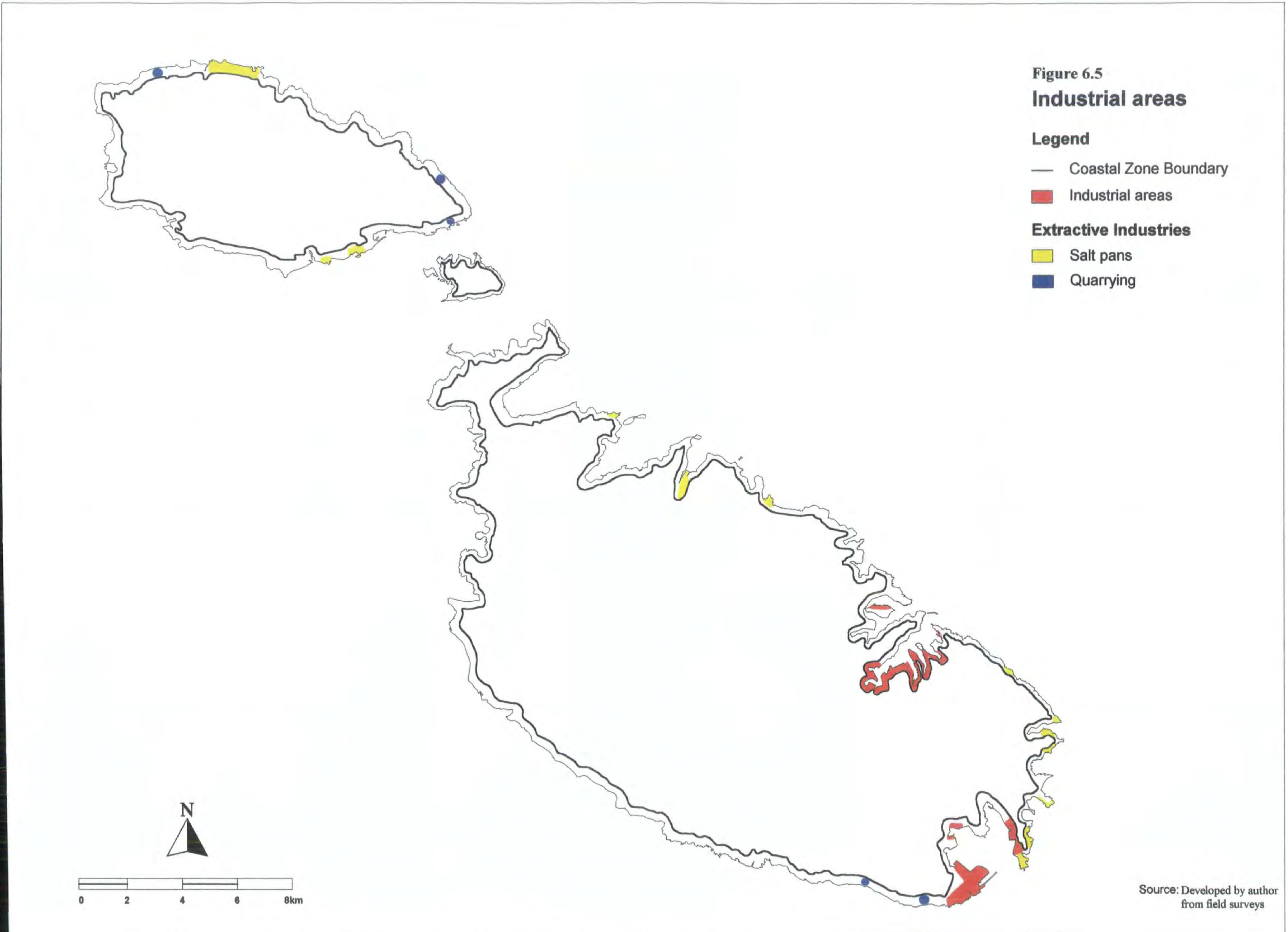


Figure 6.5
Industrial areas
Legend
Coastal Zone Boundary
Industrial areas
Extractive Industries
Salt pans
Quarrying
N
0
2
4
6
8km
Source: Developed by author from field surveys

6.8.5 Presentation of Data

Table 6.16: EXTRACTIVE INDUSTRIES and MARINE INDUSTRIAL AREAS (MIAs). Land use distribution for Malta, Gozo, Comino, and the Maltese Islands.

	Hectares			Per cent		
	extractive industries	**industrial areas**	**Total**	**extractive industries**	**industrial areas**	**Total**
I	<0.1	-	<0.1	< 0.1	-	< 0.1
II	8.2	-	8.2	5.3	-	5.3
III	0.5	-	0.5	0.3	-	0.3
IV	2.5	-	2.5	1.6	-	1.6
V	0.6	79.0	79.0	0.4	54.9	55.3
VI	1.8	3.4	5.2	1.2	2.2	3.4
VII	2.3	0.1	2.4	1.4	< 0.1	1.4
VIII	< 0.1	33.9	33.9	< 0.1	21.7	21.7
IX	6.9	-	6.9	4.4	-	4.4
X	-	-	-	-	-	-
XI	0.1	-	0.8	< 0.1	-	< 0.1
TM	22.8	116.4	139.2	14.6	78.8	93.4
XII	-	-	-	-	-	-
TC	-	-	-	-	-	-
XIII	5.5	-	5.2	3.5	-	3.5
XIV	1.4	-	1.4	0.9	-	0.9
XV	2.7	-	2.7	1.7	-	1.7
XVI	0.6	-	0.6	0.4	-	0.4
TG	10.2	-	10.2	6.5	-	6.5
GT	33.0	-	144.4	22.1	78.8	100

Source: Estimated by author from field data and cartometric measurements

Key
I to XVI - coastal segments (rows)
TM - Total of values for Malta
TC - Total value for Comino
TG - Total of values for Gozo
GT - Total of values for the Maltese Islands

6.8.6 Discussion and Analysis

Table 6.16 gives an indication of the spatial spread of the Extractive Industry and Maritime Industrial Areas, and Figure 6.5 indicates their location along the littoral. The main consideration seen from this table is that, whilst the areas occupied by the extractive industry are spread around the whole littoral of the archipelago, those in the secondary and tertiary categories are a highly localised. In fact, the latter are found in Segments V and VIII and more specifically in the Grand Harbour and Marsaxlokk Bay. Further intensification of these land uses is evident, as only the inner recesses of Grand Harbour are occupied by marine industrial areas. Out of a total of 144.4 ha, 93.4 per cent are located on Malta, with 77 per cent of these belonging to the maritime industrial services located around the two zones of Grand Harbour and Marsaxlokk Bay. The Gozo coast only has a salt-panning industry. The greater length of indented coastline along the coast of Malta gives more scope for the location of marine industrial facilities as protection from the sea swell is guaranteed more.

The location of R.O Plants near the coast is influenced by a number of factors. The most important are the following:

(a) in areas where accessibility to the shoreline is good;

(b) in areas with high population concentrations, the plants at Pembroke and Tigne' were specifically located to service the water shortage problem in a residential and touristic area, whilst the R.O at Cirkewwa services northern Malta;

(c) an appreciable distance from built-up areas is desirable due to noise problems generated by the R.O. operating plant, although the plants at Tigne and Pembroke do not respect this norm; and

(d) proximity to shoreline areas where longshore drift currents ensure a clean supply of sea water. The supply of sea water to the Plant at Marsa is of inferior quality, however, and the saline water emitted has been partly responsible for upsetting the ecological balance in the inner recesses of the Grand Harbour.

Table 6.17 highlights three factors associated with salt panning:

(a) the comparatively large areas in Segment II including 6.5 ha in Salini Bay, which is the largest area in Malta devoted to this activity;

(b) there are 5.4 ha of salt pans in Segment XII in Gozo ; and

(c) salt panning activity is almost evenly spread along the east coast of Malta, with salt pans present on almost all segments. Malta has a large accessible Globigerina shore area but the comparatively accessible Globigerina area for Gozo is more limited (cf Chapter 1). The people of both islands utilize most possible sites for this extractive industry. A typical land use distribution is shown in Figure 6.6 where salt panning activity occurs on all possible sites along on the foreshore of the south-east coast of Malta where good access from the land is prevalent.

Table 6.17 Salt panning sites presented by site (segment), number of clusters and the approximate area of each cluster.

Segment	Number of groups of salt pans	Area in hectares of each group
II	2	1.8; 6.5
III	2	0.3; 0.2
VI	2	0.4; 1.4
VII	5	0.3; 0.4; 0.6; 0.2; 0.8
XII	1	5.4
XIV	3	0.3; 0.4; 0.7
XV	3	0.5; 1.0; 1.1
XVI	1	0.6

Source: Estimated by author

Table 6.18 shows that an index (F) of serviceable coast per spatial unit of area can be deduced for each of the three Harbours. This indicates the extent of the immediate hinterland of each harbour, especially the industrially-related structures whose location is dependent on maritime proximity. These are specific structures such as the Tank Cleaning Farm at Rinella Bay in Grand Harbour, shown in plan in Figure 6.7. The diagram also serves to show the proximity of the historical fortifications and residential areas in these parts of Grand Harbour. Additional structures are Malta Drydocks the Grain Silo, the Marsa Power Station, Malta Shipbuilding in Grand Harbour; Oil Services in Marsamxett Harbour; and in Marsaxlokk Harbour the Delimara Power Station, Oil and gas storage facilities around the bay and the Freeport Terminals.

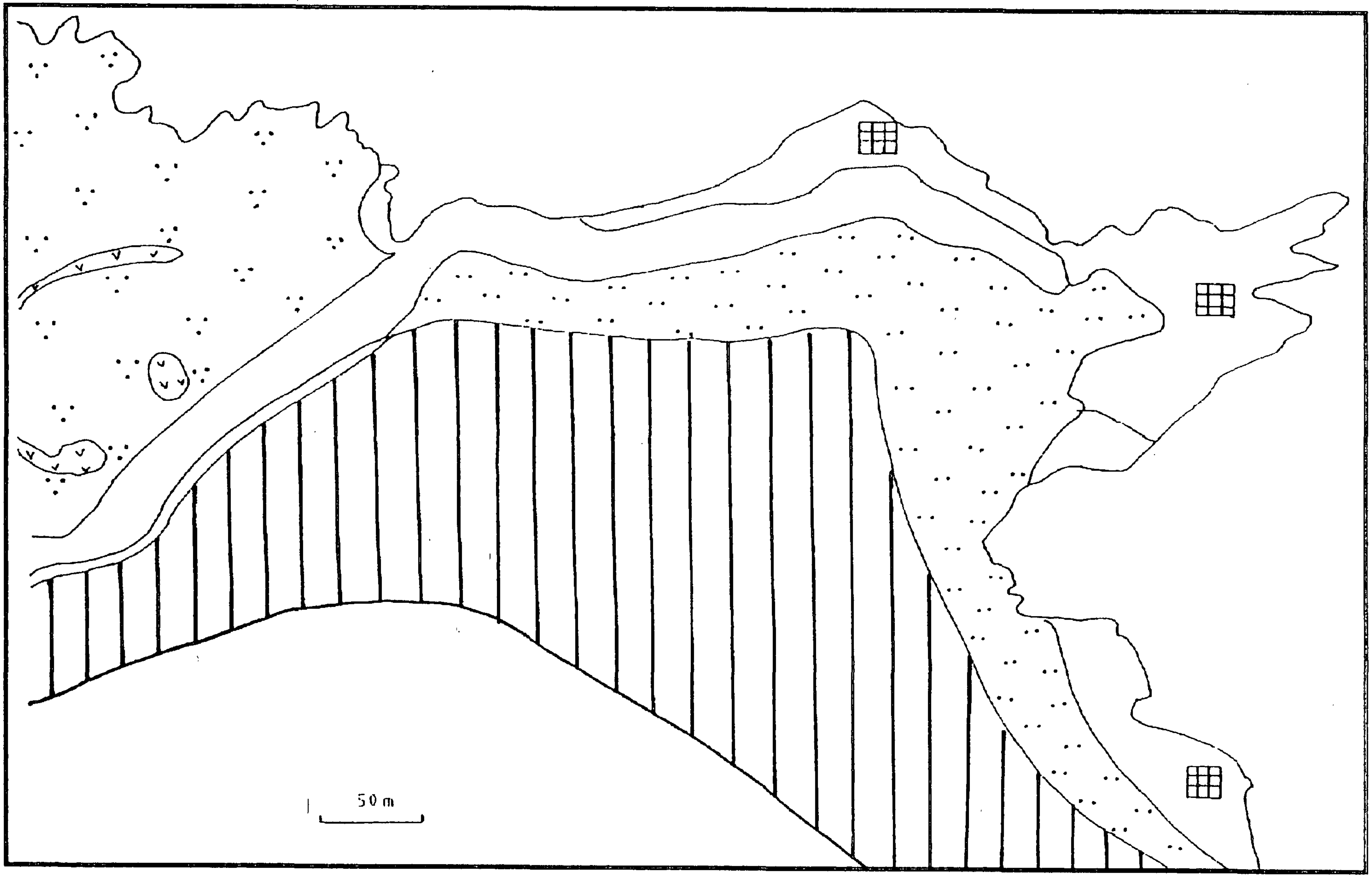


Figure 6.6 Utilization of Shore platform for salt panning sites marked in grids

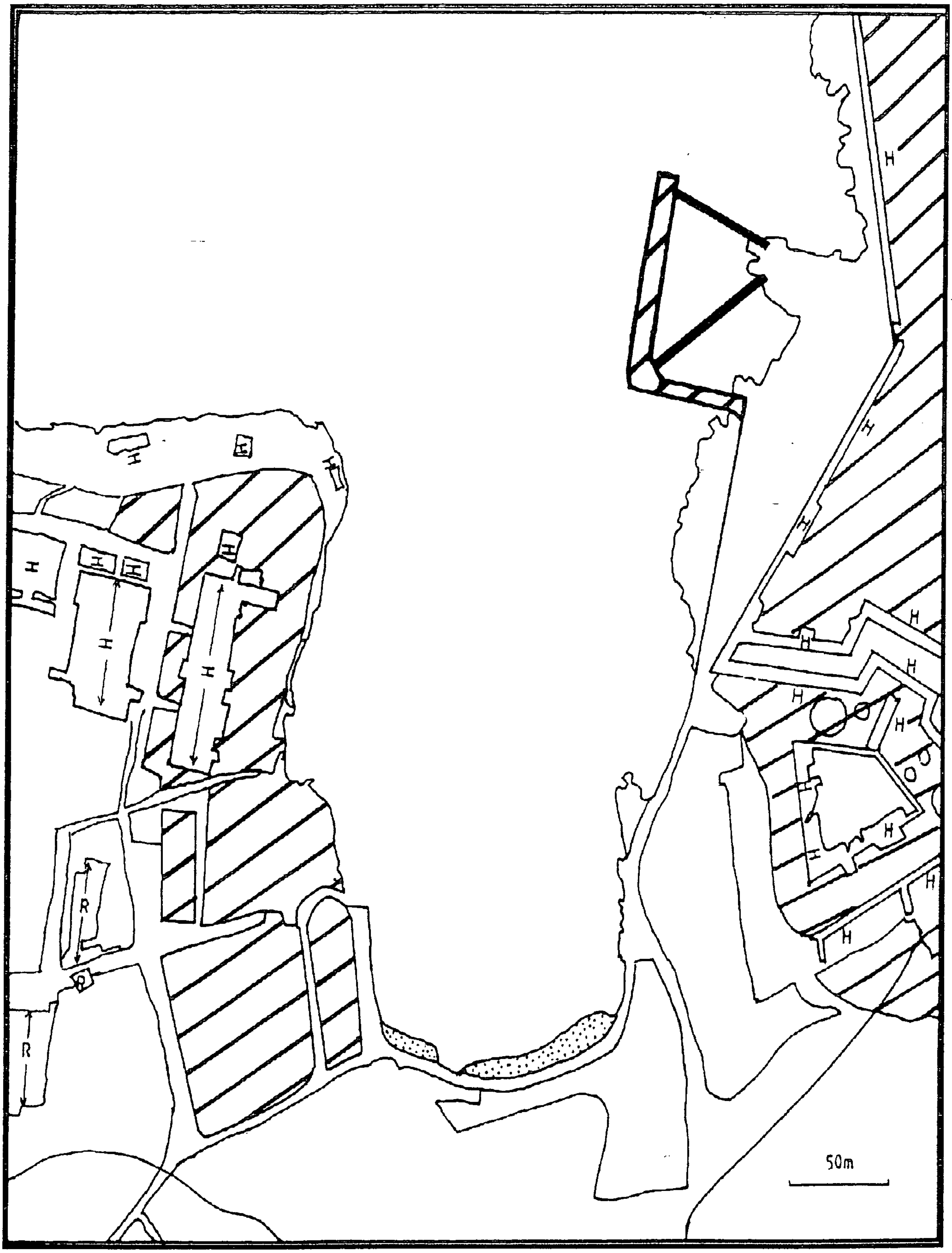


Figure 6.7 Grand Harbour, Rinella Bay: Tank Cleaning Farm adjacent to fortifications and beach

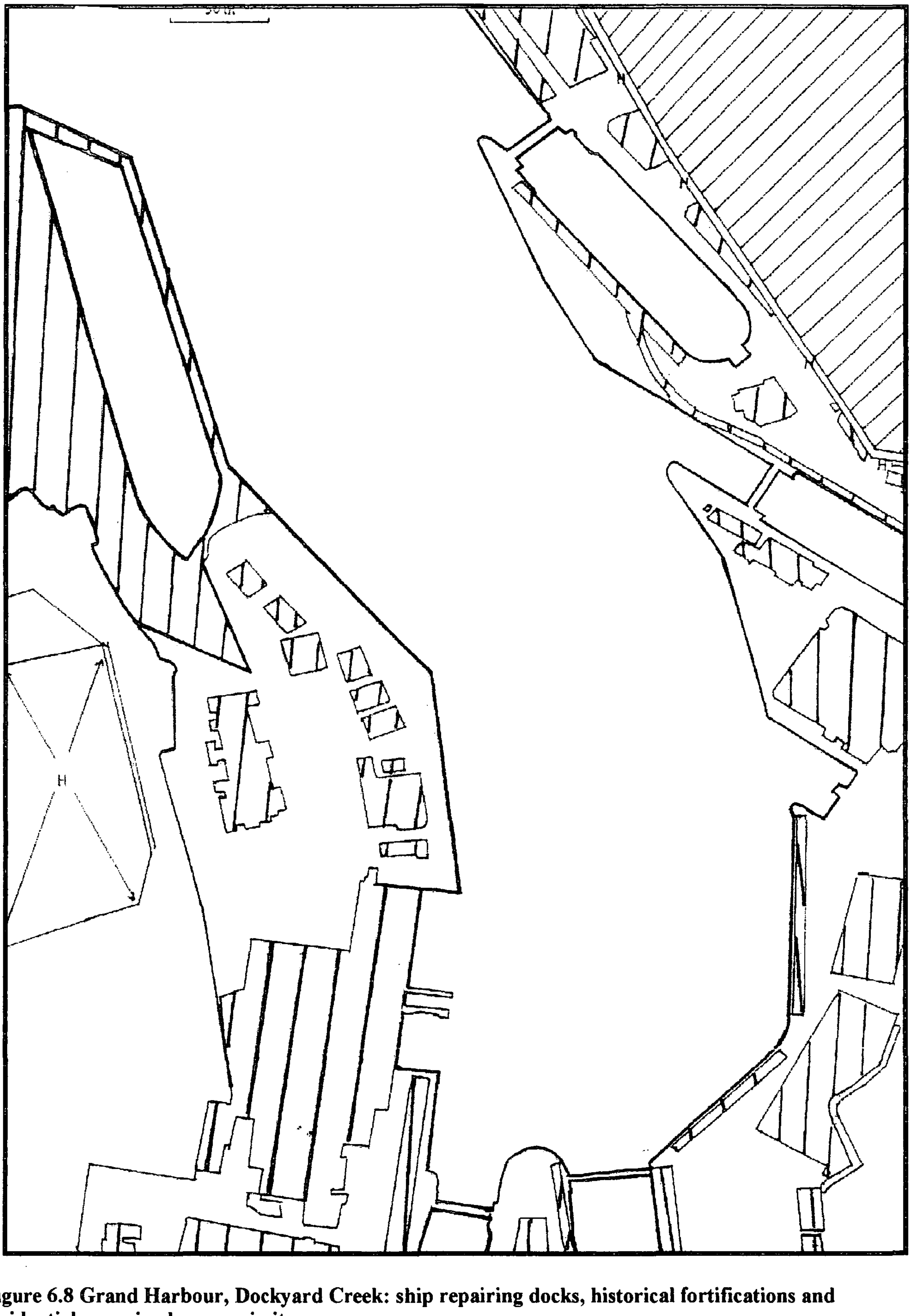


Figure 6.8 Grand Harbour, Dockyard Creek: ship repairing docks, historical fortifications and residential areas in close proximity

Table 6.18 Basic spatial dimensions of Marsamxett Harbour, Grand Harbour, and Marsaxlokk Bay

Location / Dimension	Marsamxett Harbour	Grand Harbour	Marsaxlokk Bay
A Coastal length	10.461 km	15.555 km	10.728 km
B Terrestrial coastal zone area	0.57 km²	1.29 km²	0.85 km²
C Percentage area with primary industry	4.4	0.4	-
D Percentage area with secondary/tertiary industry	-	66.2%	39.9%
E Maritime (water) area	1.390 km²	2.198 km²	4.856 km²
F A/B	0.054 km²/km	0.083 km²/km	0.079 km²/km

Source: Author's calculations

Interest in the development of the harbours in Malta can be seen from the various studies commissioned. In 1968, studies (Government of Malta, Ministry for Public Buildings and Works, 1968) were commissioned for the development of Marsamxett Harbour through a London-based firm, G. Maunsell and partners. In 1991, studies for the construction of a breakwater at the entrance of Marsamxett Harbour (Malta Development Corporation, 1991) involved a number of U.K. consultants: Allott and Lomax, Manchester; Halcrow and Partners, Swindon; Hydraulics Research, Wellingford. All the reports commissioned mentioned the importance of conserving the historic heritage of the Harbour, that any development should be sympathetic with the surrounding environment and that the transportation links with the immediate hinterland of the harbour should also be considered. In 1997, plans for the development of the existing sea terminal at Grand Harbour (Viset Consortium, 1997), were provided for the Valletta International Sea Terminal. The scale of the development proposals are such as to include within the Terminal a conference centre, amphitheatre facilities, restaurants, family recreational areas besides the improvement normally associated with the flow of sea ferry passengers.

The complete absence of any maritime industrial activity from Kullana to Ahrax Point is due to the fact that the geological nature of the rock strata does not permit coastal quarrying or salt-panning activity, whilst the topographic nature of the terrain makes the western coast very inaccessible. Furthermore, this zone is probably the most aesthetically pleasing natural/semi-natural of environments, where only a limited amount of touristic development has been allowed. The desalination plant at *Cirkewwa* does not fall within the coastal zone boundary line, although the effects of landscaping had a positive aesthetic effect. The other area where no industrial activity is recorded is St. George's to Dragut Point, where touristic and recreational activity is heavily predominant.

The Ghallis to St. George's and Benghisa to Kullana areas have extractive industry along only part of coastal zone. The first has an extensive network of salt pans at Bahar ic-Caghaq, spanning an area of about 0.5 ha the second has the only two quarries located near the coast to have broken completely through the cliff line. These cover an area of about 6.9 ha. The three other remaining zones have by far the highest concentration of industrial activity, with 83.7 per cent of all the industrial activity in Malta concentrated along a coastal length of 36.7 km for the harbours.

6.8.7 Conclusion

In all probability the topographic nature of all three harbours helped to fashion their present-day use. These features include:

a) a heavily indented coastline providing a long land/sea interface;
b) a narrow mouth decreasing the length of unexposed coast, especially for Grand Harbour and Marsamxett;
c) a deep incision inland into the land mass;
d) a deep bathymetry;
e) a minimum of siltation, as the hinterland and catchment areas are not extensive, given the smallness of the island;
f) a significant height of the backing cliffline for Grand Harbour, affording protection from landward winds;
g) a shore platform skirting all three harbours that gives a great accessibility from the sea to the land;
h) a large population living in close proximity to the harbours;
i) a rock structure made of Globigerina limestone that can be quarried to extend the serviceable land area.

6.9 Depositional Environments

6.9.1 Introduction

The 'depositional environments' land use category groups the land uses associated with the deposition of sediments along the shoreline and within the coastal zone. The range of sediments includes mainly the sand beaches, but other elements, such as sediments of terrestrial origin deposited along the coastline as a result of flow of rainwater, are also included. Soil deposits and mud flows, typical of valley-mouth environments, located within the coastal zone at the backshore area of beaches, are cases in point. The depositional environments category forms the only "soft" part of the coast of the Maltese Islands. All the other land-use categories deal with the "hard" elements of rock and concrete.

6.9.2 Background information

Sand beaches are arguably the most threatened part of the local coastal environment. There are many reasons for this. Most of the sand beaches have been sites where intensive coastal development has taken place, resulting first in the removal of the sand dune system at the backshore area, and then in the depletion of the foreshore beach area. The latter was partly due to the hard structures constructed along the littoral in the form of shoreline promenades and concrete structures for boating facilities. Essentially the problems associated with the local coastal environment are partly due to the presence of sand beaches in highly developed areas. As hardly any local literature is available to build up a secondary source base, primary source material derived from field investigation has been utilised in this thesis and also from a study for the Coastal Environment Research Programme (1991) by Professor Ewan Anderson and the author. This study examined the profile and sediment composition of the beaches of Malta. Table 6.19 refers to the beaches survey compiled during this survey all the sites are listed where swimming is suggested by the popular tourist brochures. These can be classified into three categories: sandy beaches, pocket beaches, and rock beaches. The locations are represented in Figure 6.8b. The prevalence of sites in the north and west parts of Malta and northern part of Gozo is clearly evident.

Soil deposits occurred only in selected coastal localities in Malta: Cirkewwa (segment I); St. Thomas Bay (Segment VII); Marsaxlokk Bay (Segment VIII); and Ghar Lapsi (Segment IX). These Quaternary deposits formed during the last 100,000 years are essentially soils deposited from a terrestrial source, mainly from water flow during a previously wetter period. The change in the climatic pattern that gave a drier environment dried up these soil deposits, with time consolidating the deposits into the present formations. The samples extant have survived later marine transgressions (encroachment of the sea) into the landmass.

6.9.3 Justification for study

The area occupied by deposition is the smallest land-use category. However, it forms the focal point for most recreational activity concentrated around sandy beaches, with a number of recreational establishments and facilities for the mooring and launching of sea-craft. Land use competition occurs around these zones. As a consequence, these are considered as areas where the greatest ecological problems are encountered. In fact, Plate 6.5 shows a group of volunteers attempting to restore a beach to its former condition after fine Coralline aggregate was dumped on the sand by a building contractor prior to concreting over the beach.

Plate 6.4 Malta, Birzebbugia: Typical pattern of salt pans on foreshore with the Container Terminal in background.
Source: The Author

Table 6.19: Beaches in the Maltese Islands : location, users and type of beach

Locality	Foreign and local users	Predominantly local users	Beach
Malta			
Paradise Bay	-	-	S
Cirkewwa	-	-	S, R
Cirkewwa to Ahrax Point	-	-	S, R, (4s)
Mellieha Bay	-	-	S, R (3s)
Imgiebah	(-)	-	S
Blata l-Bajda		-	R
Mistra	-	-	S, R
St. Paul's Bay	-	-	R, s
Bugibba	-	-	R
Qawra	-	-	R
Salina	-	-	R
Qalet Marku	-	-	R, s
Bahar ic-Caghaq	-	-	R, s
St. George's Bay	-	-	S, r
Dragonara Point to Msida	-	-	R
Valletta		-	R, s
Xghajra		-	R
Marsascala		-	R
St. Thomas Bay		-	S, R
Hofra l-Kbira		-	S
Hofra iz-Zghira		-	S
Peter's Pool	-	-	R
Il-Qala it-Tawwalija		-	R
Il-Kalanka tal-Patrijiet		-	R
Marsaxlokk	day-trippers	*	S
St. George's Bay		-	S, R
Birzebbugia		-	S, R
Wied iz-Zurrieq	day-trippers	-	R
Ghar Lapsi		-	R
Migra Ferha	-	-	R
Gnejna Bay	-	-	S
Ghajn Tuffieha	-	-	S (2)
Il-Prajjiet (Anchor Bay)	-	-	S
Gozo			
Xwieni Bay		-	R
Qbajjar		-	S
Marsalforn	-	-	S
Ramla	-	-	S
San Blas	-	-	S
Dahlet Qorrot		-	S
Hondoq ir-Rummien		-	S
Barbaganni Rock		-	R
Mgarr	-	-	S, R
Xatt l-Ahmar	-	-	S, R
Mgarr ix-Xini	-	-	S, R
Xlendi	-	-	S, R
Dwejra	-	-	R
Comino			
St. Nicholas Bay	-	-	S, R
St. Mary's Bay	-	-	S, R
Blue Lagoon	-	-	R

Source: Compiled by author from tourist broucheurs and field survey.

Key: R - rocky; S - sand; s - pocket; 4s - number of pocket beaches; - indicates presence of beach users; blank space indicates lack of beach users.

6.9.4 Definitions and criteria used for field identification

Widien (valleys) also formed part of this land-use category and the main indicator used to delimit the area was *Phragmites Australis* (Great Reed). The topographic and natural water drainage is in part controlled by the presence of valleys into which rain water flows from the catchment area to the seas. *Widien* are characterized by a significant break of slope formed due to faulting or a Horst and Graben type of landscape, and always ending up roughly perpendicular to the coast. The reeds are normally found either in areas where fresh water meets the coastal, more saline, water at the tail-end of a *wied*, or where a perennial stream is found as a result of the puncturing of the Upper Coralline formation at the junction with the Blue Clay formation. In theory, as all *widien* courses drain into the sea, this type of vegetation is to be found all around the islands. But urban, touristic and industrial developments, together with the construction of road networks, running through part of the valley bottom, have decreased the presence of the reeds and their associated environment. Agricultural activity along parts of the coast has also depleted their presence by uprooting them to create space for crop production. In addition, in coastal urban areas or areas where road construction runs through valleys, reeds have also been depleted.

6.9.5 Discussion and analysis

Table 6.20 presents the percentage distribution of the depositional environments category and Figure 6.8 indicates their distribution. The data shows that three-quarters of this land-use category are found on Malta. More than one-third of the depositional environments are located in Segments I and II. Two other significant features are worth mentioning: first, the sand beaches in Segment XI in western Malta, and Segment XIV in northern Gozo. The coastal geomorphological conditions prevalent in these areas are made up of promontories with scree taluses of Upper Coralline Limestone boulders. Wave action erodes the rock scree into small particles that eventually are deposited as sand in the inner recesses of the Bays (Schembri and Magri, 1996).The second significant feature is the 1.9 ha of sand at Marsaxlokk Bay (Segment V). Three main sand beaches occur here, all of which are the result of the artificial replenishment of smaller beaches. These occurred in 1988 for the beach at

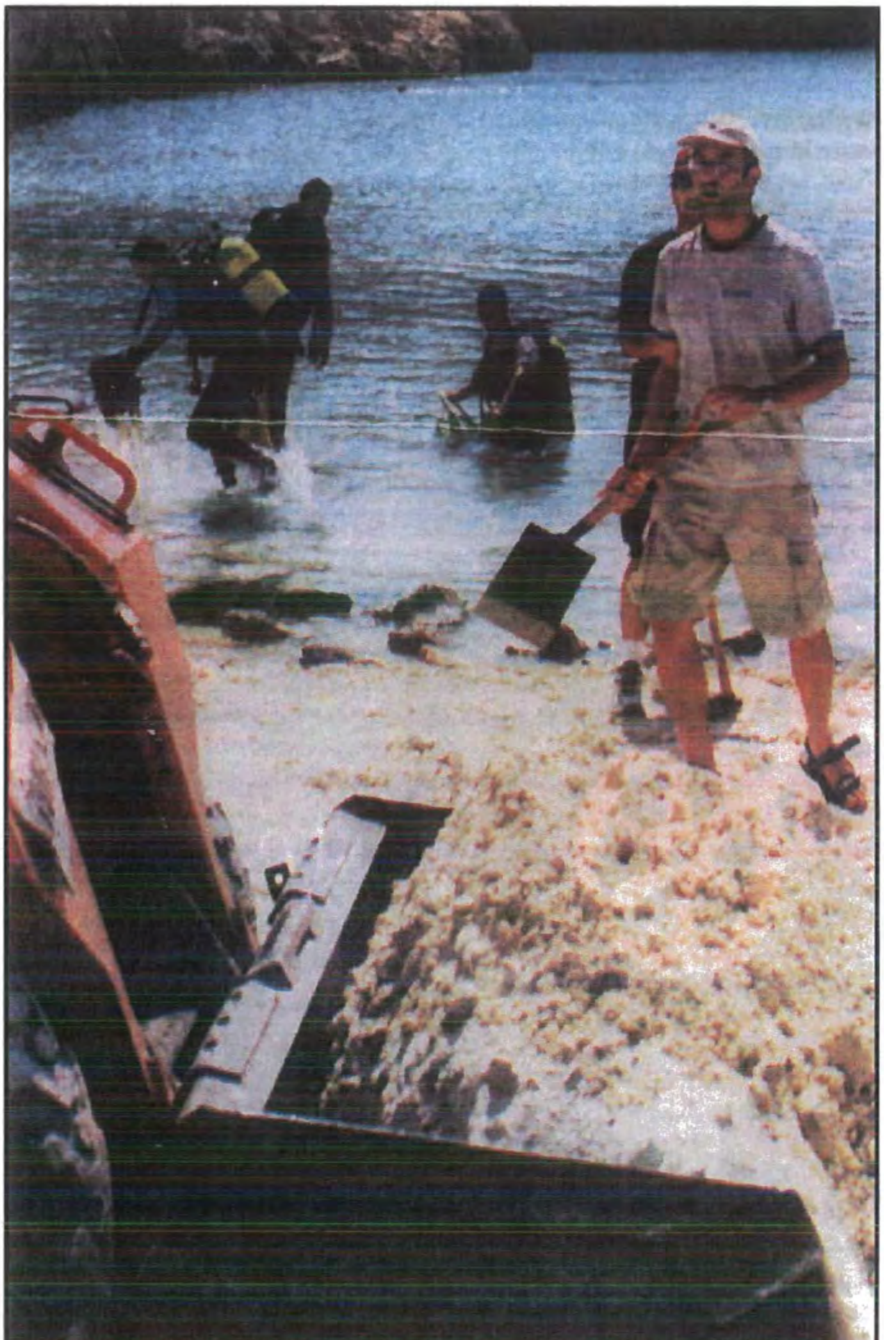


Plate 6.5 a Gozo, Mgarr ix-Xini: Fine aggregate from quarry dumped and mixed illegally over pebble beach by local council authority responsible for the area. Volunteers are attempting to "restore" the beach to its original character following a national public outcry.

Source: The Times [of Malta] 29 August 2001, p 5

6.9.6 Presentation of Data

Table 6.20: AREAS WITH DEPOSITIONAL ENVIRONMENTS. Land use distribution for Malta, Gozo, Comino and the Maltese Islands.

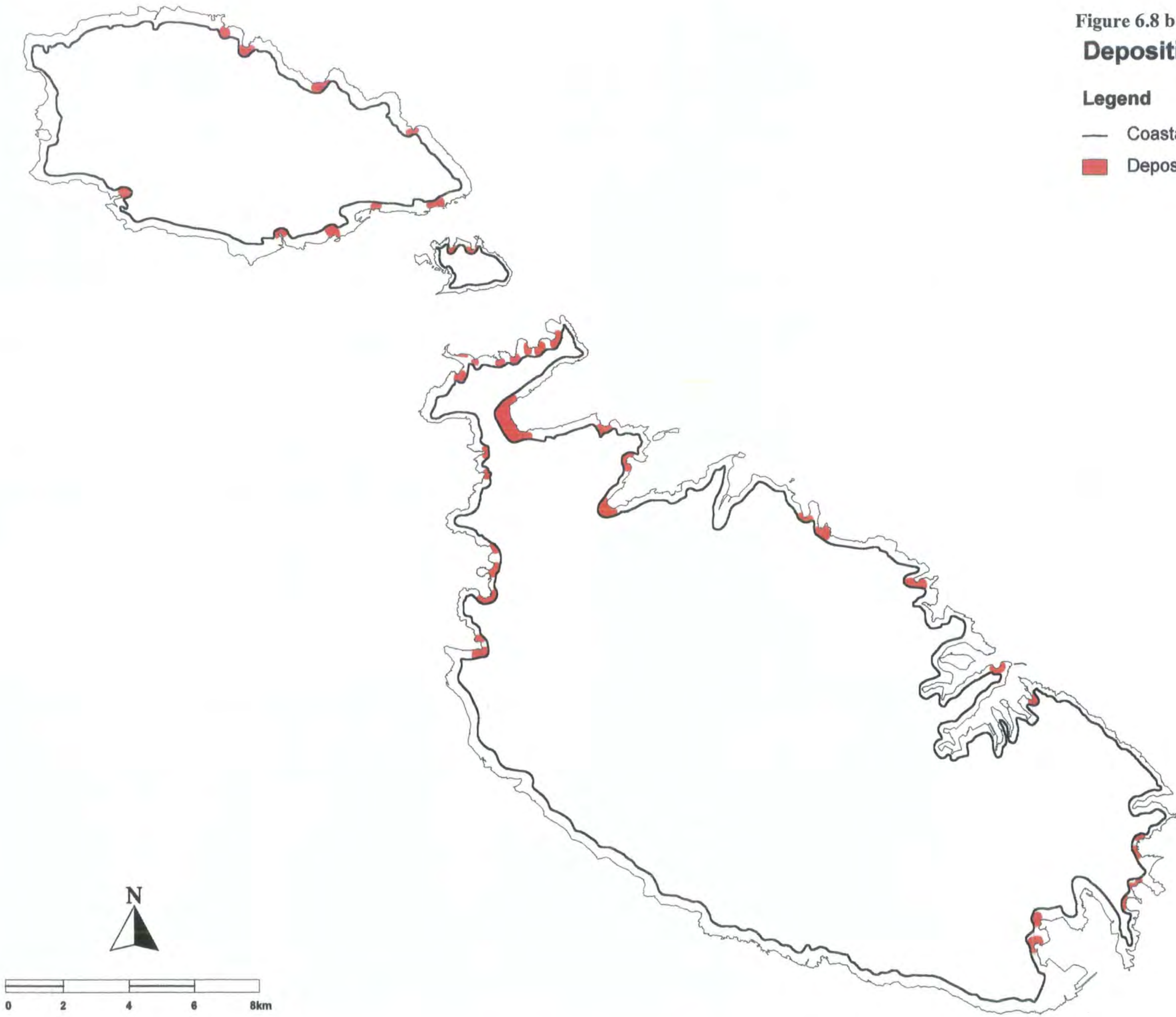
	Hectares		Per cent	
Segment	Areas with depotional environment	Total	Areas with depotional environment	Total
I	2.0	2.0	16.0	16.0
II	2.6	2.6	20.8	20.8
III	0.1	0.1	0.8	0.8
IV	0.1	0.1	0.8	0.8
V	0.1	0.1	0.8	0.8
VI	-	-	-	-
VII	0.1	0.1	0.8	0.8
VIII	1.9	1.9	15.2	15.2
IX	-	-	-	-
X	0.4	0.4	3.2	3.2
XI	2.2	2.2	17.6	17.6
TM	9.5	9.5	76.0	76.0
XII	< 0.1	0.1	<0.1	<0.1
TC	< 0.1	0.1	<0.1	<0.1
XIII	-	-	-	-
XIV	2.9	2.9	23.2	23.2
XV	0.1	0.1	0.8	0.8
XVI	-	-	-	-
TG	3.0	3.0	24.0	24.0
GT	12.5	12.5	100	100

Source: Estimated by author from field data and cartometric measurements

Key
I to XVI - coastal segments (rows)
TM - Total of values for Malta
TC - Total value for Comino
TG - Total of values for Gozo
GT - Total of values for the Maltese Islands

Figure 6.8 b

Depositional Environments



Legend

— Coastal Zone Boundary

■ Depositional Environments

Source: Developed by author from field surveys

Marsaxlokk, material being obtained from the dredging activity in the building of the Power Station; in 1989 for the beach at Pretty Bay in Birzebbugia, using dredged sand from the Container Terminal site (Borg and Schembri, 1995); and in 1998 the beach at St. George's Bay was replenished from the sand at Pretty Bay.

6.9.7 Conclusion

The main concluding comment regarding this land-use category is the fact that depositional environments have an ecological, environmental, economic, and aesthetic value far greater than their size suggests. As a management option, the modern strategy is one where beach replenishment and construction seems to be the popular practice. However, this is being done without creating or encouraging the development of the associated environments linked to beach management. Two main management factors are evident here: the development of nodal areas where sand beaches occur, and the depletion and nourishment of beaches.

6.10 Afforested areas

6.10.1 Introduction

Afforested areas, although small in size, enhance the aesthetic qualities of the larger areas surrounding them, making their proper management crucial. They have been placed alone and also in the middle of the main matrix, where all the land use data is shown. The following points are important with regard to afforested areas:

(a) they are not associated with either the urban or the rural coastal environments;

(b) the plants used are generally prone to changes, both as a result to changes in the physical conditions, such as storms, and also due to human-induced environmental conditions, such as gas emission from vehicles;

(c) the concluding remarks to this thesis place an emphasis on the coastal afforestation projects as a way to improve the environmental quality of the coast, both in the urban and in the rural localities, and to bridge the gap in the aesthetic qualities between the rural and urban coastal environments.

This section focuses on afforestation projects have been used to enhance the aesthetic environment. Figure 6.9 shows their distribution.

6.10.2 Background information

The occupation of the Maltese Islands for the last seven millennia has depleted the natural vegetation cover of the islands. The obvious way of addressing this is to plant new trees and bushes. In fact, a number of reports commissioned by the Department of Agriculture contain details regarding the beneficial returns from afforestation projects. Enhancing the general look of the environment, and the provision of shaded areas in otherwise sun-baked zones, are two of the reasons mentioned. As a result, successive local administrations and local councils have embarked upon such projects. Afforestation projects in Malta were initiated by foreigners: the Knights who planted the largest woodland at Wied il-Luq (Buskett) and the British in embellishing their military establishments, locals reserving the practice with cypress for cemeteries (Borg, 1998). Borg (1998) estimates that since 1957, when the truly local effort at afforestation started to be implemented, the tree cover area increased from 0.5 per cent in the mid-1960s to 1.5 per cent to date, of the total land area. Another estimate put the afforested and wooded areas in Malta at 1.21 per cent (Centro Studi Ricerche, 1976). Although most of the afforestation projects involved land cover of the inland areas some are found within the coastal zone boundary, the most apparent ones are listed in Table 6.21. Success at further tree planting efforts depends on a number of factors such as the choice of suitable sites and establishing good humus-retaining soils (Borg, 1997).

6.10.3 Justification for study

Two problems associated with these plantations are, first, the semi-arid climate prevailing, which is unfavourable to many species, and, second, the generally barren coastal areas of the Islands, which together put increasing pressure on the preservation and up-keep of all afforestation efforts. In addition, we may identify several problems which follow afforestation:

(a) Vandalism, ranging from the uprooting of the young saplings immediately after planting;

(b) Heavy rain that softens the soil;

(c) Chopping of the mature trees;

(d) Trees knocked down by vehicles, especially in areas where trees line main roads;

(e) Illegally dumping of domestic waste. Plants having a number of shoots and branches growing from soil level are more prone to this type of illegal rubbish dumping than plants that grow from a single stem or branch. In addition, being wind-breakers themselves, the plants also trap flying debris, increasing the risk of rubbish accumulation.

6.10.4 Definition and criteria used for field identification

Tree planting in Malta is termed "afforestation" especially when this involves the planting of clusters of trees or in single file normally where they are scarce. Tree planting in public areas in Malta can take a number of forms:

a) planting in a single file, with trees spaced about 3 m apart in rows along either the periphery of roads, on pedestrian walkways (pavements) or in the boundary between the edge of a road and a field. On paved or concrete footpaths the ground is broken up at the intervals where planting is to take place;

b) in clusters along rural slopes and ridges. These areas can be rather extensive, as at Delimara Peninsula (5 ha). The object of such an exercise was to cover as much area of barren ground as possible and to decrease the rate of water run-off from steep slope;

c) in groups, to enhance some of the recreational areas, notably children's play grounds, public gardens and urban coastal promenades such as Marsascala, Sliema and Birzebbugia. Plate 6.6 shows an example of these afforestation initiatives associated with coastal areas.

6.10.5 Discussion and analysis

As a number of afforestation projects consisted also of lines of trees planted along the peripheries of roads, the discussion in this section will examine the land-use dimensions from the linear aspect as well as from the areal perspective. In addition, Figure 6.9 should help in the identification of their location along the coast.

6.10.6 Presentation of results

Table 6.21: AFFORESTED AREAS Land use distribution for Malta, Gozo, Comino and the Maltese Islands.

	Hectares		Per cent	
Segment	**Area (hectares)**	**Total (hectares)**	**Area (per cent)**	**Total (per cent)**
I	1.4	1.4	1.63	1.63
II	21.6	21.6	25.09	25.09
III	4.3	4.3	4.99	4.99
IV	2.1	2.1	2.44	2.44
V	7.1	7.1	8.25	8.25
VI	0.1	0.1	0.12	0.12
VII	6.9	6.9	8.01	8.01
VIII	6.9	6.9	8.01	8.01
IX	2.0	2.0	2.32	2.32
X	7.1	7.1	8.25	8.25
XI	6.5	6.5	7.55	7.55
TM	66.0	66.0	76.66	76.66
XII	0.2	0.2	0.23	0.23
TC	0.2	0.2	0.23	0.23
XIII	1.8	1.8	2.09	2.09
XIV	11.2	11.2	13.01	13.01
XV	6.7	6.7	7.78	7.78
XVI	0.2	0.2	0.23	0.23
TG	19.9	19.9	23.11	23.11
GT	86.1	86.1	100	100

Source: Estimated by author from field data and cartometric measurements

Key

I to XVI - coastal segments (rows)
TM - Total of values for Malta
TC - Total value for Comino
TG - Total of values for Gozo
GT - Total of values for the Maltese Islands

(a) Spatial dimensions

From a total area of 0.86 km^2 identified as coastal afforestation, 0.66 km^2 pertain to the island of Malta, 32 per cent of which is located from Dahlet ix-Xilep to Ghallis Tower, and 22 per c ent from Fomm ir-Rih to Cirkewwa along the western coast. The remaining half is distributed equally between Segments III, IV and VI. Details of these pockets of afforestation are given in Table 6.22.

Table 6.22 Location of afforestation projects in Malta

Location	area (ha)	Sheet number
Mellieha to Mgiebah	10.8	4281, 4080, 4280/4281, 4480,/4481
Delimara Peninsula	6.3	5964 and part of 5865
Pwales	4.6	4478
Bahar ic-Caghaq	4.5	5077, 5078, 5079
South coast	2.1	4467 (Migra Ferha)
Fomm ir-Rih to Cirkewwa	6.3	3872, 3873, 3874, 3875, 4976, 3877, 3878, 4079, 3880, 3881, 3882, 3883.

Source: Estimates based on field data and cartometric measurements

Other pockets of significant dimensions include the western coastal areas from Fomm ir-Rih to Cirkewwa (Segment I) totalling 6.3 ha. The data shown in Table 6.21 gives 86.1 ha as the total area of afforestation for the Maltese Islands, one-quarter of which is located in Segment II as shown in Table 6.23.

Table 6.23 Distribution of coastal afforestation projects located in Segment II

Location	Area (ha)
Mellieha Bay	8.8
Mgiebah	3.0
St. Paul's Bay	5.4
Salini Bay	4.4
Total	20.0

Source: Estimates based on field data and cartometric measurements

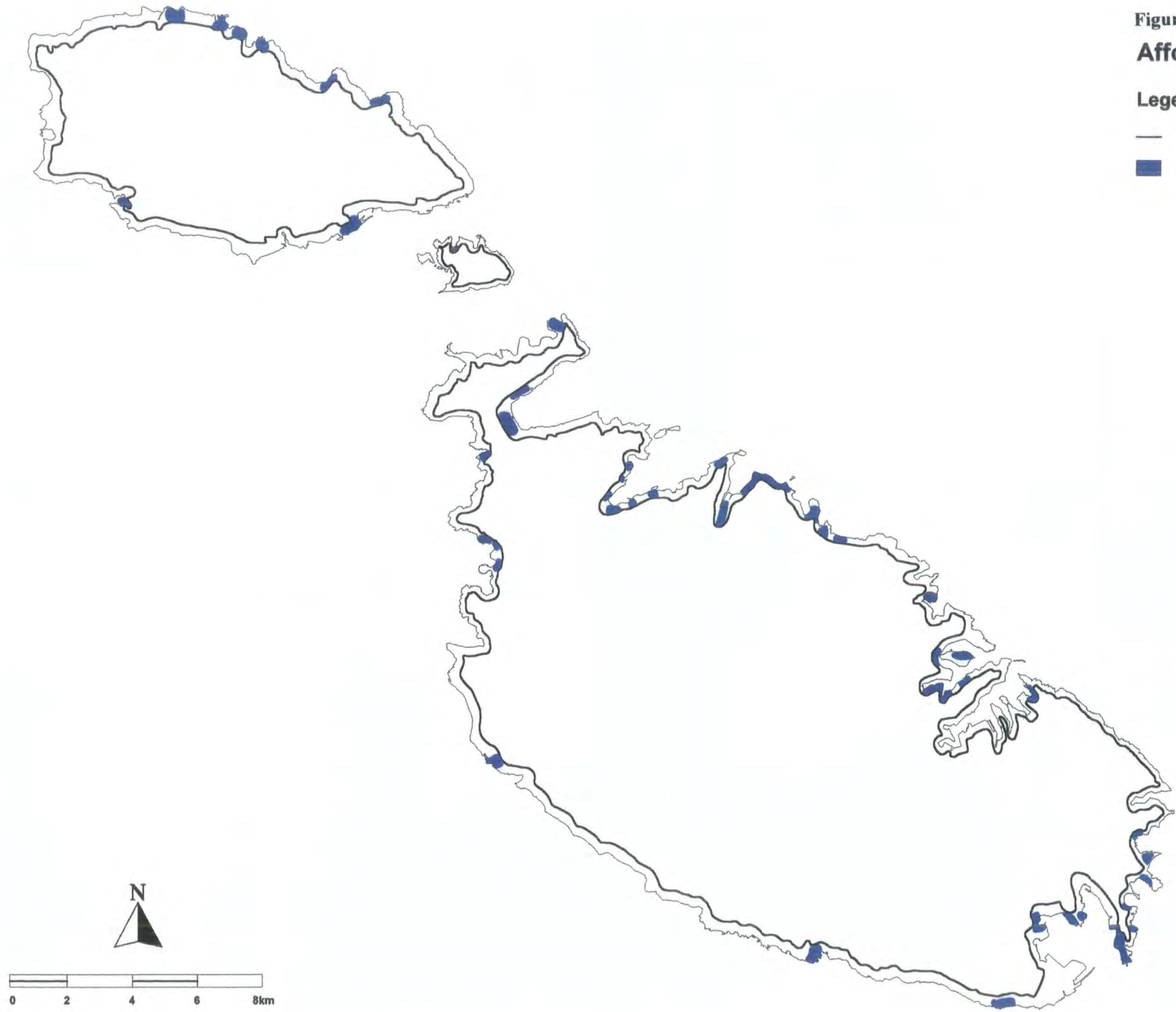


Figure 6.9

Afforestation areas

Legend

Coastal Zone Boundary

Afforestation areas

Source: Developed by author from field surveys

The high figure for this segment is accounted for partly by the afforestation projects undertaken by successive administrations, which saw the 'greening' of garrigue areas in the north of Malta. The reasons for this policy included the need to embellish the area (for example the 1.25 ha in segment I), and to cover up as much garrigue as possible on the ridges. Tree planting in segment V is also notable. Being an area where residential, historical and industrial areas prevail around the Grand Harbour, aesthetic motives were prominent here. Table 6.23 presents the spatial extent of these areas with the proximity of the locality.

Twenty per cent of this value of 6.36 ha is located around the Grand Harbour and 80 per cent around Marsamxett Harbour. The industrialisation and lack of littoral space around the Grand Harbour contributes to its small percentage value. The area around the Marsamxett littoral is clearly marked, with large coastal urban spaces where public gardens are located. In other areas, the clusters in Segment III mark projects around the Ghallis Tower on the coast road near Bahar ic-Caghaq; and the 5.5 ha in segment X further enhances the aesthetic quality of arguably the prime local rural coastal area.

Table 6.24: Afforestation projects in the localities surrounding the main Harbours of Malta

Grand Harbour	Area (ha)	Marsamxett Harbour	Area (ha)
Floriana	0.06	Floriana	0.04
Marsa	0.12	Pieta	1.75
Senglea	0.12	Manoel Island	1.43
Vittoriosa	0.12	Msida	1.56
Ricasoli	0.12	Valletta	0.04
Total	1.54	Total	4.82

Source: Author's estimates based on field data

(b) Linear dimensions

The distribution of the coastal "afforested" areas in the Maltese Islands is shown in Table 6.25. In all, 13 km of coastline have some form of afforestation, which represents about 7.1 per cent of the coastal length, of which 11 km are found in Malta (approximately equivalent to 8.1per cent of the coastal length). For Gozo the 2 km represent 4.34 per cent of the coast.

The location of the afforested areas is heavily skewed to the northern shores, with a 2.5 km long stretch of tamarisk and acacia plants growing along the coast road from Bahar ic-Caghaq to Salina Bay (Segment III). This includes the areas on Qalet Marku peninsula and Ghallis Tower precincts. Further north, from Qawra point to St. Paul's Bay, a 1.6 km of coast has five sites that have been planted with perennial trees (Segment II). Ghar il-Fekruna, a small inlet with a cave just north of St. Paul's Bay, and one of the most aesthetically pleasing areas in the whole of Malta, has been planted with acacia to complement the carob trees (*Ceratonia siliqua*) on the seaward side of the slope (Schembri and Magri,1996). In Mellieha Bay, the Ghadira nature reserve complex has also been further vegetated with a 1km length of afforestation along the shore facing Mellieha (Segment II). In the northern bays, only Ahrax Point (Segment I) has been embellished in this way. Of the sandy beaches to the north west (Segment X), Ghajn Tuffieha Bay and Golden Bay have four pockets of plantations, amounting to a total length of 750 metres in length, covering most of their area in plants. The management of Ghajn Tuffieha Bay has been entrusted to the Gaia Foundation (a local environmental group) and the number of trees planted has increased. Further south Segments IX and X), along the cliff/rdum areas the only notable additions to the natural vegetations are at Migra Ferha, Wied iz-Zurrieq and Ghar Hasan. On the south side of the island, around Marsaxlokk Bay (Segment VIII), the largest plantation is at Delimara Point with approximately 100 sq. m (93.7 sq. m), which covers practically the whole peninsula and also the small rocky bays of St. Peter Pool and il-Hofra iz-Zghira. Other afforested pockets in the south are at St. George's Bay (Birzebbugia), around Fort St. Lucian and at St. Thomas' Bay.

In Gozo afforestation is practically non-existent along the high cliffed areas to the south, north and east, with the exception of the areas around Xlendi Bay. The Mgarr harbour area, San Blas, ir-Ramla and Marsalforn (Segment XIV) have been afforested. In Comino there are patches around St. Mary's Bay and San Niklaus Bay.

These efforts aesthetically to embellish the coast of the Maltese Islands seem to follow four broad criteria:

a) to enhance the aesthetic value of tourist dominated areas, as is evident along the northern shores and the afforestation along the south coast of Migra Ferha, Wied iz-Zurrieq and Ghar Hasan.;
b) to provide public gardens and linear tree plantations along main road thoroughfares in the coastal urban areas such as Ta'Xbiex, Msida and St. George's Bay;
c) to improve the aesthetic quality near beaches, both sandy and rocky. The Delimara peninsula is an exception, as it does not fall in any of the three categories mentioned above; and
d) to provide an ameliorated micro-climate, especially in summer.

6.10.7 Conclusion

This land-use category has been isolated from all the others, as a number of years are needed for the aesthetic qualities to be observed and appreciated. This makes its management practices different, due to its fragile nature, the cultural risks involved (cf. above), and because the plants have an importance far greater than their size suggests. In addition, their aesthetic quality and appearance is highly compatible with the agricultural environment that will be described next.

Plate 6.6 Malta, Ghajn Tuffieha Bay: Afforestation programmes evident on clay slopes on foreground and natural vegetation on similar in background. Source: Undated promotional material, Malta Tourism Authority.

Table 6.25: Location and length of afforestation areas in the Maltese Islands

Malta	Linear Length (m) (approximate)	Categories		
		Beaches	Gardens	Other
Delimara	1250			-
Tumbrell Point	250	-		-
Peter's Pool	200	-		-
Hofra iz-Zghira (il-Qali)	pocket			-
Xorb l-Ghagin	pocket			-
Il-Munxar (l/o)	pocket			-
St. Thomas Bay	200	-		
Rinella Creek	pocket		-	
(Excelsior Hotel site)	pocket		-	
Pieta' to Msida	1250		-	-
Msida	50		-	
Ta' Xbiex	garden		-	
Manoel Island				-
Hilton Hotel			-	
Bahar ic-Caghaq (2)	300	-		
Qalet Marku (2)	250	-		
Ghallis (2)	] 2500	-		
Salina Bay (3)		-		
Qawra	500	-		
St. Paul's Bay (5)	1000	-		
Ghadira (3)	1000	-		-
Ahrax Point	pocket	-		
Il-Prajjiet	pocket	-		
Golden Bay	] 750	-		
Ghajn Tuffieha Bay (2)		-		
Migra Ferha	500	-		
Wied iz-Zurrieq	garden	-		
Ghar Hasan	250	-		
Total	10,250			
Gozo				
Mgarr (2)	500	-		
San Blas	200			-
Ir-Ramla (2)	300	-		
Marsalforn (2)	400	-		
Xwieni Bay	pocket (50m)	-		
Ghar il-Qamh	250			-
Xlendi	250	-		
Total	1950			

Source : author's estimates from field surveys and cartometric measurements

6.11 Arable Land

6.11.1 Introduction

The two land use categories that follow deal with the rural aspect of the coastal zone. Arable land and undeveloped areas together constitute about two thirds of the coastal zone. In addition, the aesthetic value of these land uses is high, as the dense development associated with the coastal urban land use categories is generally lacking. The land use category to be examined in this section is arable land and a distinction will be made between land which is currently cultivated and land which is lying fallow. The main reason for this is to try and identify these coastal areas that are prone to land abandonment and others that are actively producing crops. The distribution is shown in Figure 6.10.

6.11.2 Background Information

Agriculture is one of the main traditional economic sectors of the Maltese Islands. However, in recent times a number of constraints have limited this activity to a peripheral one with the decrease of agricultural land being a major problem. In 1957, 138.6 km^2 of land was devoted to all forms of agriculture. In 1983 the total agricultural area was 93.3 km^2 or 29.1 per cent of the surface area of the Maltese Islands, with arable land making up 88.4 per cent. Arable land is classified into three categories, namely, irrigated, dry and waste (National Statistics Office, 2002). In this thesis just over a quarter of the coastal zone in the Maltese Islands is classified as arable. Of this 72.4 per cent is found in Malta and 27.1 per cent in Gozo and Comino (Table 6.3). As a linear measurement, 23 per cent of the coast of Malta is identified with agriculture and 57 per cent in Gozo and Comino (Anderson and Schembri, P.J., 1989). In the 1998 survey the areas representing agriculture were estimated to cover an area of 350 ha in Malta and 133 ha in Gozo and small patches in Comino, in all totalling approximately 500ha.

Although 40 per cent of the surface area of the Maltese Islands is cultivable there are problems. For instance, 65 per cent of the fields are less than 1 hectare in area, and 80 per cent are less than 2 ha. Another problem is that the number of full-time farmers has declined from 5916 in 1975 to 2966 in 1992 and to 2129 in 1998 (National Statistics Office, 2002). In a way this is compensated for by an increase in part-time activity, amounting to 12,774 persons. These part-time farmers maintain productivity by the application of modern agricultural methods, higher quality seeds, more irrigation water, and intensive farming using drip irrigation systems and appropriate mechanized tools. These factors also account for the increase in food production. In fact, data for Gozo alone showed a 23 per cent increase in food production in one year (The Times [of Malta] 9 October 1995) with the wholesale value of agricultural products sold through organized markets was worth Lm 1.54 million in 1999. At the same time 10 per cent of Malta's imports are for food, valued to about Lm 100 million (Central Office of Statistics, 2000). The third problem is land tenure, as only 5 per cent of the arable land belongs to the farmer, the rest remaining with absentee landlords and the Government. In 1992 the Roman Catholic church, which traditionally did not give much of its land for non-agricultural purposes, passed on its property to the Government in return for educational subsidies. Future options for the development of agriculture could be influenced by a measure of land reform to allocate unused land to farmers. A fourth problem is the depletion of agricultural land by the extension of the urban areas to accommodate the increasing population and the needs of industry and tourism, together with the over-extension of a number of quarries. Although successive administrations have invested money for the revitalization of this primary economic activity, the problems of lack of water, poor soil, small parcels of land or small fields have taken their toll on the agricultural output of the islands, with the result that a fifth problem of the abandonment of arable land has emerged.

6.11.3 Justification for study

The justifications for including arable land and agriculture in a study of coastal land-use is that a good portion of the coastal zone is made up of arable land and most of the developments associated with the urban land uses are in fact areas where agriculture was formerly practiced. Coastal zone agriculture has never been identified in these Islands as a separate entity from the rest of the local agricultural land and it is through this exercise that agriculture along the littoral has been brought into focus. In addition, the element of abandoned arable land is given importance, as it is mainly this type of land use that is first earmarked for development, especially as about half of the arable land along the littoral has largely been abandoned. Although the problems of agriculture along the coast are not very different from those for agriculture found inland, the importance of coastal land being used for agriculture is that it enhances the aesthetic qualities of the zone. Even abandoned land, which in this thesis is also classified as arable, because of its potential in crop production, has its own aesthetic qualities. Furthermore, bird-trapping sites, concentrated largely all around the littoral, make extensive use of abandoned agricultural land. The recent public awareness of the negative impacts of bird-trapping and hunting also calls for a detailed appraisal of abandoned coastal agricultural land.

In addition, as about half of the land along the littoral is largely abandoned, it turned out to be necessary to identify and map it precisely. With industrial, residential and touristic investment projects maintaining momentum, the replacement of abandoned agricultural land with built-up structures can be a real threat anywhere along the coast, especially within areas that have been included in building schemes. In addition, as most of the coastal agricultural holdings are formed of small pockets of shallow soil, they can never provide a full-time job. The survey can thus identify areas where the building over and development of arable land has a greater chance to occur. As a field by field survey of the Maltese Islands was last done between 1955 and 1958 by a group of Durham geographers (Bowen-Jones *et al*, 1960), the time was now ripe for a review of at least a part of the original survey.

6.11.4 Definitions and criteria used for field identifying features

Arable land is land that can be worked by plough or spade. The broader definition of agriculture is an activity "concerned with the growing of crops and the rearing of livestock, however some restrict the term to the growing of crops alone" (Small and Witherick, 2001, 5). In fact, in this thesis standing or evidence of cropping were the main criteria used to identify arable land. Evidence of cropping was taken when fields had an overall absence of dried weed stumps from previous years, the rubble walls were still in place through most of the field perimeter and no evidence of exposure of the bedrock was evident.

Mapping agricultural land use was difficult in that it presented itself in a number of formats in different locations: as a very productive unit in valley-mouth bottoms just behind coastal inlets with sandy beaches, typical of the northern parts of Malta and Gozo; as a dry-land agriculture type along the eastern and south-eastern rocky coasts of Malta and southern Gozo; and as small fragmented patches but highly fertile zones in scree slope areas in both islands. In all cases physical field sizes tend to be small because the scree slope areas and valley bottoms and sides of valleys near the littoral tend to blend with a rugged and steep topography. This encourages field terracing, presenting a patchwork of small, elongated field patterns. The demarcation of fields is achieved by rubble walls, another characteristic form of the arable rural landscape. These are built for a number of purposes: as protection against soil erosion and gullying; as a wind protection; and as the best way of increasing the amount of flat, arable, ploughable land available on steep slopes.

For the identification of the abandoned arable land, a number of criteria were established to determine this type of land use as it tended to camouflage and blend with areas of bare rocky outcrops that had to be mapped and classified with the areas of undeveloped land that form the next section in this chapter. In this regard, the areas that posed the most problems were the gently sloping zones on Malta's east coast and the rugged western *rdum* areas with the small field pockets located between large Upper Coralline boulders strewn on the lower geological strata.

The state of the rubble walls was the main criterion used in identifying whether land was in use or abandoned. Built primarily to enhance and increase the area of arable land where the topographic slope does not permit active agriculture, rubble walls break a slope into a number of flat fields. Built from the prevailing geological stratum, they are also a reflection of the local geological rock type. Terraced agriculture is possible only if these buttressed walls are properly maintained. Varying in height from one-half metre for clayey soil areas, to two metres, where wind protection and privacy are sought, they tend to crumble and fall when the sun-baked soil becomes loose that is used to bind together the patchwork of stone boulders and cobbles with smaller splinters of rock fragments. Abandoned fields are indicated by degraded rubble walls and exposed soil and regolith faces. This was taken as the primary criterion in identifying land abandonment. In extreme cases of long-term abandonment, the exposed rock face had a smoothed rock surface (Plate 6.7).

Crop cultivation was another indication that helped in the classificaction of coastal agricultural land. At times it was difficult to identify whether an area was cultivated or not as the main surveys took place in the summer months, however the state of the rubble walls, the presence of bare rock exposure and the density and thickness of the dried weeds gave a good idea whether a field was cultivated or not even though a winter visit was not conducted. Conversely it was easy to identify coastal summer agricultural produce in *rdum* areas due to the presence of reservoirs. The presence of fodder crops also denoted agricultural activity. These areas were mainly identified through the presence of *sulla* which is conspicuous by its crimson flowers at the end of a stalk. The cultivated variety had a longer stalk than the self-seeding type. The former type of *sulla* denoting agricultural land which is in use, the latter denoting abandoned agricultural land. *Sulla* was observed in any of three conditions. The first was where a crop was still not harvested and reached a height of about 1 metre, indicating a cultivated field; the second type was where the crop was harvested and only had a 15 cm woody stump remaining above the soil; and the third condition occurred where short 20-30 cm high plants persisted, indicating an abandoned field. In general, patches of rocky outcrops and a slope in excess of 15 degrees also indicated field abandonment.

6.11.5 Discussion and analysis

Although 26.1 per cent of land in the Coastal Zone is classified as arable for the purposes of this thesis (Table 6.1), this represents only 6.4 per cent of all the agricultural land in the Maltese Islands, with almost one-half of this land use category abandoned. The Tables presented with this section give the distribution of agriculture along the coastal area and Figure 6.10 shows the distribution. The following characteristics are evident:

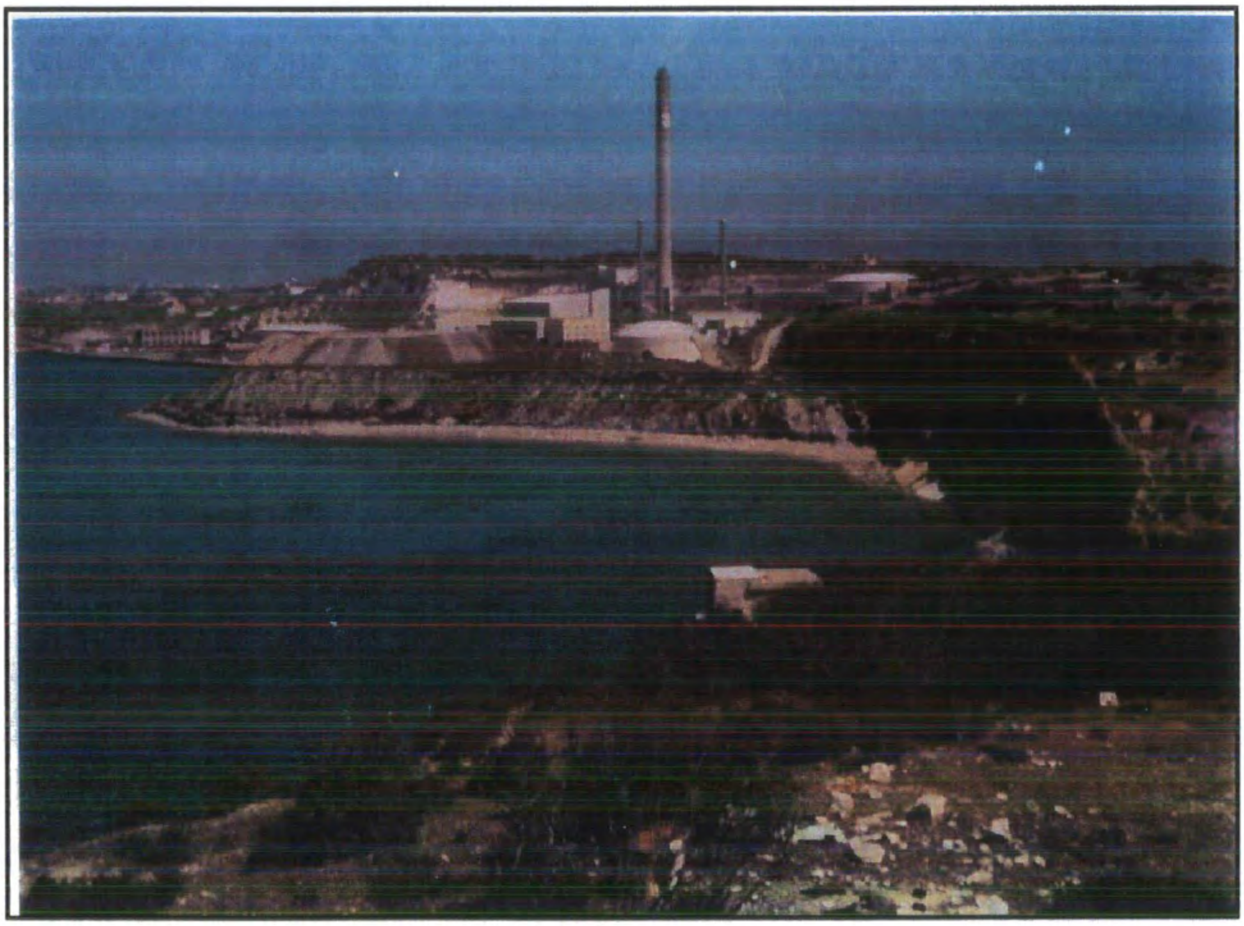


Plate 6.7 Malta, Delimara Power Station site: abandoned arable land and dilapidated area with building spoil dumping in rural coastal area.
Source : The author

6.11.6 Presentation of Data

Table 6.26: ARABLE LAND. Land use distribution for Malta, Gozo, Comino and the Maltese Islands.

	Hectares			Per cent		
Segment	**land in use**	**abandoned land**	**Total**	**land in use**	**abandoned land**	**Total**
I	22.8	-	22.8	4.7	-	4.7
II	30.0	28.5	58.5	6.2	5.9	12.1
III	3.6	4.8	8.4	0.7	1.0	1.7
IV	-	-	-	-	-	-
V	5.0	-	5.0	1.0	-	1.0
VI	1.2	7.6	8.8	0.2	1.6	1.8
VII	14.6	7.1	21.7	3.0	1.5	4.5
VIII	13.1	2.4	15.5	2.7	0.5	3.2
IX	13.3	14.8	28.1	2.7	3.1	5.8
X	99.7	60.0	159.7	20.6	12.4	33.0
XI	11.1	11.3	22.4	2.3	2.3	4.6
TM	214.4	136.5	350.9	44.1	28.3	72.4
XII	0.1	-	0.1	0.1	-	0.1
TC	0.1	-	0.1	0.1	-	0.1
XIII	1.5	6.6	8.1	0.3	1.4	1.7
XIV	10.7	31.4	42.1	2.2	6.5	8.7
XV	33.0	22.3	55.3	6.8	4.6	11.4
XVI	0.9	26.8	27.7	0.2	5.5	5.7
TG	46.1	87.1	133.3	9.5	18.0	27.5
GT	260.6	223.6	484.2	53.7	46.3	100

Source: Estimated by author from field data and cartometric measurements

Key

I to XVI - coastal segments (rows)
TM - Total of values for Malta
TC - Total value for Comino
TG - Total of values for Gozo
GT - Total of values for the Maltese Islands

(a) Three-quarters of all the arable land (cultivated land which is in use together with land which is abandoned) are found on Malta the rest on Gozo and Comino; this data shows that the arable land is found almost in the same proportions in the coastal zone as in the rest of the respective islands (cf. Chapter 1) for area (68:32 per cent) and coastal length (76:24 per cent).

(b) Almost one-half of the distribution on Malta is concentrated in segment X.

(c) Segment II has the second highest figure for Malta.

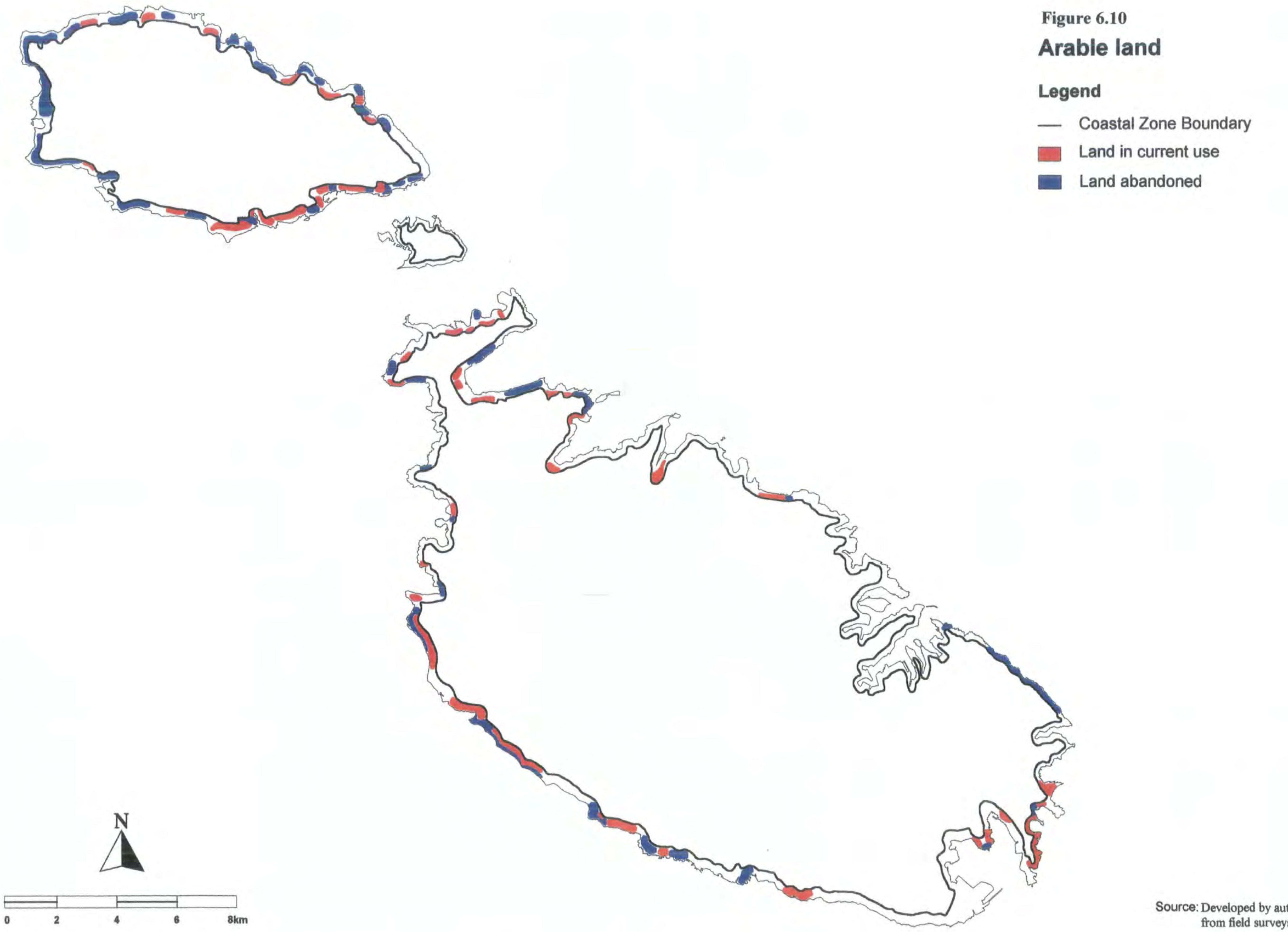
(d) Gozo is well represented in that coastal segments XV and XIV are, respectively, third and fourth on the list for the whole of the Islands.

Agricultural activity is present all around the coast of Malta, with a limited presence only in the area from Pembroke (Segment III) to the Harbour areas (Segment V). The highest concentration is found in the *rdum* areas from Fomm ir-Rih to Ghar Lapsi on the southern cliffed coast (Segment X). These areas (Figure 6.10) have a regular supply of water from perennial springs and are sheltered from northern and easterly winds by the high cliffs and from the southern and western winds by Upper Coralline boulders. The geomorphological set-up of these areas, with a height above sea-level of about 50 metres and a sloping profile that accommodates substantial agriculture, also contributes to different conditions found on the plateau above or in other parts of the coastal zone. The other areas in Malta where active agriculture is extant are located in the north-eastern coastal areas that form part of the Salini Bay, Burmarrad and Ghadira agricultural areas (Segment II).

Arable land abandonment in Malta is mainly apparent in the regions which lack perennial water. This condition is also seen in Gozo, where coastal agricultural land abandonment is most evident in the south western, west and north-western region from Xlendi to Marsalforn. (Segments XIV to XVI). Although data referring to land owned or cultivated by emigrants from Gozo is impossible to obtain, the high rates of emigration in the 1950s and 1960s coincided with a decrease of cultivated land during the same period. The land taken up by quarrying has also caused the loss of land for agriculture in Gozo.

Figure 6.10

Arable land



Source: Developed by author from field surveys

In Malta, as a linear measure, agriculture occurs in less than a quarter of the coastal zone, but is far more in evidence in Gozo and Comino. As a proportion of the total coastline of Malta, fields abandoned constitute 12 per cent and fields in use 11 per cent. (1989 survey results). For Gozo and Comino, the percentages were respectively 41 and 16.

Another issue pertaining to agricultural land is abandonment, examples are shown in plan in Figures 6.11 and 6.12. In Malta almost 40 per cent of this land in the coastal zone is abandoned, whilst for Gozo and Comino the figure is 65.5 per cent. These figures represent about ten per cent of the coastal zone for Malta and 25.2 per cent of the Coastal area for Gozo and Comino. For the Maltese Islands as a whole, abandoned agricultural land is equivalent to 15.0 per cent of the coastal zone. Agricultural land in use amounts to 12.6 per cent of Malta's Coastal Zone and 31 per cent of Gozo's Coastal Zone.

6.11.6.1 The main coastal agricultural regions

Four regions can be separately identified in the coastal zone:

(a) the *rdum* areas on the western part of Malta;

(b) the lowland areas on the north-eastern seaboard;

(c) the south of Malta; and

(d) Gozo and Comino

(a) The *rdum* (scree slopes) areas on the western part of Malta

This part of the coast is one of the most fertile on the island. Agriculture is intensive, with summer fruit trees adding on to the usual variety of tomatoes, vines and vegetables. The presence of perennial springs, issuing from fissures between the Blue Clay outcropping beneath the capping Upper Coralline formation, ensures a reliable supply of water, even during the summer months. Irrigation channels distribute this water in the fields. *Sulla* grows in areas where the water supply is inconsistent or the network of water channels does not reach.

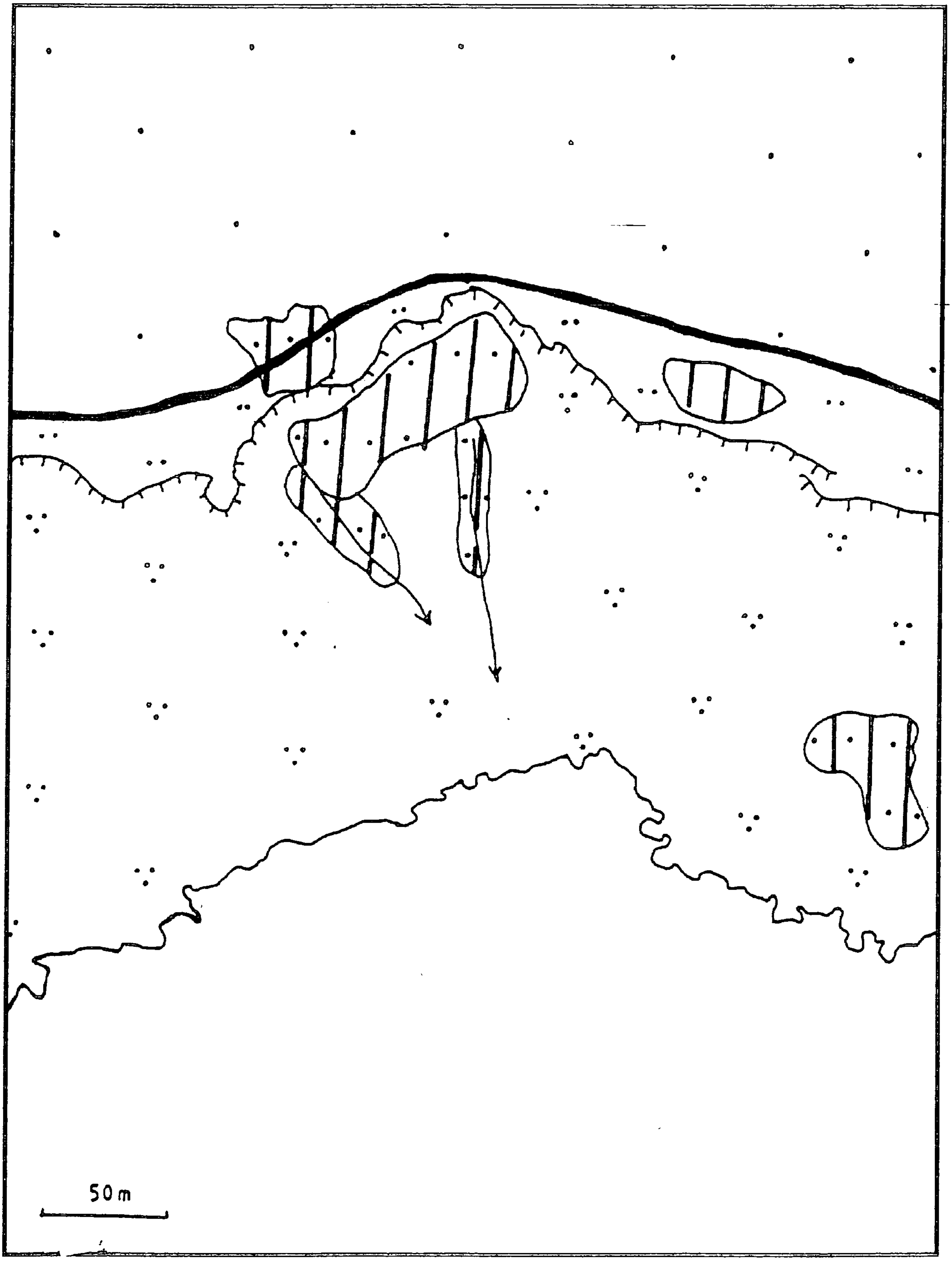


Figure 6.11 Malta, West coast: pocket arable land with stream in scree slopes

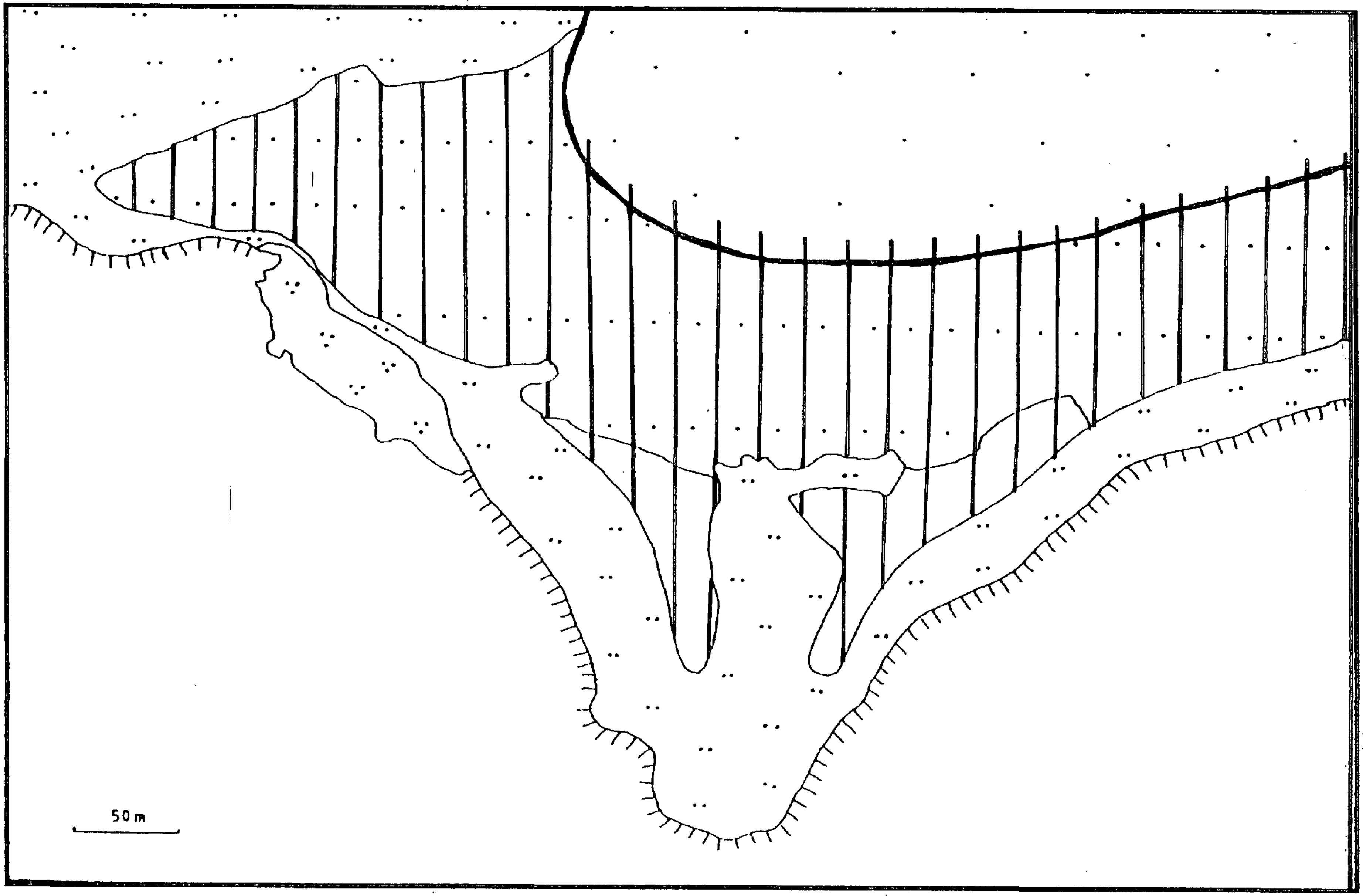


Figure 6.12 Gozo: arable land

The sectoral subdivision being used in this work is reproduced for agriculture in Table 6.26. This shows the predominance of agricultural activity in the rdum areas, where almost two-thirds of the coastal area from Il-Kullana to Ras ir-Raheb (Segment XI) is devoted to agriculture. This area accounts for 40 per cent of the coastal zone agriculture in Malta. Although land abandonment is common in this sector, the area represents the longest continuous stretch of coast devoted to agriculture (eg. Figure 6.13). The success of agricultural activity in this area is mainly due to the availability of water from perennial springs, with a further contribution from the Mtahleb area, which provides the catchment area for three valleys: Wied Ghar Ilma, Wied ir-Rum and Wied Migra Ferha (SegmentX). An eight kilometre stretch of agricultural activity is present along the coastal zone, sheltered by the south western Upper Coralline Limestone plateaux and located above the Lower Coralline cliffs that plunge from 150m at Rdum Dikkiena and Rdum Dun Nazju to 75m at the coastal edge of the Mtahleb area to Ras ir-Raheb (Segment XI). Agricultural activity increases in Mtahleb and the Rdum tas-Sarg (Segment XI) vicinity as the terrain assumes gentler slope, thus necessitating less frequent rubble wall terracing, with the result that individual fields are larger in size.

Product-wise this area can be divided into two: the first part from Rdum Dikkiena to Rdum Dun Nazju where animal fodder, and cash crops are the main products, whilst in the second part, from Mtahleb to Rdum tas-Sarg, kitchen garden products, tomatoes, legumes and also fruit trees are prevalent (Segment XI).

As mentioned earlier, land abandonment is also evident in this otherwise highly-productive agricultural environment. This land is located towards the northernmost and southernmost parts of this sector, especially towards the cliff edges, where the terrain rises at 15-20 degrees. This slope encourages the abandonment of land due to: (a) the small land parcels brought about by intensive field terracing; (b) the difficulty in using agricultural machinery; and (c) the problems associated with bringing up the produce. The lack of use has meant damage to rubble walls, followed by soil erosion

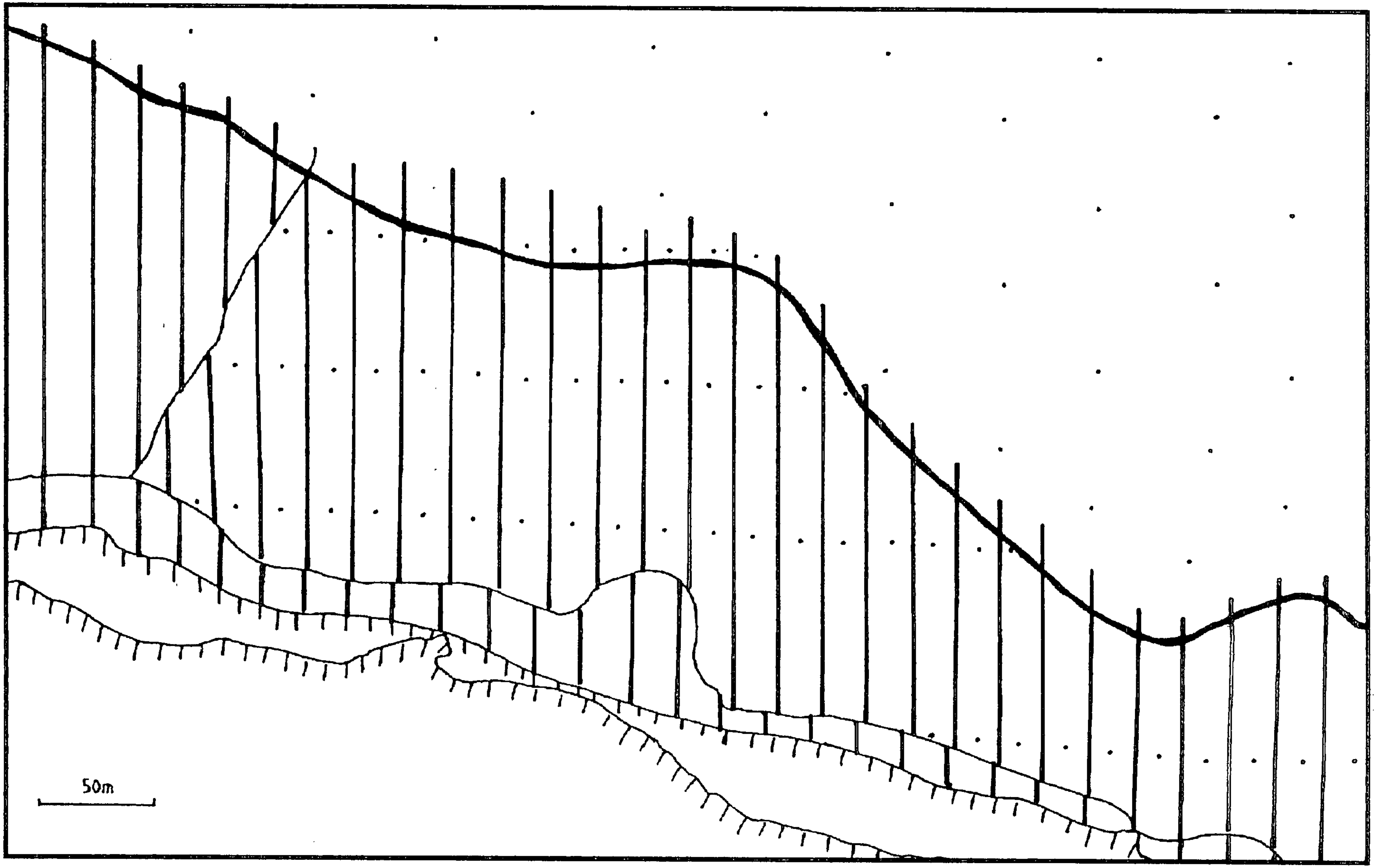


Figure 6.13 Malta, West coast: arable land

and gullying, and in some cases exposure of the bare rock. Some of these abandoned areas are strewn with self-seeding *sulla*, which although smaller in size than the cultivated variety, is used to supplement animal fodder. Other areas in Malta where coastal agriculture is successful are found just further south of il-Kullana at ix-Xwieki limits of Gebel Ciantar (Segment X), where the agricultural environment resembles that of the Kullana to Ras ir-Raheb area. A one kilometre belt of fertile agricultural land about 200 metres wide, together with five pockets totalling 6.4 ha at Wied Fulija, Fomm ir-Rih, Ghajn Tuffieha, Rdum il-Qammieh and Paradise Bay (all in Segment XI), make up the southern and western half of the island.

Abandonment of agricultural land (Table 6.26) is especially evident from Ras il-Wahx to Rdum il-Qammieh, (Segment XI) where a 1 km stretch around Qammieh Point peninsula has been taken over by bird-trapping enthusiasts. The remaining area within this 40 km length of southern and western coast of Malta is also noted for apparently never having been cultivated. Certain factors account for this: (a) the distance from the nearest settlements of Manikata, Mgarr, Dingli on the northern part and Qrendi, Zurrieq (Nigret and Bubaqra), and Benghisa on the southern part; (b) the lack of accessibility along the *rdum* areas; (c) lack of perennial water springs in the southern half from Ghar Lapsi to Benghisa (Segment IX); (d) the effects of the former aerodrome at Hal Far. Topographically speaking, the southern half of this stretch of coast is mainly flat and the plateau is punctured by a number of *widien*. Its watershed is independent from the rest of the island, giving a very small flood catchment area that does not help to maintain a regular supply of water. Agriculture in these areas is unaffected by urban sprawl.

(b) The Lowland Areas

Coastal agriculture in these parts exploited the northern fertile areas formed by alluvium deposited by ancient water courses that flowed throught the valleys in a wetter, pluvial period about 10,000 years ago. Agriculture is still very active, using a regular supply of water pumped up from the shallow sea-level aquifer by windmills. The flat nature of the terrain precludes the need for high boundary walls.

The other coastal area where successful agriculture takes place, and land abandonment is minimal, is along the northern part of Malta from Cirkewwa to Ahrax (Segment I). Representing 4.7 per cent of the coastal zone arable land for Malta, this area has a thriving agricultural activity due largely to the availability of water in perched aquifers, where the Blue Clay acts as an aquiclude below the exposed Upper Coralline Limestone. Wind driven water pumps bring water to the surface and characterize the aesthetic environment of the northern coast.

Along the north-eastern coast, from Ahrax point to Ghallis (Segment III), agriculture is mainly found along the perimeters of Mellieha, St.Paul's, Mistra and Salini Bays (Segment II). Much of the soil here has been formed from alluvium deposited during the Holocene. The presence of shallow sea-level aquifers, resulting from the land subidence that formed the Horst and Graben topography in the areas to the north of the Great Fault, ensures a reliable supply of water throughout the year. The flat terrain facilitates the use of agricultural machinery and field sizes are large enough to mitigate against the partitioning resulting from Maltese inheritance procedures, when the patrimony is divided up equally between all surviving offspring.

Abandoned agriculture is mainly found in this area along the Tal-Blata promontory. Distance from the nearest settlement, together with development prospects and a lack of regular water supply have caused land abandonment in this area. Of the remaining areas in Malta, from Ghallis to Benghisa (Segments IV, V, VI, VII and VIII), only 12.2 per cent of coastal zone has agriculture. The lack of a regular water supply, the tourist, industrial and urban developments, have depleted the number of full-time farmers and caused widespread land abandonment, have led to a situation where only about 35 ha of agricultural land in use is found in pockets at Bahar ic-Caghaq (Segment III), Ricasoli (SegmentVI), St.Thomas Bay, Hofra l-Kbira u Hofra z-Zghira (all in Segment VII), Marsaxlokk and il-Ponta l-Kbira (Segment VIII), on either side of Fort St. Lucian. Abandoned land occurs in stretches, the longest being one of 4 km, from Ricasoli to Zonqor Point at Marsascala and on the outer side of Delimara peninsula.

(c) The South of Malta

Agriculture in this part of the Island has suffered greatly from the lack of water supply, with the area from Ricasoli to Marsascala (Segment VI) having very little agricultural activity. The only areas where sizeable pockets of activity were noted were in the Hofra z-Zghira and Hofra l-Kbira precincts. There are two main reasons for this:

i) the rock stratum here is chiefly made up of Upper Globigerina Limestone, with a layer of clay underneath that gives a soil rich in clay. Thus water is retained within the soil for longer periods;

ii) most of the agriculture is practised along the sides of widien and valley bottoms;

iii) alluvium carried down enhances soil fertility.

The main result of the agricultural abandonment in these areas is bird-trapping and hunting. They have the advantage of facing south east and east, are topographically elevated at 100 m above sea level, and are situated about 2 km away from of the main urban residences and major road communication networks. A sewage treatment plant in the limits of Marsascala has been constructed to stop land abandonment by the provision of water for irrigation. But this method has not succeeded in promoting agriculture in that irrigation has not yet reached the coastal areas mentioned. The plant is only operating at half capacity and all the local farmers still consider farming as a part-time activity. Unfortunately, with the increase in land given over to industrial and ancillary activities in the South of Malta, potentially fertile agricultural land may never realise its potential.

(d) Gozo and Comino

Agriculture in the two smaller islands has also suffered the same fate as the island of Malta. Land abandonment has been further accenuated with a sharp decrease in full-time agricultural labour. Alternative employment in Malta and elsewhere has been the main reason, even though Gozo is well-watered, with the presence of perennial springs. In fact it is only in these areas where Blue Clay slopes are found that coastal agriculture has thrived in two areas, one to the north east and the other to the south of the Island. In all the other areas, from Xlend*i* (Segment XV) Marsalforn (Segment XIV), land abandonment is evident. At least a 10 km stretch can be identified.

In Comino only the area around St. Mary's valley is agriculturally productive. The decrease in population from around 50 to 10 in a span of 30 years has in part brought this about. Furthermore, attempts to turn Comino into a tourist resort has in no way helped to promote other economic activities, although a pig farm intended to breed disease-free animals proved its worth for a time.

Agriculture in Gozo has in all probability been affected more than anything by the pace of industrialization and the effects of emigration. In fact, two-thirds of the arable land in Gozo is abandoned. Of the remaining 9.5 ha, the longest cultivated stretch is on the southern coast facing Malta, from Ta' Cenc to just behind il-Gebla tal-Halfa (Segment XV), where 3.5 km and 2.0 km stretches are evident. On the northern coast, the San Blas area is the largest of three main pockets, the other being found at Dahlet Qorrot, ir-Ramla and Ghar il-Qamh (Segment XV). These areas are well watered with perennial water springs in evidence. For the rest of Gozo a 10 km length from Xlendi (Segment XV)to Ghar il-Qamh (Segment XVI) land abandonment is common.

6.11.7 Conclusion

The general state of the coastal arable land in the Maltese islands is a microcosm of the situation in the islands as a whole, with small field parcels and land abandonment being prominent features. Although the main difference lies in the general topographic set-up of the terrain over which agriculture is practiced, with the coastal areas having a generally more rugged topography, and the production of food limited to patches growing crops for animal fodder more than in the inland agricultural areas, the coastal areas with arable land give the rural environment high aesthetic qualities and blend well with the undeveloped areas that are the next land-use feature to be discussed.

6.12 Undeveloped Land

6.12.1 Introduction

With the high population density and the intense pace of development in the coastal zone, together with the presence of areas devoted to agriculture, the areas that are as yet undeveloped are limited in the Maltese environment. However, there has been less pressure in the north of Malta and Gozo for two reasons: first the tendency for residential and recreational areas to cluster together in accessible zones and, second, the grouping of marine-related industries in the southern coastal areas. In general these are located in areas away from the coastal urban zones. The purpose of this section is to review the location of these zones. In addition, the differentiation of this land use category into four separate land uses has helped in identifying the land use type which in this section is more prone to attract development.

6.12.2 Background Information

Natural vegetation (not planted by humans) was an important component in the coastal land use studies. It was used in the 1989 survey and retained in the 1998 survey as one of the identifying factors in demarcating the landward limit of the coastal zone (cf Chapter 1). In this section vegetation will be used as an indicator to distinguish between two of the four land uses grouped under the undeveloped land category, namely garrigue or steppe maritime vegetation, these are demonstrated in Figure 6.14, and rupestral or *rdum* vegetation, shown in Figure 6.15. The latter normally has pockets of arable land, whilst the former is devoid of any agricultural activity as soil erosion is widespread in this type of environment. The other two categories are distinguished by the absence of any vegetation and generally identified by the type of rock prevailing.

Natural vegetation in the Maltese Islands is typical of a Mediterranean type of climate where the semi-arid environment, the shallow and humus-deficient soil, coupled with the effects of humans, have together conditioned the natural vegetation of the Islands to the maquis, garrigue and steppe plants. Studies on the Mediterranean and Maltese vegetation have a long history but citing the most significant accounts in Tomaselli (1977) for the Mediterranean and Haslam and Royle (1968), Haslam, Wolsey and Sell

(1977 for Malta. In Duca and Zammit (1989) for the Maltese Islands, one can decipher the number of halophytic (salt-tolerant) species that are significant along the coastal margin and for distinguishing the major vegetation biomes prevalent. In addition, a pictorial guide (Sultana and Falzon, 1995) was a great aid in identification.

Another main indicator to distinguish the main features in this section were landforms. Although through experience the four categories mentioned here are easily distinguished the literature backing the observations was important. Textbooks that review coastal landforms formed the basis for the studies (Strahler and Strahler, 1984; Waugh, 2000), specialist sources dealing with specific features such as shore platforms (Sunamura, 1972; Trenhaile, 1987) and for the local situation (Buttigieg, Vassallo and Schembri, 1997). The literature dealing with the scree slopes include works by Alison (1998), and for the local situation Schembri and Magri (1996) provide the background. Using the case study of Gozo, Ellenberg (1983) reviews the coastal geomorphology of the Gozitan coast. The author identified four main types, with garrigue and steppe vegetation prevalent on the western, northern and north eastern coast; maquis on the western *rdum* areas; cliffside vegetation along the southern margin; and the rest identified as maritime maquis. The latter is typical of areas along the eastern sea board where human impact is the greatest. Cultivated areas shown as a separate category are found within *rdum* and valley bottom areas.

The lack of natural vegetation along the coast of the Maltese Islands is further aggravated by a saline microclimate. Thus only salt-tolerant vegetation can thrive. Haslam *et. al.* (1977) estimated that only 14 per cent of total floristic species occur along the coast. The breakdown is given as follows in Table 6.27.

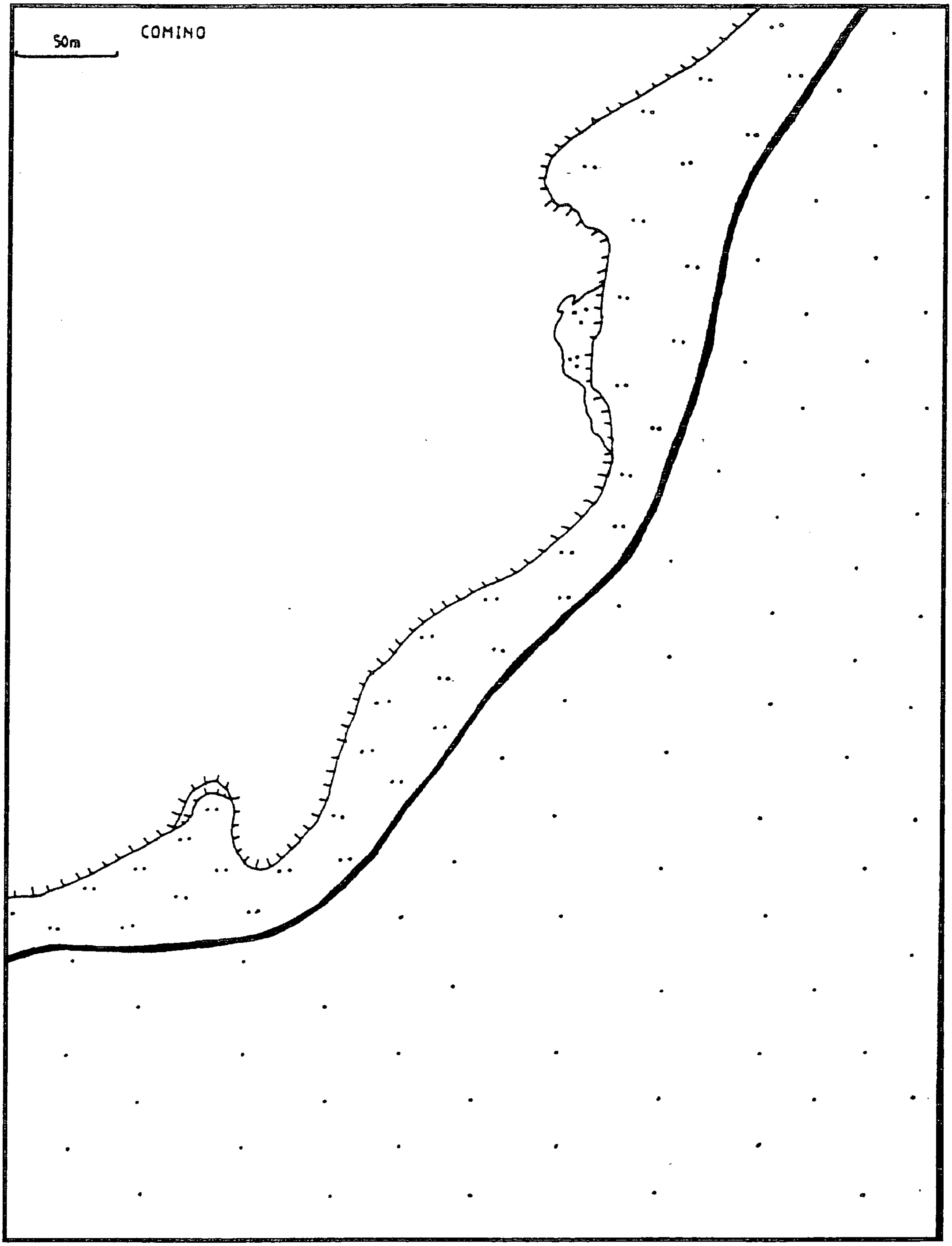


Figure 6.14 Comino: undeveloped coastline in remote coastal rural areas showing a predominantly "garigue" environment.

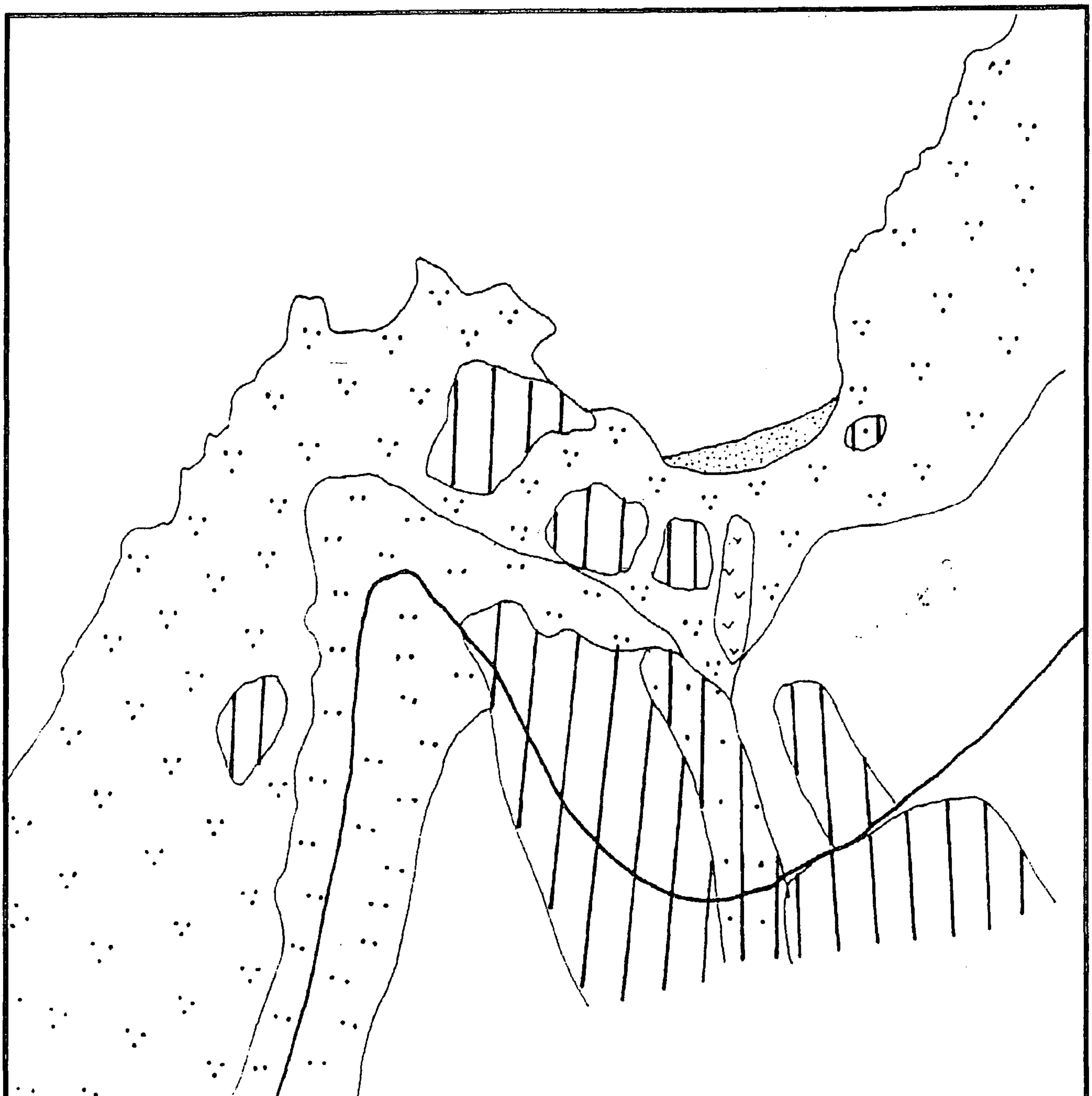


Figure 6.15 Gozo, ,San Blas: Land use pattern typical of scree slope (rdum) areas with garigue plateau and pockets of arable land in valley leading to small inlet with beach

Table 6.27: Coastal flora as a percentage of total flora for each category of geomorphic feature in the Maltese Islands.

Geomorphic feature	Per cent of Total Flora*
Sloping rocky shores	5.0
Coralline cliffs	1.8
Clay or soil slopes	1.7
Sandy bays	3.6
Salt marshes	1.7
In sea water	0.3

*Only 12 per cent of the above have a totally terrestrial substatum

Source: Haslam et. al., 1977

6.12.3 Justification for study

A study of undeveloped land is justified for a number of reasons, prominent among which are the following:

(a) it provides the open spaces needed for recreational purposes;

(b) many consider it as aesthetically acceptable;

(c) it provides a natural habitat for a number of flora and fauna;

(d) it blends well with the agricultural environment, presenting relatively large tracts of open countryside and enhancing coastal scenery; and

(e) parts of it have high value investment potential and are therefore very prone to development.

6.12.4 Definitions and criteria used for field identification

Undeveloped land can be defined as that which has as yet not accommodated any type of major human modification such as urbanization or changes to the littoral by the construction of breakwaters or other major land reclamation projects. For the purposes of this thesis, undeveloped land (Plate 6.8) can be identified through a number of factors:

(a) the predominant geomorphological features are still, to a large extent, the result of physical processes, and have not yet been built over;

(b) where present, a natural vegetative cover prevails; and

(c) cultural features are largely absent.

In addition the definition used by Olsen and Seavey (1990) confirms the interpretation given to the undeveloped parts of the coast definition used for the land use categories in this thesis. In fact "bedrock ledge", "boulder-strewn areas" and "rock pools" are clearly important markers in interpreting the land uses in this category. The scenic value of these areas is also confirmed.

" Rocky shores include naturally occurring shorelines composed of bedrock ledge or boulder-strewn areas, extending from below mean low water to above the mean high water mark. These areas frequently contain tide pools. Many rocky shores are well recognized for their scenic value. Rocky shores are often important tourist attractions, and are used for surf casting and skin diving by increasing numbers of people."
(Olsen and Seavey, 1990, 61).

Four elements make up this land use category. Two of the elements are distinguished by the geological and geomorphological properties, namely the Unvegetated Coastal Rock and Coastal Rock Platforms, the other two elements are distinguished primarily by the type of vegetation growth and secondarily by the rock type, namely, Steppe Maritime Vegetation, associated with steep rocks and cliffs, and Rdum Rupestral Vegetation, associated with scree slopes. A short description of the four main categories follows.

(a) Low sloping unvegetated rock areas

This type of rock is low-lying, predominantly composed of Upper or Lower Coralline limestone formation. The generally exposed nature of the rock is due to its low profile, making areas near the shoreline vulnerable to storm surges, sea spray and tidal changes. Although the formation is highly pitted (containing numerous small circular holes of about 2 cms in diameter) the adverse marine conditions decrease the soil trapping facilities associated with this type of formation further inland, and limit the growth of vegetation. The main environmental threat to these areas comes from attempts to cover the surface of these areas in concrete to make them easier to walk on. Vegetated coastal rock is predominantly made up of Upper Corollaine Limestone

**Plate 6.8 Malta, South East coast: Typical Globigerina Limestone cliff.
Source: The Times [of Malta], Property and Construction Supplement 13 May 2001, pIII.**

or Lower Corollaine Limestone. The general topographic conditions are rather similar, with low sloping areas of around 2° - 5°. However, the pitted nature of the geological properties of these outcrops places these surfaces on a different frequency to those mentioned.

These include:

- the growth of vegetation due to trapping of soil and other particles washed down from the hinterland;
- trapping of water in pools; and
- a lack of physical accessibility over the rock surface itself (Segment I).

The latter condition regulates human use along the littoral where the pitted surface is present. This rock provides particles for sand and sandy beach formation by erosion. The bays and inlets along the northern shore of Malta are a case in point. Thus access to these coastal stretches is restricted to the sandy pockets whereas, in areas where the smoother Globigerina Limestone prevails, human use extends over most of the littoral.

(b) Coastal rock platform

This is usually of Globigerina Limestone. It normally has a smooth, easily erodable surface. Such areas are ideal for all types of maritime activity, especially if they are located within bays, as they present an accessible and smooth coastline. Such areas within bays are highly in demand (Buttigieg, M., Vassallo M. and Schembri, J.A. 1997).

Various scientific terms have been used to distinguish these areas from other coastal geomorphological units. Shore platform, wave-cut platforms are the most commonly used terms (Sunamura, 1972; Trenhaile, 1987). Although students of these environments limit themselves to examining these features when they are present in large spans, the local limited coastal environmental area does not allow for such spaces. Within the parameters of this land use exercise, shore platforms have been divided into types depending on the presence or otherwise of vegetation. Essentially this division distinguishes broadly the following.

Unvegetated coastal rock is predominatly made up of Globigerina Limestone, and is located very near to the sea surge zone that precludes any vegetation growth. Normally it has a smoothened surface; is occasionally backed by a low cliff line or steep rock face; and is practically all accessible. These physical factors result in making these areas highly prone to development, especially where there is an element of shelter from sea swell in the inner recesses of bays, or where jetties afford physical protection. In fact they are considered as an extension of the areas where marine recreational activities occur; the latter were developed partly as a result of a previous low sloping unvegetated rock sites. Practically all areas on the eastern Malta coastlines (Segments II, IV, V and VIII), where marine reacreational activities occur, have these coastal physical geographical properties. As a management option for these areas more use should be made of those properties to trap soil and water. A project for the planting of salt-tolerent maquis vegetation especially on the areas nearer the coastal roads could be embarked upon. A few instances of these do exist, two notable ones being at Qalet Marku area and Mgarr Harbour in Gozo (Segment XIV).

(c) Steep rock faces and cliffs (garrigue vegetation)

This unit is normally of a Coralline Limestone formation. Its highly pitted nature enables the trapping of small amounts of soil; the distance from the shoreline decreases the effects of storm waters; and the lack of protection from the wind produces stunted vegetation growth. On cliff sides, vegetation growth is conditioned by the height reached by storm waters. The height above sea level varies from 25-150m on average. The cultural use of these areas is for bird-trapping and hunting during the open season. The cliffs also provide good vantage sight-seeing areas, Dingli Cliffs in Malta and Ta' Cenc in Gozo are typical examples.

(d) Boulder scree areas (Rupestral Vegetation)

This unit is identified by the presence of Upper Coralline Limestone boulders that have fallen over the other geological formations (as a result of the erosion of the underlying Blue Clay/Greensand immediately underneath it). The end result is the presence of Upper Coralline boulders forming talus on the slopes below. In addition, the boulders that do not reach the far end of the slope or lie at the bottom of the cliff edge within a flat area, provide an excellent source of natural shelter for plants and produce conditions of humidity and temperature for their immediate environment. This coupled to the presence of soil formed from the eroding Upper Coralline cliffs, and the supply of water through natural seepage brought about by the Blue Clay/Upper Coralline Limestone junctions, provides *rdum* areas with a distinctive type of vegetation called rupestral or cliff-side vegetation. These physical conditions were the main identifying factors for this type of land use.

Out of a total coastal zone area about 38 per cent are devoted to this category; of this, 80 per cent are garrigue and rupestral type areas, whilst unvegetated coastal rock, at 7.5 per cent and coastal rock platform at 10.5 per cent, make up the other two categories. Thus undeveloped open land comprises more than one-third of the coastal zone area.

6.12.5 Discussion and analysis

The data for the spatial distribution of this area is shown in Table 6.28, following the coastal divisions into segments used in the previous sections. Figure 6.16 gives the distribution on a map of the Maltese Islands. Coastal undeveloped areas are limited along the south eastern and eastern coastal areas, whilst the segments that make up the northern segment of Malta i.e. I, II and XI make up one-half of the undeveloped areas of Malta. The other significant contribution in this sphere is that of segment IX with 7.0 per cent. Examining the various details presented, land classifiable under the low land coastline type is only 16.5 per cent of all the coastal area under examination, whilst the remainder is associated with steep slopes, cliffs and scree slopes.

Only zone II has all the four variables represented, even though the two variables associated with low lying land are very limited in extent. *Rdum* areas make the most impact for their limited distribution. Segment IX has the least variability, with practically all the area occupied by garrigue vegetation, whilst segment V, (Harbour areas) is notable for the absence of garrigue areas. All the other zones have a distribution of the three most common rock configurations.

6.12.6 Presentation of Data

Table 6.28: UNDEVELOPED AREAS. Land use distribution for Malta, Gozo, Comino and the Maltese Islands.

	Hectares					Per cent				
	Shore plat-forms	**Low sloping Rock**	**Cliffs and steep slopes**	**Scree slopes**	**Total**	**Shore plat-forms**	**Low sloping Rock**	**Cliffs and steep slopes**	**Scree slopes**	**Total**
I	-	9.4	26.0	1.7	34.2	-	1.2	3.3	0.1	4.6
II	10.8	13.4	29.3	34.8	94.0	1.5	1.8	4.5	5.0	12.8
III	11.3	2.9	33.6	-	47.7	1.5	0.4	4.6	-	6.5
IV	2.5	6.4	2.1	-	10.4	0.3	0.9	0.3	-	1.5
V	2.7	2.2	-	-	4.5	0.4	0.2	-	-	0.6
VI	3.0	1.7	7.1	-	11.7	0.4	0.2	0.9	-	1.5
VII	4.2	5.8	10.3	-	20.3	0.6	0.8	1.4	-	2.8
VIII	0.8	2.0	5.6	-	8.2	0.1	0.3	0.7	-	1.1
IX	0.4	0.8	49.8	-	51.0	0.1	0.1	6.8	-	7.0
X	-	4.3	16.71	69.6	90.6	-	0.6	2.0	9.7	12.3
XI	2.4	2.7	26.4	120.9	150.9	0.3	0.4	3.4	16.4	20.5
TM	37.5	50.7	205.8	229.5	523.5	5.1	6.9	27.9	31.2	71.1
XII	3.6	0.9	33.2	-	37.7	0.5	0.1	4.5	-	5.1
TC	3.6	0.9	33.2	-	37.7	0.5	0.1	4.5	-	5.1
XIII	10.9	-	17.4	-	28.3	1.5	-	2.4	-	3.9
XIV	1.6	3.4	9.5	39.8	54.3	0.2	0.5	1.3	5.4	7.4
XV	5.4	1.3	61.9	3.0	71.6	0.7	0.2	8.4	0.4	9.7
XVI	3.8	1.6	15.5	-	20.9	0.5	0.2	2.1	-	2.8
TG	21.7	6.3	104.3	42.8	175.1	2.9	0.9	14.2	5.8	23.8
GT	63.4.	58.8	344.4	269.8	736.1	8.6	7.9	46.6	37.0	100

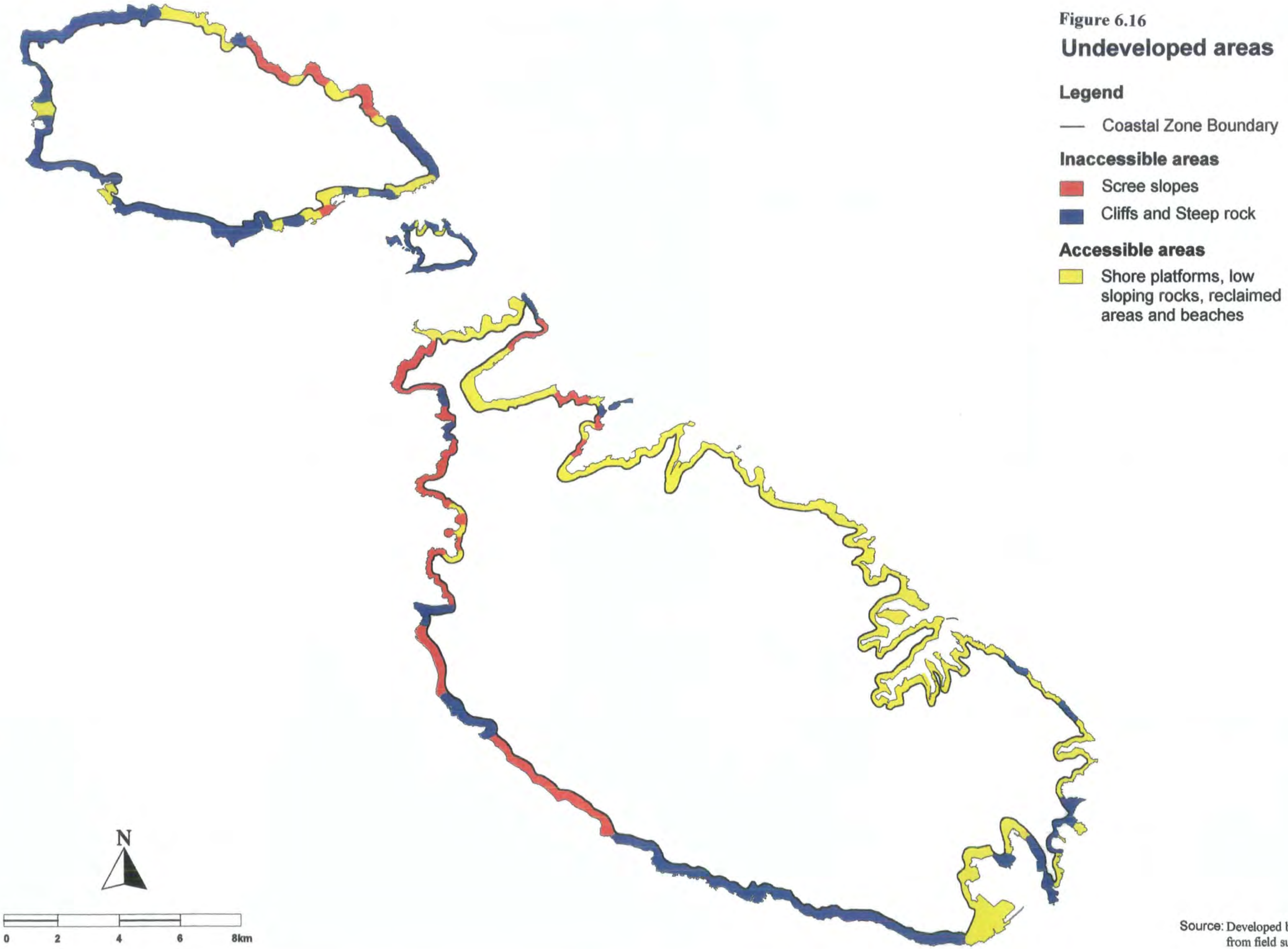
Source: Estimated by author from field data and cartometric measurements

Key

I to XVI - coastal segments (rows)
TM - Total of values for Malta
TC - Total value for Comino
TG - Total of values for Gozo
GT - Total of values for the Maltese Islands

Figure 6.16

Undeveloped areas



Source: Developed by author from field surveys

The intensive cultural use in all the segments except IX and XI, indicates that undeveloped areas make up between one-half and three-quarters for the segments in the southern and north western areas. Segment X has intensive agricultural activity and thus the natural regions are understandably depleted, even though agriculture blends well with the natural environment. In fact segments IX, X and XI have almost their whole coastal zone taken up by agriculture and the undeveloped areas put together. Including the agricultural element together with undeveloped areas, it is apparent that, for segments II, III, VI and VII, half the area is occupied by the undeveloped areas and arable land elements. Segments VIII and IV have approximately one-quarter of their area devoted to these two land use categories. The reason is that relatively large areas in these segments reflect the urban land uses, i.e., the residential, recreational and industrial activities. The last two segments, namely I and V, possess the smallest ratios of 0.6 per cent and 4.4 per cent for these land use categories, respectively, the latter reflecting the urban and industrial character of the Harbour regions.

6.12.7 Conclusion

The main conclusion regarding this land-use category is that the major physical division of the island of Malta by the Great Fault is immediately apparent, with the areas to the north exhibiting 84 per cent of rupestral *rdum* type of land use. The nature of the terrain determines the degree of accessibility or otherwise of the coastal areas. In general, cliffs and scree slope areas, with the associated rugged topography, generally preclude development. Low sloping shorelines and shore platforms, if located in areas that are in embayed zones, attract development due in part to the accessibility afforded by the low sloping profile. In fact, in this land use exercise, the areas that have uses other than the ones examined in this section all have a good degree of accessibility. The exception to this rule lies in the dilapidated areas category where access and topography do not necessarily condition dilapidation. This will be discussed in the final section.

6.13 Dilapidated areas

6.13.1 Introduction

This is the category that was affected most by the methodological changes made to the 1998 Survey from those of the1989 Survey. There are two reasons for this. The first is a logistical one, where the larger number of surveyors in the 1989 Survey could quickly produce detailed mapping with more land-use categories. The second reason is of a practical nature. In keeping with the general policy of both this thesis and the 1998 Survey, by maintaining the smallest number of land-use categories possible, and at the same time having a complete coverage of the coastal zone, a number of land uses that had a negative effect on the environment have been grouped together. These included two main types of pollution: those originating from the sea such as oil, tar and flotsam (floating debris), and pollution found on land. The latter includes the dumping of domestic waste. Building rubble and building sites, and roads that were under construction, were also included in this category. In the 1998 Survey, the issue was of having to parcel out different areas in a site that was affected by more than one type of problem. A good case in point was the dumping of domestic waste on building sites.

The term "dilapidated areas" evolved as a result of a search for a suitable term that could be given to land areas that were not covered by the other categories. Other alternative names such as "inert," "leftover," and "inactive" were considered unsuitable, misleading or inappropriate, and did not fit any practical, technical or academic jargon and terminology. "Dilapidated areas" was found to be convenient as a descriptive term for all areas that were in a state of neglect. In fact, where terminology is concerned, this is one of the land use categories that facilitated mapping for the 1998 Survey, as it included a relatively large number of elements (land uses that can be made up into one land use category). The complete identification of all the land falling within the coastal zone was therefore made easier and more efficient. Figure 6.18 shows the distribution of the land uses along the coast.

6.13.2 Background information

The high population density and the rapid increase in the socio-economic development of the island has put a great pressure on the disposal of solid waste. Data for 2000 has that 1.2 million tons of construction rubble, representing 85 per cent of all waste, was dumped at Maghtab (National Statistics Office, 2002). The effect of this on the general environment is noticeable in all areas. Investment in the recreational market, with the building of hotels and other places of entertainment, the need to provide residential housing, and the development of coastal industrial maritime areas, condition parts of the coastal zone into sites of permanent development. As this thesis examines the spatial distribution of land-use along the coastal area, the dilapidated areas land use category is directly associated with the building industry. These building sites generate a number of problems:

- sites are normally surrounded by an area of spoil and of building material debris;
- access roads are partially blocked with debris and building machinery;
- new infrastructure facilities for drainage, water and electricity and new roads have to be provided, increasing the area of spoil around sites.

6.13.3 Justification for study

In justifying the inclusion of this land use category here, one can cite a number of factors:

- the negative environmental quality of the areas affected by this type of problem;
- the effective change in land use into land for domestic waste; and
- the change of low sloping shore platforms from recreational localities to hazardous zones due to tar deposition along the littoral.

6.13.4 Definitions and criteria used for field identification

Six elements are associated with this land use category, four linked with the building industry, with the other two being domestic waste and tar. Our definition of the dilapidated areas will encompass the following land use type that impinge negatively on the aesthetic environment these include those associated with the with the building industry as stated in Chapter 5:

(a) Urban wasteland. These areas are generally found in urban zones and include all pockets of land lying within the built-up area. They were usually found between separate house block units. This temporary use varied from make-shift car and/or boat parks to areas where illegal dumping of domestic refuse occurred. Spatially speaking they afforded open spaces in ribbon-type built-up areas;

(b) Transitional land. These areas are associated with arable land that has been either abandoned or is in the process of being developed. Normally these are areas that are adjacent to sites being developed for residential, recreational or industrial needs but are now derelict and earmarked for development. Essentially they were areas that were used for agriculture. Whilst urban wasteland is identified as being surrounded by residential housing, these areas are earmarked for immediate development;

(c) Recent additions and new constructions. These pertain to the building sprawl and are essentially an addition to the network of residential areas;

(d) Dumps of building material. Associated largely with the building industry this land use category is easily identified. Two types of sites are normally identified: dumps of building material in areas officially recognised for such purposes, and in areas were it is illegal to follow such practices, (Figure 6.17).

(e) Domestic waste. This includes household refuse and refuse from catering establishments dumped illegally along the littoral. The most favoured sites are afforested; and

(f)Tar. Grouped within this land use category, but essentially of a maritime origin, tar constitutes the end result of oil dumping in the open water which finally reaches the shoreline. It has been placed within this category for the sake of convenience; it constitutes only 1.2 per cent of the whole land utilities (1989 Survey).

6.13.5 Presentation of data

Table 6.29: DILAPIDATED AREAS. Land use distribution for Malta, Gozo, Comino and the Maltese Islands.

	Hectares		Per cent	
Segment	Area (ha)	Total	Per cent	Total
I	6.1	6.1	7.6	7.6
II	18.4	18.4	22.9	22.9
III	13.3	13.3	16.6	16.6
IV	2.8	2.8	3.5	3.5
V	12.1	12.1	15.1	15.1
VI	9.2	9.2	11.5	11.5
VII	3.6	3.6	4.5	4.5
VIII	9.1	9.1	11.4	11.4
IX	0.5	0.5	0.6	0.6
X	0.1	0.1	0.1	0.1
XI	3.0	3.0	3.7	3.7
TM	78.2	78.2	97.3	97.3
XII	-	-	-	-
TC	-	-	-	-
XIII	1.5	1.5	1.8	1.8
XIV	0.3	0.3	0.4	0.4
XV	0.2	0.2	0.3	0.3
XVI	-	-	-	-
TG	2.0	2.0	2.5	2.5
GT	80.2	80.2	100	100

Source: Estimated by author from field data and cartometric measurements

Key
I to XVI - coastal segments (rows)
TM - Total of values for Malta
TC - Total value for Comino
TG - Total of values for Gozo
GT - Total of values for the Maltese Islands

6.13.6 Discussion and analysis

A number of features are apparent from the data in Table 6.29:

a) the dilapidated areas category is found along the eastern coast of Malta, all segments (I-XI) are represented;

b) the areas where intensive touristic development is taking place have a high percentage of this land-use category with new building construction;

- Segment IV - St. Julian's Bay and St. George's Bay;
- Segment VI - St. Thomas's Bay; and
- Segment VII - Marsascala Bay.
- In Gozo the areas around Xlendi (Segment XV) and Marsalforn Bays (Segment XIV) are the best examples.

The Freeport terminal at Marsaxlokk Bay in Segment VIII and the Grand Harbour area in Segment V are linked to industrial development. Segments along the south and western coast of Malta (Segments IX to XI) possess less dilapidated areas and are normally affected by the deposition of tar.

The Table 6.29 and Figure 6.18 presented with this section highlight a number of issues:

(a) a concentration of abusive land uses practices on the eastern coast of Malta (Segments I to VIII);

(b) the predominance of the urban wasteland category, accounting for one-half of the total;

(c) areas that feature dumping of building material do not coincide with the urban wasteland areas, showing that dumped material is transported to selected sites away from the traditional urban areas;

(d) 80 per cent of the urban wasteland category is located in segments II, III and V; and

(e) 50 per cent of the area with dumped material is located in segment II.

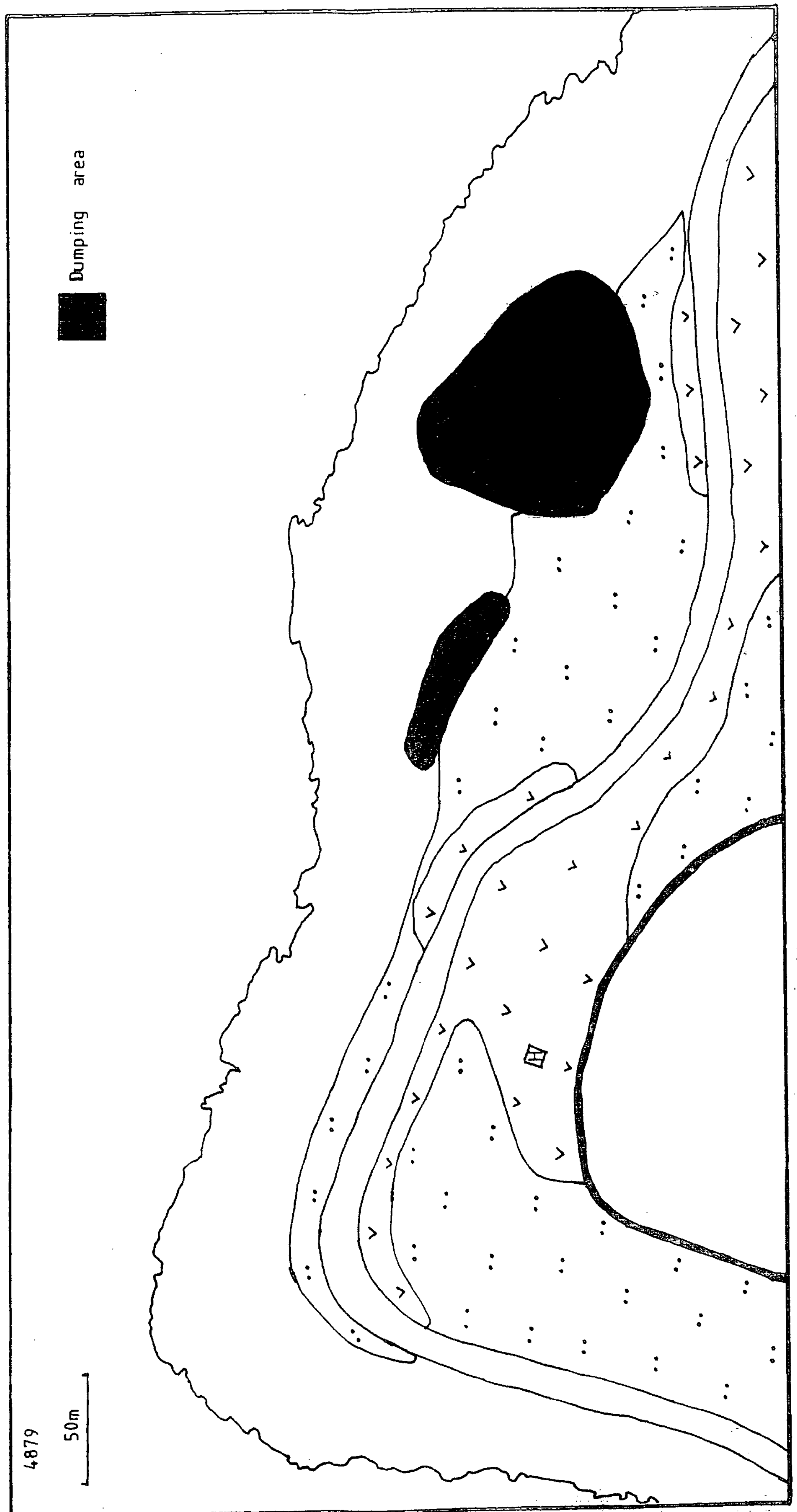


Figure 6.17 Gozo, North coast: site of illegal dumping area on foreshore near historic tower and afforested area.

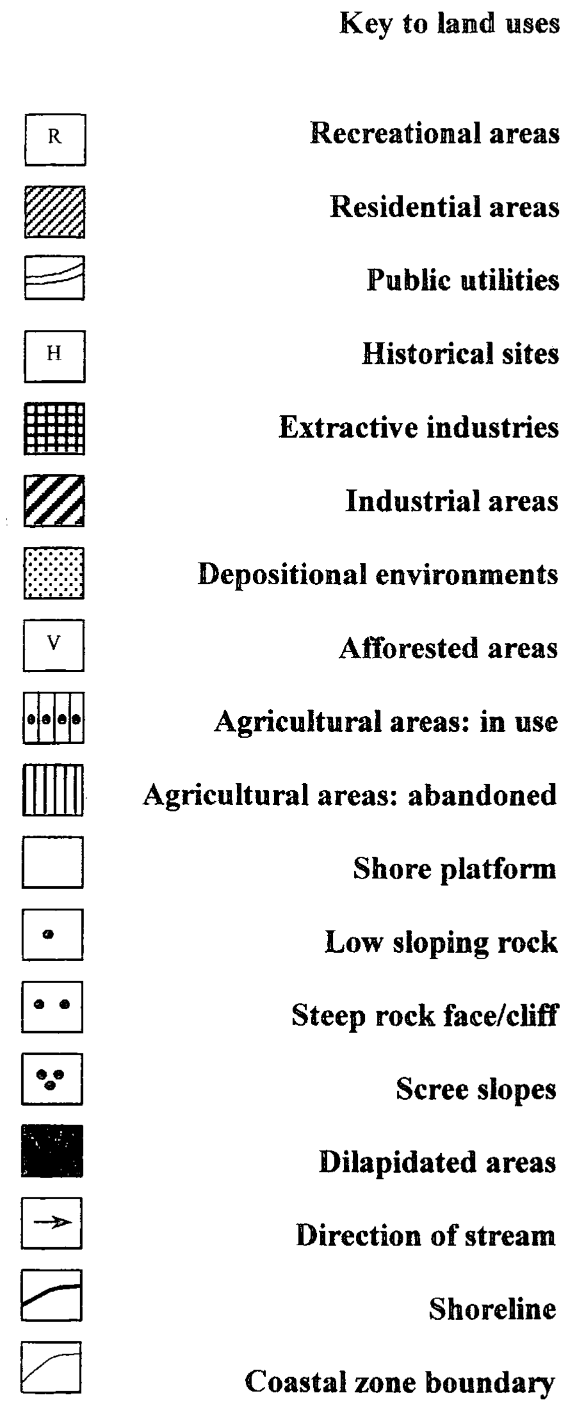
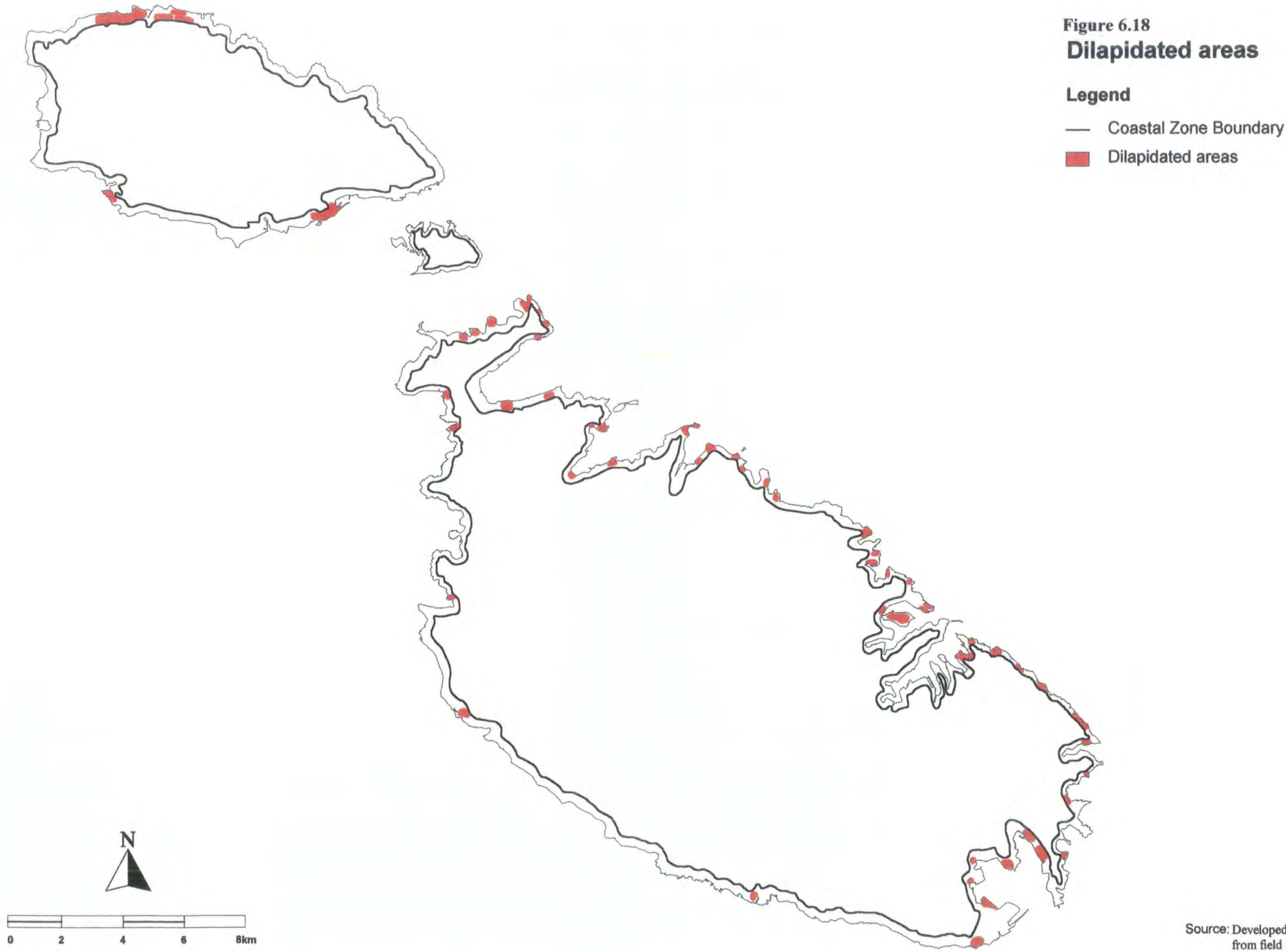


Figure 6.18
Dilapidated areas



Source: Developed by author from field surveys

6.13.7 Conclusion

This final category has put into perspective the problems in managing land use, in that the dilapidated areas whether located in urban or in rural areas depreciate the coastal zone, besides affecting negatively the aesthetic environment. Essentially the debris accumulated and located in the urban areas mainly consists of refuse material originating from household and restaurant leftovers, whilst the dilapidated areas in the rural surroundings mainly consist of dumped vehicles in inaccessible areas with scree slope and cliffs and tar patches in rural accessible areas. Areas where building development is taking place and consequently fall within this category are generally confined to the coastal urban areas. The end result of this is that there is a difference between the types of dilapidation, depending on the prevailing activities occurring in the area where dilapidation has been identified.

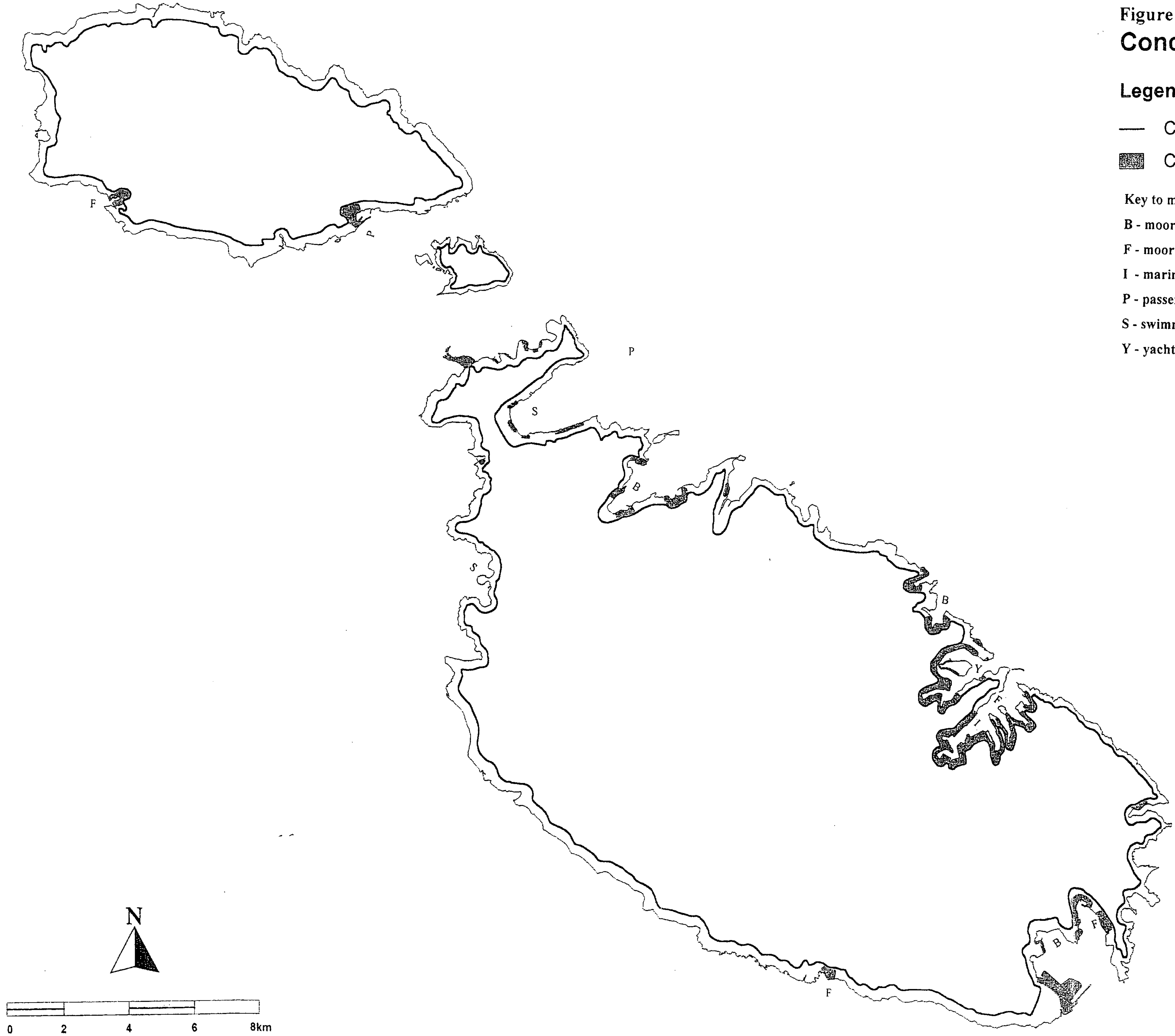
6.14 General conclusion: sea and ocean uses and concrete areas

A coastal zone management plan generally envisages a plan for sea uses together with that for land uses. Although this thesis is mainly concerned with land uses, the uses made of the area of internal waters has also to be taken into consideration. However, this will be done on a qualitative basis in that presenting the data for sea uses at the same dimensions and scale as for land uses would upset the rigour established in the thesis, and sea uses of the internal waters are generally conditioned by the physical fabric of the shore and land-based coastal activities.

One of the best indicators that promote an idea as to the linkage of sea uses to land uses is the presence of concrete platforms. These are constructed along the shoreline and are generally used to enhance the efficiency of the land/sea interface. Their presence along the shoreline is demonstrated through the dimensions given in Table 2.11 where 13.2 per cent of the coast is estimated as having a concrete face, the large proportion constructed along the Malta littoral. Figure 6.19 shows the distribution of concrete platforms along the littoral of the Maltese Islands. Three factors emerge:

(a) concrete platforms are generally located in areas where a large number of land uses occur, such as marine servicing areas and industrial areas, and also residential areas;

Figure 6.19
Concrete platforms



Legend

— Coastal Zone Boundary

Concrete platforms

Key to main sea uses

B - mooring of recreational boats

F - mooring of fishing vessels

I - marine-based industry

P - passenger ferry terminal

S - swimming

Y - yacht marinas

Source: Developed by author from field surveys

(b) the accessibility of the area is generally high, with a low sloping rock face or shore platform being the main geomorphological feature;

(c) embayed areas possess more of their coastline with a concrete face than rectilinear areas.

Thus coastal segments IV, V, and VIII, which are the urban/industrial segments, have the greatest length of their shoreline lined with concrete. Segments I, II and VII have a similar concrete face only in parts of their littoral, generally in the inner recesses of Bays. The other segments have a notable absence of concrete faces and very little land claim.

Sea uses along the coast of the Maltese Islands reflect two main issues. First is the degree of accessibility of the coast from the landward side. Coastal areas that have a low degree of slope are normally accessible with the result that the adjacent waters are intensively used. Secondly the shoreline is generally concreted over to enhance accessibility and accommodate ancillary uses such as jetties and boat slipways. In many areas breakwaters have also enhanced the efficiency of the shoreline and associated internal waters by providing all-weather zones and increasing the servicing area around a bay especially when the breakwater edge that faces the bay is only a few centimetres above the water line. In addition, the dredging of parts of the sea bottom in bays and harbours permits the servicing of vessels with a deep draught.

Figure 6.19 shows the areas that are concreted over and the predominant sea uses adjacent to the shoreline. These sea uses are distributed among six categories. Their distribution is conditioned by the degree of slope of the shoreline and the general indentation of the coast: the greater the indentation and the lower the slope the more intensive is the use of the coast (cf. Chapter 3). Another consideration that has emerged is that with the exception of the distribution of industrial activities in Grand Harbour most of the large scale coastal activities and projects whether of an industrial or recreational nature are occurring at the outer reaches of bays and inlets or in areas having a rectilinear coastline. This issue will be tackled in the concluding chapters of this thesis, however the focus of the next chapter will remain on a detailed description and analysis of each segment of the coast.

Chapter 7 A discussion of the coastal segments

7.1 Introduction

In the preceding chapter the discussion centred around coastal land use as seen from the aspect of the whole littoral area for each separate island. The main distinction that was made was between land uses that had either a predominant urban or rural character and that will be retained. The argument now focuses on examining the land uses for each segment (I to XVI). Table 7.1 demonstrates the varied dimensions of the segments. These include variations in coastal zone area, littoral length and mean coastal zone width.

Table 7.1: Selected data for all coastal segments

Segment	Area (ha)	Length (km)	Mean coastal zone width (m)
I	89.4	7.4	120.8
II	253.7	23.8	106.6
III	115.7	8.0	144.6
IV	48.2	7.7	62.6
V	193.3	25.6	75.5
VI	38.1	6.3	60.5
VII	69.1	13.8	50.1
VIII	96.9	10.8	89.7
IX	101.5	17.3	58.7
X	258.0	12.5	206.4
XI	194.8	21.6	90.2
Mean: Malta	124.5	14.1	96.9
XII Comino	42.5	8.1	52.5
XIII	45.2	5.5	82.2
XIV	114.9	13.1	87.7
XV	142.3	20.9	68.1
XVI	51.0	9.6	53.1
Mean: Gozo	88.4	12.3	72.8
Mean: all Islands	115.9	13.3	88.1

Source: Compiled by author from cartometric measurements

7.2 Segment I

7.2.1 Physical Attributes

The Segment stretches from Cirkewwa Point to l-Ponta ta' l-Ahrax is 7.4 km in length and has one of the shortest lengths of Segments for the Maltese Islands, amounting to 3.5 per cent of the total coastline. The total area of the coastal zone is 89.6 ha and the average width of the coastal zone is 120.8 metres. The orientation towards the north and northwest in addition to the low, sloping profile influenced the author to identify this segment separately from the other adjacent ones, i.e., Segments II and XI, conditioning the size. However, the Segment has a large number of land uses when compared to other coastal segments. Eleven land uses were identified with coastal units 2 and 4 having the highest number.

The general orientation of the area faces North, however since the coastline has an embayed form parts of the six bays face in different directions: ir-Ramla ta' Wied Musa has sides facing NE and the opposite shoreline NNW, at ir-Ramla tal-Bir the sides face NE and WNW, ir-Ramla tal Qortin (NNE and WNW), Armier Bay (E and NNW), ir-Ramla tat-Torri having a general orientation to the NW with one side of the littoral facing NE the opposite side SW; and the last inlet, and the only one not to have any sand, is at Dahlet ix-Xmajjar with sides facing NE and W.

The segment consists of a low sloping rock profile with the main outcropping geological formation being Upper Coralline Limestone. Quaternary continental deposits are also evident. The geological formation of this littoral is made up of Upper Coralline Limestone and forms part of Marfa Ridge. Horst and Graben formations that characterize the part of Malta to the North of the Great Fault, consisting of ridges (Horst) and valleys (Graben), manifest themselves in an embayed littoral environment. The Coastal zone in Segment I facing the South Comino Channel is in fact part of the Horst formation still above sea level. The Channel is the submerged part of the Graben.

7.2.2 Land uses

Using the data in Appendix 1, and examining the values for this segment, i.e., the area in hectares for every land use in each coastal unit and the percentage values for each land use category, it was possible to construct Table 7.2. This Table also provides synoptic information. This segment is dominated by recreational areas (a) arable land (j) steep rock faces (n); and low sloping rock profile. Depositional environments (h) and afforested areas (i) also are present. The highest figure in the matrix is for steep rock faces for coastal unit 4 with 47.21 per cent of the values for all the land uses represented in the sheet. Five land uses are not represented: residential areas (c), industrial areas (f and g), abandoned agricultural land (k) and shore platforms (l).

Table 7.2: Selected synoptic data for coastal units in Segment I

Coastal unit	Number of land uses	Per cent: land uses out of max.16	Per cent: area of segment
1	5	31.25	7.7
2	11	68.75	33.1
3	8	50.00	15.1
4	9	56.25	44.1

Source: Estimated by author from land use data

The overall scenario for this segment is one that is dominated by recreational land uses set in a rural environment. One-fifth of the area consists of an active agricultural sector with a good natural water supply from the shallow aquifers, producing a variety of crops at all seasons, and substantial parts of an undeveloped shoreline with sandy beaches. The low sloping profile of the terrain indicated by the 9.4 ha of low sloping rock provides good access within the coastal zone and accounts for the presence of agriculture as an important economic activity. In addition, the presence of agricultural land near the littoral indicates that the area has not been affected by urban and recreational development, as in other parts of Malta. Almost 30 per cent of the land uses mapped are also indicated by steep rock, with three-quarters of this for the whole segment found along the eastern perimeter of the segment. The area is in general rural in character as the urban and industrial land indictors are represented only through the land uses devoted to recreation: coastal units 2 and 3 providing more than two-thirds of this capacity for the whole segment. The presence of hotels in these areas accounts for this. Of particular interest are two land uses depositional (h) environments and dilapidated areas (p). The presence of five sandy beaches mentioned above along the littoral account for this situation. The high incidence of dilapidated areas (p) is all due to two factors - building debris as a result of public works along the coast and hotel restructuring. The endemic problem of dumping of domestic waste also accounts for part of this land use category.

Three main development initiatives occurred along this segment. The increase in the capacity of the Ramla Bay Hotel and its associated facilities such as sporting and recreational facilities necessitated the tapping of more water resources from adjacent boreholes and took some areas of fertile agricultural land from its hinterland. The extension of the Gozo Ferry Terminal changed the overall rural fabric of the northern most tip of Malta in that facilities included the widening of the road network, a larger area devoted to ancillary passenger services, and the extension of the breakwater and ferry berthing facilities hampered the bathing and scuba-diving facilities in the vicinity (The Times [of Malta] 13 May 2003, p 6). The third development evolved into a hot political issue when a number of boathouses, built without the necessary permits adjacent to 17th century fortified walls constructed as part of the defence of the north Malta coast, were demolished by the Armed Forces of Malta on instructions by the MEPA. In all probability this was one of the first highly publicized incidents where enforcement of the building regulations was seen to be occurring.

Potentially the area has high aesthetic qualities with five small sandy beaches along the length of the littoral and a low sloping garrigue shoreline. However passage over part of the foreshore is impeded as it is fenced across part of the beach which is leased to the hotel. In addition, the presence of substantial quantities of rubbish left over by campers and other users, especially within the afforested parts of this area, and the illegal dumping of domestic and construction waste generated in urban areas, spoil the overall environment (Plate 7.1). In fact, the area around the old watch tower has been leased to a private entrepreneur to develop a camping site for commercial purposes also with a view at controlling litter dumping.

It is the highly accessible nature of the whole segment, its rural character, its relative distance from the urban areas of Malta, the clean beaches facing the Comino Channel that make the area a popular destination for swimmers, campers and also of developers. In fact the MEPA, in its local plan for the North of Malta, has referred to this zone as a high quality area, and its management to focus on the identification of camping sites, the maintenance of the historic walls and tower and the upkeep of the environs of the Gozo Ferry Terminal. In addition, the problem with the proliferation of boathouses (one-roomed cubicles used as summer residences) in the area has prompted the MEPA to issue guidelines regarding their location, cleanliness and legal status (The Times [of Malta} 25 November 2002, 48).

7.3 Segment II

7.3.1 Physical attributes

The limits of Segment II commence at il-Ponta ta' l-Ahrax limits of Mellieha to Ghallis Point. The need to group together all the north eastern Bays in Malta was the main reason for this segment to be the second largest one for the Islands. With a coastal length of 23.8 km, an area of 253.7 ha, and an average coastal zone average width of 106.8 m is the fourth widest for the Islands. The localities that feature prominently in this Segment are Ghadira, St. Paul's Bay, Bugibba, Qawra and Salina Bay. These skirt Mellieha Bay, St. Paul's Bay and Salina Bay. St. Paul's Islands are located in this Segment.

The general aspect of the Segment is to the northeast, however, the sides of the Bays are oriented differently and Table 7.3 has been compiled to show varying orientations of the sides of the each bay.

Plate 7.1 North Malta, Dahlet ix- Xmajjar: Dumping of domestic debris and unused household appliances in coastal rural area identified as the first official campsite. Source: The Times 2nd June 2001

7.3.2 Land uses

Just over one-third of the cells presented in this Segment and seen in Appendix 1 denote no type of land use, with coastal units 10, 16 and 18 having the least variability, with few land uses shown (Table 7.4). Coastal unit 10 represents St. Paul's Islands, and unit 18 Salina Bay. The remaining coastal units have a fair spread of both urban and rural related land uses. With the recreational land use category (a), arable land (j) and (k) and land uses (m), (n) and (o) for coastal units 14, 15 and 16 are highly represented. Dilapidated areas in this Segment feature prominently in urban areas in most other parts of Malta.

The main geological features of the Segment can be divided into two: the area from il-Ponta ta' l-Ahrax to St. Paul's Bay features scree slope landscapes (*rdum*) with Globigerina Limestone shore platforms at intermittent distances. The second part features a low rock coastline of Lower Coralline Limestone. The Horst and Graben formations mentioned in Segments I and XI are also evident in this Segment; the bays are in themselves the end result of this process.

Most of the land use categories identified for this thesis are represented in this segment, with the exception of the industrial land uses. The fact that a high proportion of the land uses mapped appertain to the rural environment indicates the overall setting of the segment. However the 19.6 ha of recreational areas and the 20.5 ha of public utilities indicate that the area has a substantial part of it devoted to urban development. In addition the 2.3 ha of marine servicing areas located for most of the urban littoral length show that the servicing of marine related activities occur along substantial parts of the coastal area. One outstanding feature of the land use scenario are the afforested areas. At 21.6 ha it is one of the highest for any segment because the area and length of the segment itself is rather high and a number of areas within the segment have been afforested in an effort to improve the aesthetic quality of the environment. In addition, some of the undeveloped areas possess zones that have a supply of good soil and natural water sources that encourage growth of indigenous trees and maintain the health of afforestation areas. Prominent among these are the Ghadira area behind the sandy beach at Mellieha Bay and is-Simar at St.Paul's Bay.

Table 7.3 Main compass orientation of selected parts of the main bays and inlets in Segment II presented in contiguous sequence

Name of Bay	Locations	Compass orientation
Mellieha Bay	Dahlet ix-Xilep to Ghar Baqrat Ghadira Bay Ghadira Bay to Ras il-Griebeg	SE NE NW
L/o Selmun	Mgiebah to Ras il-Mignuna	N to E
Mistra Bay	Mistra Bay Sides of Bay	SE SW; NE
St. Paul's Bay	Rdum Rxawn to Pwales Pwales Beach Pwales Beach to Tal-Ghazzelin Tal-Ghazzelin Rdum l-Abjad/Bugibba to Qawra Point	SE NE NW NE NW
Salina Bay	Qawra Point to Salt Pans Salt Pans Salt Pans to Ghallis Point	E NE NW

Source: Compiled by author from 1:25,000 scale map of the Maltese Islands

Table 7.4 Selected synoptic data for coastal units in Segment II

Coastal Unit	Number of land uses	Per cent: land uses out of max.16	Per cent: area of segment
5	5	31.25	6.0
6	9	56.25	11.5
7	7	43.80	6.6
8	8	50.00	7.6
9	10	62.50	19.2
10	2	12.50	2.4
11	10	62.50	5.0
12	11	68.75	8.9
13	8	50.00	7.5
14	7	43.80	5.5
15	10	62.50	4.2
16	3	18.75	0.9
17	5	31.25	3.7
18	3	18.75	0.7
19	8	50.00	6.6
20	5	31.25	3.7

Source: Estimated by author from land use data

Another important land use feature is the depositional environment category where the 2.6 ha appertain almost to one beach at Ghadira which is by far the most popular beach in Malta and also the largest. However a number of pocket beaches are present along most of the littoral of the segment one of which at St. Paul's Bay is heavily degraded due to the concrete structures placed along the shoreline that modified wave impact and refraction in the bay depleting the sand supply. The beach was further degraded by sewage overflows into the sea.

The four land use categories identified for the undeveloped part of the coast show that the segment is highly represented in all of them. The aesthetic qualities of the area are a feature that should be given the required attention. In fact, one particular zone within this segment, Il-Fekruna, has recently been in the news. The area possesses a secluded pocket beach backed by a steep afforested clay slope. The local council, in monitoring new development boundaries proposed by the MEPA, realized that it had included it within the new development areas. Representations to the press had the Authority acknowledge its mistake. However, the area forms part of the larger Xemxija zone in St. Paul's Bay and which is a highly desirable area for up-market local and tourist accommodation. Only the scheduling (no development permits to be issued) of this and similar zones by the MEPA can stop this.

The coastal zones of Segments I and II fall within MEPA's North West Local Plan area and as such their coastline, with the exception of the urban areas of Xemxija, Mellieha, Qawra and Bugibba, has been designated as an Opportunity Development Zone (ODZ). This means that future development can only be considered if the application consists of coastal related activities and its proposed location does not fall within the scheduled areas (Planning Authority, 2001,106). In fact the go-ahead has been given for the establishment of a marine park at Qawra Point as part of the efforts to increase to the 80,000 tourists who visit Malta through the local diving associations (The Times [of Malta] 8 July 2002, p 5).

A number of planning issues for the St. Paul's/Bugibba/Qawra area have been compiled by MEPA. These are: conflicting land uses due to high pressure for residential development, increase in population density, partly due to height of buildings and the conversion of one and two storey premises into high-rise apartment blocks with poor quality building design and increase in traffic congestion. In addition, the need to increase public amenities that include the building of a new school, a regional sports complex and a new regional bus and coach transport station put further pressure on the locality (Planning Authority, 2001). In order to minimize the pressure on the coast a series of land use strategies have been proposed by MEPA. These include location of tourist accommodation away from the rural areas to zones within the urban area, zoning urban areas into Residential Priority Areas and Entertainment Priority Areas in addition to the re-routing of through traffic. The latter is a very sensitive issue especially in bottleneck areas along Xemxija Hill and Ghadira Bay. Further measures include the protection of historic zones by the designation of an Urban Conservation Area and the scheduling of environmentally sensitive areas to guard the natural environment, and ensure public access to the foreshore by restricting the development of boathouses and beach rooms. In addition, the Ghadira Nature located at the landward side of Ghadira Bay is a protected bird sanctuary and is visited by 10,000 people every year, 38 per cent of which are school children (The Times [of Malta] January 6 2003 pp 20-21).

7.4 Segment III

7.4.1 Physical attributes

This Segment starts at Ghallis Point and finishes at Dragonara point. It is 8 km long and, like Segment I, is one of the shortest segments, occupying only 3.8 per cent of the whole littoral. The rectilinear nature of the coast, the almost uniform aspect through most of its length, and the low-sloping profile throughout, have influenced the boundaries of the segment, as its littoral is very different from the embayed features of the segments on either side of it.

The predominantly rectilinear nature of the coast is characterized with a marked lack of notable indentations and this has produced a coastline that is highly exposed to winds from the north east, compromising the variety of land uses and making the extensive use of this part of the littoral hazardous. The predominant orientation of the littoral of this segment is to the NE, however the orientation of Qalet Marku Bay is to the NNW and Bahar ic-Caghaq Bay is to the NNE.

The main geological outcrop consists of Lower Coralline Limestone that presents a pitted surface on exposure, making the rock surface difficult to walk on. Thus, although access to the littoral should be good, in that the degree of slope does not exceed three degrees, this geomorphological condition curtails access to the shoreline.

7.4.2 Land uses

After examining the coastal units for their coastal land use variability, in Appendix 1 a 112-cell matrix is shown for this segment, with 70 cells being unrepresented, approximately 62 per cent of the total. Residential areas (c), scree slope areas (o) , and industrial areas are unrepresented, whilst historic sites (e), depositional environments (h) and arable land are all limited to only one particular unit. The natural features of this segment comprise almost one-half of the coastal zone area mapped with shore platforms (l) and low sloping shoreline (m) constituting 30 per cent, the remainder being made up of steep rocks. Depositional environments feature as land use category (i) and their distribution is conditioned by the presence of peninsulas of Qalet Marku and Qreiten Point. In fact, these features occupy only the most relatively indented part of the littoral of this segment from Ghallis point to Bahar ic-Caghaq. The remainder of this littoral is occupied with steep rock faces and deep waters and less indentation along the coast is evident. Table 7.5 gives a synopsis of the data for this segment found in Appendix 1.

Table 7.5: Selected synoptic data for coastal units in Segment III

Coastal unit	Number of land uses	Per cent: land uses out of max. 16	Per cent: area of segment
21	7	43.8	9.3
22	7	43.8	7.0
23	4	25.0	8.0
24	11	68.8	16.5
25	3	18.8	11.7
26	5	31.3	45.2
27	5	18.8	2.3

Source: Estimated by author from land use data

The table gives the number of land uses present in each coastal unit, with unit 24 having the highest variability, with 11 out of the 16 land uses monitored. Variability decreases on either side of the Qalet Marku peninsula. Two main features contribute to the land uses in the segment. The first is the coast road running parallel to the shoreline almost the whole length of the segment, the second is the Maghtab rubbish dump that has grown from the hinterland area onto a very visible location near the coast road. Although the presence of the landfill maintained the rural character of this segment pockets of recreational development are evident. The land uses that are prevalent along this littoral are those associated with the recreational environment, notable among these are boathouses, a hotel, a caravan site and a "fun park" where family water sports and other activities are organized. These land uses are concentrated along the low sloping part of the coastal segment whilst along the cliff-side areas development is farther away into the hinterland.

The nearby presence of the main refuse dump of Malta at Maghtab in the limits of Bahar ic-Caghaq can be seen from part of this segment, although it is not within the coastal zone boundaries used for this thesis, the landfill is highly visible from the coast, water seepage affects the sea water quality in its vicinity, strong winds carry flying debris towards the coast and its presence has conditioned development along this part of the littoral. The Maghtab landfill remains the major environmental sore of the island and following the publication of the Solid Waste Management Strategy for the Maltese Islands in 2001 it was estimated that Lm 70 million are needed to close it down. A number of proposals were put forward in the Strategy as part of the measures to deal with the problems of disposing of 1.5 million tons of solid waste annually. The measures included the closing down of the site by 2004 and the landscaping of the whole site to enhance the rural character of the area (Government of Malta, 2001).

The dump is already posing health hazards to the population in the vicinity, is an eyesore from wherever it is visible and ruins the high aesthetic qualities of the environment. Its further increment may pose a great physical hazard to motorists should it spill over in wet weather conditions. In addition, seepage of liquid material into the sea has also been reported (The Times [of Malta] 23 November 2002, 6), as is the smell of burning rubbish with the emission of noxious fumes and wind-blown litter. This dump has featured as the centre of the debate for a number of years in that it is considered as being the country's main environmental problem and a typical example of a small island with no response to its waste disposal problem. A recent proposal involves the dumping most of the debris in the "landfill" into the sea creating either an artificial island, or combining the reclaimed land with a breakwater to protect the area from the strong northeast storms, jetties to service a number of boats and yachts, and a promenade for coastal walks.

In addition to the land reclamation the idea was put forward to excavate part of the existing littoral to add on to the additional services. An area with up-market residences and a hotel also have been proposed. Depositional environments feature as land use category (i) and their distribution is conditioned by the presence of the peninsulas of Qalet Marku and Qreiten Point. In fact, these features occupy only the most relatively indented part of the littoral of this segment from Ghallis point to Bahar ic-Caghaq. The remainder of this littoral is occupied with steep rock faces and deep waters and less indentation along the coast is evident.

7.5 Segment IV

7.5.1 Physical attributes

Segment IV stretches from the peninsula at St. George's Tower to Dragut Point at the entrance to Marsamxett Harbour. Most of the coastline is accessible from the landward side and is highly urbanized. The average width of the coastal zone is 62.6 m, making it the narrowest zone in any Segment in the Maltese Islands.

The general orientation of the segment is to the NE, however the Segment can be divided into two. One part has embayed features with three main inlets, St.George's Bay, Il-Qaliet, St. Julians's Bay and Balluta Bay, the other having a predominantly rectilinear coastline up to St. Elmo Point. The sides of the bays are oriented in different directions to the general aspect of the Segment. The sides of St.George's Bay face SE and NW respectively, and for St. Julian's Bay S and N. Balluta Bay has two main inlets, one facing NNE and the other NNW, with the first having sides facing to the E and NW and the second having a concave shape with an orientation from N to WNW. The rectilinear parts of the coast also faces NE. The main subdivision of the two sectors is dependent on the physical attributes of the area, where a fault running in a perpendicular direction to the coast at St. Julian's Point was partly responsible for the Lower Coralline Limestone formation giving way to Globigerina Limestone. Shore platforms and a low sloping coastline are characteristic geomorphological features prevalent along the whole littoral.

7.5.2 Land Uses

The matrix presented gives an indication of the land uses extant in segment IV, with a low range of values for the land uses for every unit. The highest value is seen for coastal unit 36, with 68.75 per cent representing 11 out of a maximum of 16 land uses. All the other units have a land-use representation of less than eight of the 16 land-use categories. There are two main reasons for this: the fragmentation of the coastal zone of this Segment into 9 units gives a small area for each unit, restricting the space for a variety of land uses; secondly, the area is highly urbanized, having very few land-use categories associated with the "rural" environment, thus limiting the variety of land uses.

Table 7.6: Selected synoptic data for coastal units in Segment IV

Coastal unit	Number of land uses	Per cent: land uses out od max. 16	Per cent: area of segment
28	5	31.25	10.2
29	3	18.75	3.9
30	8	50.00	11.0
31	4	25.00	8.1
32	6	37.50	24.3
33	4	25.00	5.2
34	6	37.50	15.5
35	6	37.50	12.9
36	11	68.75	8.9

Source: Estimated by author from land use data

Examining the land uses through the details given in Appendix 1 and the data in Table 7.5, a high proportion of the segment is identified as urban. Land uses associated with the urban environment (a-d) form the greater proportion for each coastal unit. In addition, data for land use p, denoting dilapidated areas, are also significant, with Plate 7.2 highlighting one of the problems of dilapidation. The limited development along units 35 and 36 is seen from the data for steep rock (m) at 40 per cent in cell 35, and 28 per cent for cell 34, indicating areas with a low rock coastline.

This segment has one of the highest proportions of urban land uses along the littoral of the Maltese Islands. The main reason for this is that the area already had a high residential urban character, forming part of the post-1950 urban growth away from the main harbours' conurbation. In addition, the 1960s building boom was partly concentrated in this zone where these areas were marketed by property developers as a viable investment. Building took the form of flats geared to attract foreign buyers and the overall business attitude was more akin to property speculation than to develop a truly local product. In addition the building style was imported from northern Europe with little consideration to local climatic conditions or aesthetic quality and resembled long lines of pigeonhole blocks. The post 1980s mass tourism impact on Malta affected this area greatly in that a number of hotels were built in the St. Julian's locality and the 1990s craze for the recreational value of Paceville put further pressure on the residential urban environment of the area turning the zone into a *mecca* for night revelers. In conjunction to these developments the coastal area has also been affected. Most hotels and guest houses are located along the shoreline together with a large number of restaurants. A number of old houses have been demolished to make way for blocks of flats and the few older residences left have been turned into restaurants. Clear examples of this situation can be seen along the Sliema seafront where properties are marketed at Lm 150,000 - 200,000 for each flat. These values are six to eight times the prices asked for similar properties for other coastal localites (The Sunday Times [of Malta]10 November 2002). The shoreline has also been greatly modified in that a strip of reclaimed land along most of the coastal perimeter has been added to allow for the provision of commercial shoreline concessions on the water's edge.

Although the situation does not seem to be as congested in the Sliema area, in that the road skirting the waterfront is wider, a 20-metre shore platform and a 6-metre cliff and a 2-metre wide pavement separates the buildings from the shoreline, the area is none-the-less as attractive to property developers and entrepreneurs. In addition, the Sliema coast consists of a rectilinear coastline fronting the open sea whilst the St. Julian's front lies within a bay enclosed by a breakwater. The problems associated with the dilapidated areas are essentially the result of the perennial construction going on the localities, dumping of restaurant and household rubbish in unbuilt zones and parking lots and the tar washed on the rocks from the illegal flushing of oil from all types and sizes of sea craft.

Among the important proposals that the Structure Plan for the Maltese Islands puts forward for this segment are the following: to secure public access to the whole coastline by bringing the littoral into public ownership and resisting the demands for shoreline and beach concessions by private developers. These include requests for jetties, private beaches, pathways, swimming pools and waterpolo pitches (Planning Authority, 2002b). Unfortunately part of the only stretch of undeveloped coast at Pembroke has been converted into a football pitch only a few meters away from the shoreline. Requests at promoting sites for beach replenishments must be subject to a satisfactory Environmental Impact Assessment. Although a third of the tourist accommodation capacity for Malta is located in this area, 68 hotels and 14 tourist villages, the Structure Plan envisages that 4000 additional tourist beds will be required by the end of the Structure Plan period in 2010. However, this total has already been exceeded especially with the addition of more hotels in the Paceville area (Planning Authority, 2002b) putting further land use pressure on coastal resources. However the most important issue concerning land use problems in this segment are the problems generated by the development of the tourist and recreational capacities on the residential areas. Although policies for the regulation of commercial establishments in residential areas are in place and stringent rules are applied regarding the location of bars and restaurants adjacent to residential areas, noise and general nuisance prevail just the same. In addition, problems with a lack of parking facilities affect residents just the same.

Plate 7.2 Malta: St. Julian's Bay: problems of dilapidation in urban areas spill over to the near shore waters with sewage and liquid overflows in bathing zones. Source: The Times 14th August 2001

7.6 Segment V

7.6.1 Physical attributes

The Segment includes the two main Harbours in Malta and the combined length of 25.6 km is the longest for all segments. The segment commences at Dragut Point and ends at Ricasoli Point. The two harbours have been included together due to the generally similar physical features they possess and their difference of physical properties from the adjacent segments.

The area is highly embayed and characterized by a series of peninsulas and creeks. These inlets have developed as a result of faulting and the erosional quality of the Globigerina Limestone formation that has developed into a ria system of ridges and valleys in a previously pluvial environment. The tilting of the Islands to the East caused marine invasion into the valleys and formed the Harbours and a series of creeks.

The general orientation of the Harbours is to the north east. The all-weather nature of the creeks at Grand Harbour can be gauged from the general pattern of the main orientation, with each creek having a general NW-NNW trend, whilst the Harbour itself faces NE, a 75-90 degree change in direction. The situation at Marsamxett Harbour is fairly similar, with an orientation for the creeks ranging from SE to NW with the Harbour opening also to the NE. It is this degree of shelter from the prevailing NE winds that has given the local Harbours their high economic status. In fact for Grand Harbour, out of a total coastal length of 15.6 km, 64.0 per cent is occupied by wharves and promenades, whilst for Marsamxett Harbour, with a total length of 10.5 km, 54.8 per cent of the littoral is paved and occupied by promenades.

7.6.2 Land Uses

The lack of land use variability in the Harbours is gauged from the section on segment V in Appendix 1, with most of Marsamxett Harbour's coastal units exhibiting a greater variability than those around Grand Harbour. In fact the farther out towards the mouth of the Harbour that a coastal unit is located, the greater is its land use variability. This is seen in coastal units 37 to 43 for Marsamxett Harbour (Table 7.7) and coastal units 55 and 56 for the Grand Harbour (Table 7.8). Coastal industrial land uses (g) are extremely site selective and occupy an area of around 90 per cent or over for the particular coastal unit which they form (eg. Coastal units 46, 49, 50 and 51) the Power Station at Marsa is included with this category (Plate 7.3). The recreational and residential land use categories are also manifested more in the coastal units pertaining to Marsamxett Harbour and to Grand Harbour. The dilapidated areas (p) which normally accompany the urban residential areas and recreational zones, at least as far this research is concerned, are also present in the form of metal scrap-yards.

The main distinguishing feature between the two Harbours, which is reflected in section 6.8, is that Grand Harbour caters for both industrial development (Malta Dry-docks) and recreational facilities (boating, Cruise Liner Terminal), whilst Marsamxett Harbour has developed exclusively around recreational activities especially tourist accommodation and yacht marina development. For Grand Harbour these two main economic activities are located adjacent to one another, with the areas nearer to the Harbour mouth catering mainly for recreational activities. The activities at the far end of the harbour are more concerned with industrial activities.

The lack of land use variability in the Harbours is gauged from the section on segment V in Appendix 1, with most of Marsamxett Harbour's coastal zone exhibiting a greater variability than those around Grand Harbour. Coastal industrial land uses (g) are extremely site selective with the Power Station at Marsa bracketed with this category (Plate 7.3). The recreational and residential land use categories are evident along the coast of Marsamxett Harbour than that of Grand Harbour. The dilapidated areas (p) which normally accompany the urban residential areas and recreational zones, at least as far this research is concerned, are also present in the form of metal scrap-yards.

This segment exhibits properties that are typical of coastal industrial areas and the site-selective land uses are the result of a long historical legacy attached to Grand Harbour by way of maritime services and to Marsamxett Harbour by way of the touristic and yacht marina services that have developed in the last thirty years. The new developments of Manoel Island and Tigne Point in Marsamxett Harbour and the

Table 7.7: Selected synoptic data for coastal units in Segment V (Marsamxett Harbour)

Coastal Unit	Number of land uses	Per cent: land uses out of max. 16	Per cent: area of part segment*
37	6	37.5	1.6
38	6	37.5	2.9
39	6	37.5	3.9
40	8	50.0	9.0
41	7	43.7	7.4
42	6	37.5	4.6
43	7	43.7	4.8
44	4	25.0	1.1
45	6	37.5	2.6
46	5	31.2	19.9

Source: Estimated by author from land use data
* total for this column is 57.8 per cent the remainder is found in Table 7.8

Table 7.8: Selected synoptic data for coastal units in Segment V (Grand Harbour)

Coastal Unit	Number of land uses	Per cent: land uses out of max. 16	Per cent: area of part of segment*
47	1	6.3	0.6
48	1	6.3	0.5
49	5	31.2	12.8
50	2	12.5	4.7
51	3	18.8	5.2
52	5	31.2	0.8
53	4	25.0	4.1
54	4	25.0	2.4
55	5	31.2	1.3
56	6	37.5	9.8

Source: Estimated by author from land use data
* total for this column is 42.2 per cent the remainder is found in table 7.7

changes to the Cottonera littoral in Grand Harbour with the rehabilitation of parts of the waterfront which are in progress (Plate 7.4) constitute other focal points in the development of the whole local littoral.

The Grand Harbour Local Plan (Planning Authority, 1997a) considers that the centuries-old industrial and urban developments in this area, together with the consequent high population density, are the main reasons for the land-use problems. In fact, the deterioration of the urban fabric, the inefficient use of space for commercial and industrial activities, the poor maintenance of the historic buildings together with the increasing pollution of the area are the greatest problems. In general, the Plan envisages a number of policies that affect the coastal zone area. Among these are the following: good accessibility to the waterfront along most of the non-industrial perimeter; restoration and care of the bastions, fortifications and historical artifacts; an efficient land use system for the Drydocks and the camouflage from land of the large industrial workshops either by covering them with a large "Nissan hut" type of shelter, but this would not be compatible with the overall aesthetic environment of the fortifications, or provide a trellis with creepers along the road hiding the workshops from view and at the same time landscaping the street. In fact proposals for the latter have been put forward through the local council (pers. comm. MEPA official). Other suggestions include the establishment of regular ferry links to other parts of the Harbour and the efficient connections to the hinterland; addition to the existing afforestation projects; upgrading of the Cottonera and Marsamxett waterfronts by enhancing a multiplicity of uses such as recreational and commercial establishments; the strategic siting of small enterprise workshops; and, the overall enhancement of the touristic potential of the area with the development of the Cruise Liner Terminal and the Cottonera Waterfront Project as the flagships of the Harbour.

The main problems associated with the physical and human fabric of the localities surrounding the Grand Harbour have been identified as follows:

- Decline and ageing of the local population coupled to a substantial number of abandoned houses;

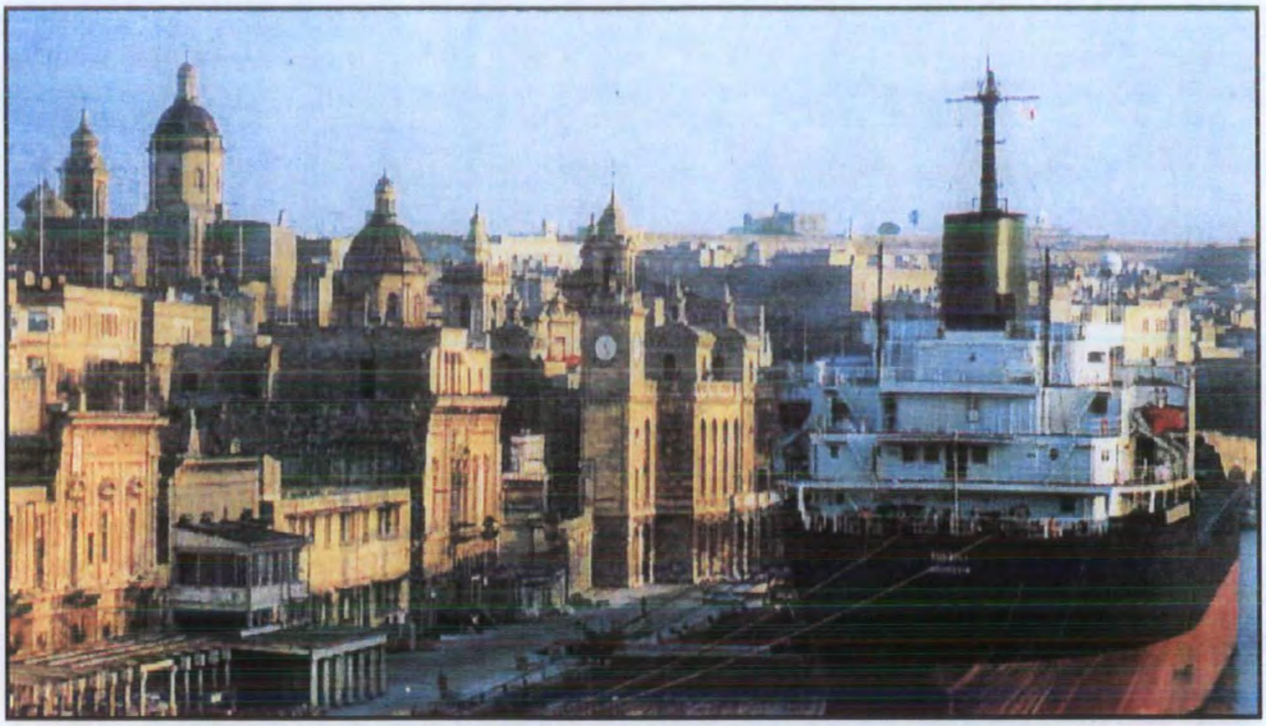
- deterioration of the architectural fabric including historical sites and residential zones with pockets of poor quality housing reminiscent of slum areas;
- Lack of adequate community facilities and open spaces;
- Inefficient use of industrial land;
- The land use conflicts generated with industrialization, port activity, residential zones and touristic development.

The Plan envisages the following main proposals to address these problems:

- Reversing population decline and regeneration of urban areas and rehabilitation of historic zones;
- Reducing the impact of industry on residential areas and historic zones;
- Encouraging tourism especially in the Three Cities;
- Streamlining port function; and
- Assisting non-coastal dependent industry through the supply of sites away from the littoral;

Effectively the changes to the littoral land uses were substantial in order to accommodate the above proposals. The Cottonera Waterfront Project has transformed the coast of the southern part of the Grand Harbour with the upgrading of the coastal areas; tourism to the Three Cities has generated an increase in economic activity; and the upgrading of the Cruise Liner Terminal at Valletta promises to enhance the liners' Malta stopover in the central Mediterranean (Planning Authority, 1997). Proposals to develop Sliema Creek and Pieta Creek for yachting by increasing the number of berths in Marsamxett Harbour must be considered in the light of existing facilities, and the increasing demand for these facilities (Planning Authority, 2000b).

Plate 7.3 Malta, Marsa Power Station within the dense urban environment
Source: Pers. Comm. Department of Information.



Source: Undated promotional material, Malta Tourism Authority.

Source: The Author

Plates 7.4 a and b Malta, Cottonera, Birgu (Vittoriosa): The ship repairing facilities are being replaced with a yacht marina, a casino, a hotel and the upgrading of the waterfront.

7.7 Segment VI

7.7.1 Physical attributes

The limits of Segment VI start at Ricasoli Point and end at Zonqor Point just before Marsascala Bay. The small coastal locality of Xghajra is included in this segment. The coastal length of this segment is 6.3 km. With a coastal zone area of 38.1 ha it gives an average coastal zone width of 60.5 metres. From Table 7.1 it can be seen that this segment is the smallest in all the dimensions presented in the table. The overall orientation of the segment is to the NE and, with a rectilinear coastline throughout, there are no substantial changes of aspect through most of the littoral area. The main physical features of the area are the two main geological formations, of Lower Coralline Limestone and Globigerina Limestone that outcrop at the coastal margin, and the rectilinear nature of the shoreline. The lack of any embayment features has probably increased the isolation of this segment and accounts for the limited land use variability of this segment.

7.7.2 Land uses

The distribution of land uses in this segment is one that respects the coastal rural environment. However, the dilapidated areas (p) are prominent, due to dumping of domestic refuse and building of a road along the littoral. Land use for extractive industries is mainly comprised of salt panning on the Globigerina Limestone foreshore. Rinella Movie Park and the coastal locality of Xghajra constitute the recreational land uses (a) in this segment.

Table 7.9: Selected synoptic data for coastal units in Segment VI

Coastal Unit	Number of land uses	Per cent: land uses out of max. 16	Per cent: area of segment
57	2	12.5	8.9
58	5	31.3	23.6
59	8	50.0	28.9
60	4	25.0	3.9
61	3	18.8	25.8
62	4	25.0	8.9

Source: Estimated by author from land use data

The lack of development in this segment is mainly due to the sewage outfall at the Wied Ghammieq near Xghajra. In addition, the lack of embayment features, and in general the high amount of dilapidated areas, have militated against further use of this stretch of coast. The exposed nature of the coast, coupled to the proximity of Grand Harbour, has necessitated the building of defensive structures. The presence of a series of coastal towers built by the Knights, and a line of pill boxes in the defence of the Second World War against the Italians and Germans, have given a distinctive character to the area. These fortifications could be enhanced and included within a coastal heritage trail including the San Leonardo Fort. This proposal can be implemented with the collaboration of two heritage associations, *Din l-Art Helwa* and *Fondazzjoni Wirt Artna*. An additional walk around the Rinella Movie Park would be an interesting addition. The recent emphasis of investment in the film-making industry includes the possible extension of the facilities to include more parts of the foreshore. However the random dumping of refuse along most of this littoral places it high on the list of dilapidated areas and strong enforcement procedures must be put into place before any Heritage trail proposals are implemented.

7.8 Segment VII

7.8.1 Physical attributes

Marsascala Bay and the littoral up to the Delimara Point make up this Segment. The main dimensions pertaining to this segment are given in Table 7.1. Within the list of segments presented this zone is the third smallest of the littoral, having an area of 69.1 ha and a coastal length of 13.3 km. This segment has the narrowest coastal zone width for the whole of the Maltese Islands. Although this segment can be considered to form part of the east Malta coast, a minor difference to the preceding segments II to V in the general orientation is evident, as it tends towards the SE at Delimara. However, the orientation of the sides of Marsascala Bay are to the NE and S respectively.

Two main geological formations characterize this segment: Lower Coralline Limestone is the main outcrop at Marsascala Bay, with the Globigerina Limestone formation prevailing for the remaining part. The three strata that make up the Globigerina Limestone formations play an important part in both the geo-morphological set up of the Segment and the associated land uses. The coastal configuration of the Segment from St.Thomas's Bay to Delimara Point is mainly due to the high degree of erosion of the upper and middle strata of Globigerina Limestone with a series of small inlets separated by prominent but short peninsulas. The presence of salt panning activity as an extractive industry is mainly due to the presence of the third rock layer as seen from the surface, namely the Lower Globigerina limestone formation on most of the peninsulas. In fact, the main reason for the presence of the promontories is that the Lower Globigerina Limestone has a lower rate of erosion than the other two strata.

7.8.2 Land Uses

The distribution of the land use types along this segment reflects the degree of recreational development along this area of the coast, with coastal units 63, 64 and 65 and 66 having urban oriented land uses, whilst units 67 and 68 have rural oriented land uses. The general issue that comes out of the coastal land uses of this segment is that it is typical of the coastal development in Malta, as seen in the past centuries. Coastal fortifications along the littoral reflect the military defensive needs of the last four centuries up to 1945; salt panning sites show the need for small scale economic enterprises are still needed; boat houses and small one storey houses provide for the summer recreation needs of low-wage earners and some are still a remnant of the coastal residences of the past century; recreational and residential development at Marsascala show modern tourist needs.

Table 7.10: Selected synoptic data for coastal units in Segment VII

Coastal unit	Number of land uses	Per cent: land uses out of max.16	Per cent: area of segment
63	12	75.0	20.5
64	11	68.8	10.3
65	7	43.8	19.5
66	8	50.0	15.1
67	7	43.8	16.1
68	5	31.3	18.5

Source: Estimated by author from land use data

The distribution of the land use types along this segment reflects the degree of recreational development along this area of the coast, with the coast along Marsascala having urban oriented land uses and the remainder have rural oriented land uses. The general issue that comes out of the coastal land uses of this segment is that it is typical of the coastal development in Malta. Coastal fortifications along the littoral reflect the military defensive needs of the last four centuries up to 1945; salt panning sites show the need for small scale economic enterprises; boat houses and small one storey houses provide for the summer recreation needs of low-wage earners, and some of these are still a remnant of the coastal residences of the past century; however the recreational and residential development at Marsascala show the modern tourist and recreational needs.

This segment is the typical situation of the recreational development of the rural area of the coastal zone. The proximity to the main urban centre of Malta and the high degree of accessibility of the shoreline both from land and the sea have turned attention to Marsascala Bay. However, the intense urbanization of segment IV is still not evident at Marsascala even though it is a rapidly expanding locality.

7.9 Segment VIII

7.9.1 Physical attributes

The area of Marsaxlokk Bay constitutes this segment. Oriented to the south east, it has a coastal length of 10.8 km and a coastal zone area of 96.9 ha, giving an average coastal zone width of 89.7m. The Bay consists of a number of inlets, with Pretty Bay and St. George's Bay separated by the St. Lucian Peninsula from Marsaxlokk village Bay. The orientation to the south east, coupled to the wide mouth of the Bay, have conditioned the construction of a number of jetties and breakwaters with the purpose of turning the Bay as much as possible into an all-weather area. As the south east winds blow an average of 15 per cent of the days with storms during the winter, the recreational and later economic necessities were facilitated by the civil engineering works. The geological formation predominant in the area is Globigerina Limestone. This was partly responsible for the formation of the indented coastline, which, together with erosion by flowing water from terrestrial origins and the subsidence of the land, brought about a marine transgression forming the present coastal configuration.

7.9.4 Land uses

The coastal land use variability of the Bay is evident from the Table 7.11, where the extreme ends of the Bay in units 69 and 77 show only 3 land uses each. Land use variability increases in the other segments that represent the inner parts of the Bay. The higher variability for unit 75 is due to the presence of industrial areas at St. George's Bay with associated problems of oil seepage (Plate 7.5) and physical encroachment on archaeological remains (Plate 7.6).

Table 7.11: Selected synoptic data for coastal units in Segment VIII

Coastal Unit	Number of land uses	Per cent: land uses out of max.16	Per cent: area of segment
69	3	18.8	6.5
70	6	37.5	4.7
71	5	31.3	2.7
72	9	56.3	12.5
73	9	56.3	7.5
74	9	56.3	7.9
75	11	68.8	13.7
76	10	62.5	18.1
77	3	18.8	26.3

Source: Estimated by author from land use data

The land uses present along the littoral demonstrate that the Bay has both urban and rural land uses. A case in point is Delimara Peninsula which has only three main types of land uses associated with the natural environment, and another is Benghisa Peninsula with three types associated with industrial zones. The other units are typical of the coastal urban environment with residential, recreational and historical land uses. The end result is mainly due to the large expanse of the Bay being the broadest in Malta and the development of the littoral for industrial purposes throughout this century. Thus the rural element evident in some units is in fact a result of a lack of attention for this area in past centuries and the limited degree of accessibility for parts of the littoral. However, the removal of the Fuel Installation Depots from St. George's Bay within the next decade should pave the way for an opportunity to upgrade the area for an aesthetically-pleasant residential development.

Plate 7.5 Malta, Birzebbugia, St. George's Bay: Managing hazards in coastal urban environments: warning signals prohibiting bathing due to oil seepage from Installation Depot. Note the Container Terminal in the background and the typical seafront upgrading by local council in foreground with paved promenade and street lighting, waist-high railings to counter hazard of two metre drop to shore platform. Steps provide access to foreshore.

Source: The Author

Plate 7.6 Birzebbuga, St. George's Bay: Road development and Local Council's upgrading of the promenade are seen threatening with physical encroachment on archaeological heritage of Bronze age silos on shore platform. Source: The Author

The publication of the Marsaxlokk Bay Local Plan includes a number of recommendations that assist in developing a rational land use policy for the coast, the urban fabric, the rural hinterland, and to minimize the conflicts that the industrial potential of the area presents. These include:

(a) Relocation of the March 31st Fuel Installation Depot and the Liquefied Gas Installation to a site in the Freeport area. These measures would provide space for the extension of urban development as the presence of the Depots within the urban zones is creating a series of environmental problems.

(b) Designation of Urban Conservation Areas, Opportunity Areas and Design Priority Areas are aimed at improving the quality of the urban fabric. These are applicable mostly to the seafront and incorporate restrictions to the building heights along the coast, recommendations regarding the architectural style of house facades especially the newer developments where blocks of flats replace old houses and designs of shop and commercial premises and restaurant fronts have to satisfy specific aesthetic criteria.

(c) Waterfront improvement is to be attended to by embellishing the coast road through the improvement of the existing road surface, the construction of a wide promenade with accompanying street furniture such as benches, lampposts, and waist-high railings all along the seafront.

(d) The overall 'greening' of the coastal environment. Afforestation programmes aim to cover whole areas with trees and shrubs as in the case of the north-facing area of Delimara Peninsula and around St Lucian Tower. Tree planting programmes, designated to enhance the littoral length of the Bay, normally involve the planting of trees in single files on the pavement or promenade skirting the coast.

(e) Attention to the historical and archaeological heritage is to be attended through a number of measures. Development of a heritage footpath linking points of tourist attraction to a number of pre-historic and military fortification sites such as towers, redoubts, and defensive walls. Attention towards the upkeep of all the military fortifications to be encouraged. Already a number of sites are used for commercial purposes, these include Fort St. Lucian and Pinto Battery however others are in a poor state of repair and urgent action is called for.

(f) Improvements to the existing road network have also been proposed. As a central policy measure these include the already established roads leading to the Power

Station site and the Freeport Terminal to decrease heavy traffic from the urban core areas and the coast.

(g) Attention to the 'soft' parts of the coast such as beaches has also been undertaken with the embellishment of the Pretty Bay beach that turned a large area of sand into a multi-recreational zone with a children's playground, a small football/basketball pitch and the addition of street furniture. The local councils have stepped up their efforts to upgrade the area by widening the promenade, embellishing the pedestrian walkways, increasing the street furniture and improving the facilities for the mooring and servicing of boats. The replenishment of the small beach in 1989, improvement to the existing parking facilities and the increase in the recreational facilities on the beach are intended to enhance and promote the general appearance of the area.

The land uses present along the littoral demonstrate that the Bay has areas that are found in either end of the coastal land use spectrum used for this study, i.e. urban on one hand and rural on the other. A case in point is Delimara Peninsula which has only 3 main types of land uses associated with the natural environment, and another is Benghisa Peninsula with 3 types associated with industrial zones. The other units are typical of the coastal urban environment. The end result is mainly due to the large expanse of the Bay, the widest and broadest, and the development of the littoral for industrial purposes throughout this century. Thus the rural element evident in some units is in fact a result of a lack of attention for this area in past centuries and the limited degree of accessibility for parts of the littoral. However, the removal of the Fuel Installation Depots from St. George's Bay within the next decade should pave the way for an opportunity to upgrade the area for an aesthetically-pleasant residential development.

7.10 Segment IX

7.10.1 Physical features

The coastal area of this segment is 101.5 ha and stretches from Benghisa Point to Il-Kullana. The average width of the coastal zone here is 58.7 metres. The general orientation of the coast is towards the South but ranges from the South East at Benghisa to the South West at il-Kullana, an approximate change of 45°. Steep slopes and cliffs cover most of the coastal margin with a number of inlets linked to faulting. Wied ix-Xaqqa and Wied Iz-Zurrieq are narrow faulted features in the cliff face. A series of caves mark the cliff / water interface: with Blue Grotto, Il-Hnejja, Ghar ix-Xaghra, Ghar Lapsi and Ghar it-Torkija being the most prominent, and Ghar Hasan at about 50m above sea level. Promotories are also evident. The main geological formation is Lower Coralline Limestone with Globigerina Limestone stretching at either end of the segment. A downthrown formation of Upper Coralline Limestone from Ras il-Hamrija to Ix-Xoqqa is evident

7.10.2 Land use

The lack of variability in the land use distribution in this segment is evident from Table 7.11 where only one coastal unit is represented by half of the land uses used in this survey. Wied iz-Zurrieq is located in this unit. Out of a total of 160 coastal cells, only 43 are represented (26.9 percent).

The rural character of the segment is evident from the lack of land uses associated with recreation. These are concentrated at Wied iz-Zurrieq and Ghar Lapsi. However, the land uses associated with the extractive industries (f) are represented for coastal units 78 and 80, these being two quarries that have broken through the cliff-line. Coastal unit 86 (cell 86f) has a 4.6 ha area occupied by a Reverse Osmosis plant. With regards to the "rural" land uses (j to o), these are well-represented, with (6 X 10) 21 out of 60 cells in Coastal units 78, 86 and 87 having less than one-half of their coastal land use in land uses other than steep slopes and cliffs. The 6.3 ha of land mapped on sheet 4864 was steep slopes and cliffs, the only coastal cell to have only one land use in all of the coastal survey. Arable land takes up a quarter of all the land use for the segment, with the highest concentration in Coastal units 86 and 87 the equivalent of with 86.8 per cent for the whole segment.

Table 7.12: Selected synoptic data for coastal units in Segment IX

Coastal unit	Number of land uses	Percent: land uses out of max. 16	Per cent: area of segment
78	5	31.3	14.3
79	3	18.8	1.0
80	5	31.3	5.0
81	3	18.8	4.5
82	2	12.5	0.4
83	8	18.8	20.3
84	1	6.3	6.2
85	6	37.5	8.9
86	7	43.8	23.4
87	3	18.8	15.8

Source: Estimated by author from land use data

The rural character of the segment is evident from the lack of land uses associated with recreation. These are concentrated along the small coastal hamlets of Wied iz-Zurrieq and Ghar Lapsi. However, the land uses associated with the extractive industries (f) are represented by two quarries that have broken through the cliff-line and a 4.6 ha area occupied by a Reverse Osmosis plant. The "rural" land uses (j to o), are well-represented with arable land, steep slopes and cliffs.

This segment marks a sharp break in the coastal land use sequence observed so far. Its proximity to the preceding segment of Marsaxlokk Bay is not reflected in a similarity of land use. The hinterland that does not fall within the coastal zone identified for this thesis is developing into an industrial base, with a large number of factories. The flat nature of the platform here facilitated the building of an airfield and Nissan huts, part of the military bulwark in the defence of Malta and the central Mediterranean in World War II. There is an abrupt change in the topography from low sloping shoreline of Segment VIII to one with cliffs and steep slopes for this segment. There is also a change in the general geomorphological nature of the coast, with a rectilinear shoreline as opposed to the embayed coast of Marsaxlokk Bay. However, the land uses seen towards the end of this segment are similar to those found in Segment X that follows.

7.11 Segment X

7.11.1 Physical attributes

Stretching from Il-Kullana to Ras Ir-Raheb for a length of 12.5km, the area mapped is approximately 258.0 ha, representing an average coastal width of 206 m. This considerable width is mainly due to the break of slope being located at the farthest inland distance of any Segment, as the indicator for the landward limit, the halophytic plant *Inula crithmoides*, grows on the edge of the cliff scarp that backs the scree. The area of coastal zone for this segment represents 73 per cent for that for the whole of Gozo. The orientation of this segment is from the SW at Il-Kullana to W in Wied Ras ir-Raheb, a 45° change in orientation.

The Maghlaq Fault affecting the western part of Malta was responsible for the uplifting of the Island, and gave the topographic scale to this segment. In addition, the terraced slopes are the result of the capping of Upper Coralline Limestone slumping over the unstable wet Blue Clay beneath, giving boulder scree slopes. These main features are found within the coastal zone of this segment: a cliff with a sheer drop into the ocean or skirted by a narrow shore platform; a scree slope area with agriculture as the main economic activity; and, thirdly, an Upper Coralline Limestone cliff between the slope and the fourth feature, a plateau. The limit of the *Inula chrithmoides* at a few metres beyond the cliff line marks the extent of the coastal zone.

7.11.2 Land uses

Land use distribution in this segment is completely dominated by "rural" categories. For all units except for units 95 and 99, land uses are clustered between i and o. This situation is reflected in the data given in Table 7.13, where the highest value is only a maximum of six land uses out of 16 represented in the coastal units 89 and 95. In addition, nine different land uses are apparent in the whole segment.

Five land uses are represented throughout the segment. These are afforested areas (i), arable land (j and k), cliffs and steep slopes (m), and scree slopes (o). A low rocky shoreline (m) is only apparent in three instances, in units 88, 89, 98 and 99.

Table 7.13: Selected synoptic data for coastal units in Segment X

Coastal units	Number of land uses	Per cent: land uses out of max.16	Per cent: area of segment
88	6	37.5	5.9
89	6	37.5	14.7
90	4	25.0	1.6
91	3	18.8	0.2
92	4	25.0	15.3
93	5	31.3	5.0
94	2	12.5	4.7
95	6	37.5	13.8
96	4	25.0	13.9
97	5	31.3	10.0
98	4	25.0	6.1
99	5	31.3	8.8

Source: Estimated by author from land use data

The uniformity in the land use pattern throughout the whole profile of this segment is due to two factors: geological and geomorphological properties that have given scope to terraced cliff-side agriculture; and the lack of human accessibility which has helped to retain the rural features of the area. This segment has pleasant aesthetic environmental qualities. In the North West Local Plan (Planning Authority, 2001) it is proposed to maintain the aesthetic quality of the segment by ensuring that at least footpath communication to the beaches is properly maintained by removing any structures that impede access at Ghajn Tuffieha, and Anchor Bay. The situation at Gnejna Bay and Ramla Bay is somewhat different in that vehicular access and parking facilities are to be improved together with the embellishment of the roads that lead form the nearest villages to the bays. This involves an afforestation and tree planting programme.

7.12 Segment XI

7.12.1 Physical attributes

This is the last stretch of coast to be reviewed for Malta. The segment stretches from Ras ir-Raheb to Cirkewwa Point and has a coastal length of 21.6 km, with an area of 194.8 km^2. The average width of the segment is 90.2 metres, which is very near to the mean width for the Malta Segments at 96.9metres. This high percentage shows that a lack of land use variability is evident. The general orientation of the segment is to the northwest. However, there is a marked change in orientation along the littoral from Ras ir-Raheb, which is oriented to the west, to Cirkewwa Point which is oriented to the north. As the segment is mainly made up of an indented coastline, the bays present different and varying degrees of orientation. Table 7.14 shows these.

Table 7.14: Main compass orientation of the bays in Segment XI

Bay	Orientation
Fomm ir-Rih Bay	N to SW
Gnejna Bay	N to SW
Ghajn Tuffieha	N to W
Golden Bay	W to SW
Anchor Bay	N to S
Paradise Bay	N to S

Source: Compiled by author from 1:25,000 scale map of the Maltese Islands

The general physical features of the area are composed of cliffs and scree slopes, with the bays made up of sandy beaches. The Faults normal to the coast have encouraged features common to the Horst and Graben landscape, with the bays featuring as the submerged parts of these formations. Practically all of the different types of geological features of the Islands are found along this segment, with the capping Upper Coralline Limestone formation presenting spectacular landscape scenery of scree slopes over the Blue Clay formation. The basal formation is normally Globigerina Limestone but some areas with Lower Coralline Limestone are also present. The general lack of development in this segment is mainly due to the inaccessible terrain that this landscape presents. In addition, the dense faulting prevalent makes the area prone to landslides, especially after intense precipitation.

7.12.2 Land uses

Twelve coastal units are identified with this segment. The land uses identified along this segment are essentially related to the rural fabric, with a prevalence of scree slope areas and cliffs. The urban-related land uses are all clustered with the land uses associated with the recreational activities and clearly represented in four of the coastal units. These are occupied with hotels and boathouses.

Table 7.15: Selected synoptic data for coastal units in Segment XI

Coastal unit	Number of land uses	Per cent: land uses out of max. 16	Per cent: area of segment
100	4	25.0	1.1
101	7	43.7	11.1
102	9	56.3	17.8
103	10	62.5	11.6
104	9	56.3	6.8
105	5	31.1	10.1
106	5	31.1	9.0
107	9	56.3	4.9
108	7	43.7	4.5
109	3	18.7	0.2
110	4	25.0	3.1
111	6	37.5	14.6
112	8	50.0	5.2

Source: Estimated by author from land use data

The main determining factors for the development of the land uses in this segment are, first, the relative isolation of the segment from the main Maltese urban network; second the lack of accessibility from the sea to the land; and third the fact that there is an absence of a coastal road that runs parallel to the shoreline. As a consequence, the linear type of development is lacking, leaving a healthy aesthetic natural environment with development concentrated in selected pockets. The land use pattern of this segment is rather similar to the one found on Gozo.

An interesting factor is that the North West Local Plan covers substantial areas of coastal segments I, II, X and XI. As a result the segments have a number of common attributes, the notable factors being the overall rural character of the environment with coastal agriculture, sandy beaches, cliffs and scree slopes and therefore land use problems are evident throughout.

The MEPA identified a number of key factors that are the main pillars of its strategy for these areas especially as a number of sandy beaches notably at Ghajn Tuffieha, Gnejna and Golden Sands are considered as fragile environments. The main policy is to protect the natural environment of the area by the conservation of coastal habitats, rehabilitation of public access and enhancing the landscape value by implementing a

Management Plan of the under the auspices of the GAIA Foundation for Ghajn Tuffieha. This is in line with the scheduling of areas with landscape value for the benefit of users and also to protect sensitive zones from human influences and to safeguard the physical environment. In fact vehicular access is controlled and allocated only to parking areas above the bays, restoration of historical buildings, and the protection of agricultural land. Beaches are to be afforded special attention in that the number of kiosks on the sand is to be controlled and no sand can be moved away. However the aesthetic quality of the area attracts new developments and permission has been granted for a new hotel to replace an older one built in the 1970s. The developers claim that the project will be compatible with the environment and the plans include the embellishment of the area and are the result of the excellent cooperation between the developers and MEPA (The Times [of Malta] 3 April 2003, 4). The owners of the hotel already operate another four hotels and tourist complexes in Malta.

7.13 Segment XII

7.13.1 Physical attributes

This segment deals with Comino. As with the other segments, the demarcation of the coastal zone of this island followed the criteria established in Chapter 1. As there are few indentations along the coast of Comino, the coastal zone boundary is largely a line running parallel to the coast that gives a coastal zone area of 42.5 ha and a coastal length of 8.1 km. This data produces a coastal zone width of about 52.5 metres, making it the second smallest coastal zone width for the Maltese Islands.

As the whole island has been included in one coastal unit, all of the compass directions are present along the Comino coast, however the two main bays that are an important feature in the development of tourism on the island, and which basically provide the only built-up area in the coastal zone of this segment, face to the north. Probably the main contributory factor in this regard is that Comino provides a degree of shelter for the coastal zone of the north of Malta.

The main characteristic of the physical features of Comino is its uniformity in the geology with a predominance of the Upper Coralline Limestone formation together with associated landforms. The latter provide a scenic value to the coastal zone, with caves, stacks and rock windows on the western side of the island. Probably the main contributory factor in this regard is that Comino provides a degree of shelter for the coastal zone of the north of Malta.

7.13.2 Land uses

The land uses that feature in this segment have already been discussed elsewhere in Chapter 1 in the context of a comparison between the islands that make up the archipelago. They are also presented in the appendix as a separate group of data. However, comparing them to the other segments, the similarity with the land uses extant in Segments IX and XIII is evident with regards to the area of the coastal zone that is undeveloped and the similarity to the situation in segment X, with a limited amount of land devoted to recreational development. The main difference, however, with the other segments emerges in the amount of land identified as arable. The lack of natural water resources along the coast and the lack of a permanent population and the rugged terrain are not conducive to the development of agriculture.

The physical isolation of Comino, the limited accessibility from the sea through most of its shoreline, and the absence of a sizeable population, place the island in a disadvantaged position with respect to the other two islands. However the aesthetic qualities of the island together with the cluster of rocks to the south west of the island provide a marketable value in excess of its size especially in tourism development such as ecotourism.

The Local Plan for Comino (Malta Environment and Planning Authority, 2002b) proposes a number of measures whose aim is to safeguard its landscape value and protect the natural habitats and protect it from urban related development. Among these are the following:

- Designating it as a Nature reserve;
- Its formal scheduling as an Area of Ecological Importance and as a Site of Scientific importance;

- The entire island together with its associated minor islets shall be afforded the same level of protection as scheduled property;
- Confirm its status as a Rural Conservation Area; and
- Development initiatives are to be limited solely to those aspects where infrastructural needs for communication between Malta and Gozo are necessary.

Meanwhile the MEPA has set up a Steering Committee for Comino (The Sunday Times [of Malta] 21 July 2002) to oversee environmental management concerns on Comino. The committee is to formulate and implement a management plan aimed to identify ecological, archaeological and recreational assets in order to strike a balance between land and sea use (The Times [of Malta] 13 November 2002). Positive elements regarding the safeguard of the aesthetic qualities of the island stem from the fact that MEPA have removed an illegal concrete structure at Kemmunett, one of the islets off Comino (The Times [of Malta] 13 November 2002. pp30-31). This was apparently built by a prominent Maltese company that organizes round island cruises to assist the lighting of its passengers on the islet.

7.14 Gozo

7.14.1 Introduction

The Segments that follow appertain to Gozo. MEPA recognized that Gozo is 'significantly different from Malta especially in housing, tourism, industry, transport (including double insularity problems), tourism and recreation' (MEPA, 2002 b, 2).
Development guidelines for Gozo follow an overall strategy whereby caution has to be exercised due to the limited land available, and the unique cultural and natural characteristics of the island that make it a desirable place 'to visit and inhabit' (MEPA, 2002 b, 2). In addition, development projects need to be compatible with planning policy, the surrounding environment and nearby activities, be efficient on land use, and create wealth and employment opportunities.

7.14.2 Segment XIII

7.14.3 Physical attributes

The general orientation of this segment, stretching from San Dimitri Point to Xweini Bay, is almost uniform to the north. The rectilinear nature of the coast, having an average width of 82.2 m and an area of 45.2 ha, presents few changes in the overall compass direction. However the bay at Xwieni has sides facing east and west respectively. The geology of the coastline is made up of a Lower Corolline Limestone that presents as a steep rock face and cliff for most of the littoral, up to Reqqa Point. The remaining part of the coastline is made up of low-sloping Globigerina Limestone where salt pans have been dug into the rock surface.

7.14.4 Land uses

The land uses are clustered around the "rural" categories and the physical uniformity of the Segment can be deduced from the presence of land uses (l), the shore platforms, and n (steep rock and cliffs), throughout the zone for this segment. The land uses associated with human modification of the natural environment are also uniform throughout the 5.5km length of the segment with arable land, most of which is abandoned, being prominent, and dilapidated areas associated with an illegal refuse tip that is developing underneath the cliffside and over the shore platform.

Table 7.16: Selected synoptic data for coastal units in Segment XIII

Coastal unit	Number of land uses	Per cent: land uses out of max. 16	Per cent: area of segment
114	3	18.8	9.7
115	6	37.6	33.0
116	6	37.6	57.3

Source: Estimated by author from land use data

This segment bears the marks of an area that is rural in character. The location at the northernmost tip of Gozo is one factor. However the presence of extensive amounts of accumulated rubbish, a land use that is largely associated with urban areas in this thesis, shows the need for an organized coastal zone management strategy.

7.15 Segment XIV

7.15.1 Physical attributes

Extending from Reqqa Point to Qala Point, this segment is long, because of the need to group together all of the main bays located on the north of Gozo and second, because of the notable change in orientation that marks out different segments in the thesis comes only after an appreciable length of coast. With a coastal length of 13.1 km making it the second longest segment for Gozo and an area of 114.9 ha producing an average width of 87.7 m. The orientation of the coastal zone of this segment changes direction from north to east, with further changes noted at the main bays to the north coastline. Reqqa Bay and sides oriented to the south east and north west, Marsalforn Bay and ir-Ramla to the NNW and NNE.

The physical features found on this segment of coast are varied and can in fact be placed into two sections. In Section one from Reqqa Point to Dahlet Qorrot, the geology is dominated by clay scree slopes, having five bays Xweini Bay, Il-Qbajjar, Ir-Ramla, Marsalforn Bay and San Blas Bay as marked indentations along the coast. The second part has a shore platform of Middle Globigerina limestone that skirts most of the shoreline and is associated with rectilinear properties of the coast, largely consisting of lower Coralline Limestone with a low sloping rock profile.

7.15.2 Land uses

Six coastal units are identified in Table 7.17, giving a breakdown of the number of land uses for each unit and the percentage area of each unit. Although, in general, the greater the area of coastal units, the more varied is the land use spectrum that a unit possesses, this does not apply to this segment, as coastal unit 117 is the third largest in area in land use variability as it possesses the largest number of land uses in the segment - 12. The coastal unit that includes Marsalforn Bay with its tourist and residential development, accounts for the high variability in this coastal unit. The area of Dahlet Qorrot and coastal quarry in unit 122 provides the variation in the land uses for this unit when compared to units 118 to 121.

Table 7.17: Selected synoptic data for coastal units in Segment XIV

Coastal unit	Number of land uses	Per cent: land uses out of max. 16	Per cent: area of segment
117	12	75.0	18.1
118	7	43.8	25.9
119	3	18.8	11.5
120	4	25.0	30.5
121	1	6.3	0.1
122	8	50.0	13.9

Source: Estimated by author from land use data

The differences in the land use concentration along this segment are particularly evident in the coastal units that have a degree of protection by the building of jetties and breakwaters and the attraction of recreational activities. Especially in Marsalforn Bay with its tourist and residential development. In addition, the area at Dahlet Qorrot and a coastal quarry provide further variation in the land uses. However attempts at "rehabilitating" this unused quarry met with stiff opposition from the local population in the vicinity and the local council of Qala under whose political jurisdiction the coastal locality appertains. In fact a referendum on the issue was conducted by the local council and a huge majority voted against the proposal.

7.16 Segment XV

7.16.1 Physical attributes

The segment stretches from Qala Point to Wardija Point, with a total length of 20.9 km. The coastal zone area is 142.3 ha, giving a coastal zone width of about 68m. The weather conditions affecting the Comino Channels are important in the Ferry crossing schedules between the Islands. Thus the orientation of the segments is important. This segment has a general orientation due South towards the Comino Channel. However at Xlendi the orientation changes to the South West.

7.16.2 Land use

Table 7.18 shows the degree of land use variability along the segment and with each coastal unit. The variability is greater from Qala Point to Mgarr Harbour, with more than one-half of the land use categories represented in the unit. Coastal unit 130, that includes Xlendi Bay, also has the same degree of variability.

Table 7.18: Selected synoptic data for coastal units in Segment XV

Coastal unit	Number of land uses	Per cent: land uses out of max. 16	Per cent: area of segment
123	9	56.3	14.8
124	8	50.0	10.9
125	10	62.5	8.5
126	8	50.0	15.5
127	2	12.5	6.4
128	3	18.8	23.0
129	3	18.8	5.3
130	9	56.3	10.4
131	4	25.0	5.2

Source: Estimated by author from land use data

The consistent feature of the segment is cliffs almost one-half of all land use categories of the segment and arable land representing most of the remaining land uses. However the low sloping rock (m) and shore platform (l) are present in about 5 per cent of the area. Notable indentations occur at Mgarr Harbour, Mgarr ix-Xini and Xlendi Bay. The geology of the sector is varied, with all of the main geological strata featuring at some stage.The variability is greater from Qala Point to Mgarr Harbour, with more than one-half of the land use categories represented. Xlendi Bay also has the same degree of variability. This segment, like most of Gozo, is a clear example rural littoral development in that the recreational aspect emerges along areas where there are indentations of the coast.

This segment, like most of Gozo, is a clear example rural littoral development in that the recreational aspect emerges along areas where there are indentations of the coast. A case in point involved the Qala Creek Project. This proposal put forward by Gozo Prestige Holidays incorporated a five-star hotel and a yacht marina with port facilities and a tourist village utilizing the site of a coastal unused quarry at a cost of Lm 41 million and was expected to take 4 years to complete (The Times [of Malta] 28 August 2002, 4). In addition, the developers insisted that public access to the beach at Hondoq ir–Rummien will be enhanced and not restricted contrary to what the local fear (The Sunday Times [of Malta]: Classified Property Pages 10 November 2002, 1). However in a landmark example for environmental management in the Maltese Islands, the population refused to endorse the development following a referendum organized by the local council at Qala (The Times [of Malta] 2 November 2002, 11).

7.17 Segment XVI

7.17.1 Physical attributes

This Segment completes the coastal zone of the Maltese Islands. It is rural in character and located at the far north western ends of the Islands. The length of this segment is 9.6 km with an area of 51.0 ha, representing a coastal zone width of approximately 53m. The segment stretches from Wardija Point to San Dimitri Point. The rectilinear nature of the coastline conditions a regular orientation towards the West, with the exception of the inlet at Dwejra where orientations of the sides of the bay are towards the north and south. About 41 percent of the coastal zone area is taken up mainly by cliffs and to a lesser extent by shore platforms and low sloping rock. The main geological feature is the Lower Coralline Limestone formation that outcrops along most of the littoral. The most notable indentation is at Dwejra Bay, designated as a Site of International Scientific Importance because of its unique geomorphological features that include an arch and endemic vegetation that grows on a stack.

7.17.2 Land uses

Table 7.19 shows the lack of variability in the land use of the segment, with coastal unit 134 having the highest number of the land use categories. This area is the Dwejra Bay region and land use b is represented by a series of boathouses. They mark the difference between this coastal unit and the other four in this segment. A notable feature is that most arable land is abandoned.

Table 7.19: Selected synoptic data for coastal units in Segment XVI

Coastal unit	Number of land uses	Per cent: land use out of max. 16	Per cent: area of segment
132	3	18.8	22.2
133	2	12.5	16.1
134	6	37.5	27.1
135	2	12.5	16.2
136	4	25.0	18.4

Source: Estimated by author from land use data

The overall lack of variability in the land use of the segment is evident, however, the land use at Dwejra Bay is represented by a series of boathouses within the rich natural environment. A notable feature is that most arable land is abandoned. The land uses extant in this segment are a manifestation of its geographical position. The furthermost tip of Gozo is not an area ideal for development. Thus its rural nature has been left untouched by development. The land uses extant in this segment are a manifestation of its geographical position. The furthermost tip of Gozo is not an area ideal for development. Thus its rural nature has been left untouched by development.

7.18 Conclusion

The MEPA in its Draft Gozo and Comino Local Plan outlined the main needs for the island. Three overall policies were proposed. The first concerns access to the foreshore with the public having 'free and unhindered' rights (MEPA, 2002b, 110), however this must not be interpreted as a right to improve access. The second concerns the coastal Viewshed Protection Zone. This provision concerns the built-up areas where no lateral extension to the built footprints and no vertical increase to the building heights are to be undertaken without authorization. Thirdly, the coastal areas that have an ecological, natural, or landscape value are to be safeguarded by the appropriate legislation. This includes the need for EIAs where modifications to existing beaches are requested and the prohibition of creating new beaches where none existed before.

The land uses along the Gozitan coasts are predominantly associated with the rural environment with pockets of recreational land uses. The most prominent of these are at Mgarr, site of the Malta-Gozo Ferry terminal, and Xlendi (both sites in Segment XV) a fishing village community transformed into a tourist area and Marsalforn (Segment XIV) a seaside resort with recent haphazard development of flats holiday homes and hotels similar to some areas in Malta. However one major point of concern for the future development of the predominantly rural Gozitan coast are the Malta Hilton-type projects proposed for two sites at Mgarr ix-Xini and Qala (both sites in Segment XV). The two proposals envisage the quarrying of rock along the waterfront to create a shoreline that accommodates yachts by cutting through a substantial part of the hinterland. The case at Mgarr ix-Xini is to widen a natural inlet whilst the case with the Qala seafront is to use and modify the site of a derelict and abandoned coastal quarry. As both sites lie on an exposed part of the coast breakwaters are needed to create safe anchorage. These types of proposals, if implemented, will alter the scenic coast of Gozo in a substantial manner, reduce the natural aesthetic qualities of Mgarr ix-Xini, and encourage similar developments in the future.

A number of modifications were observed in an assessment of the local littoral carried out between April and May 2003. The principal aesthetic modification concerns the embellishment of the promenades practically in all localities. This consists of

- resurfacing of the pavements using a combination of coloured tiles, with the end result consisting of a mosaic of red grey and green hues;
- planting of trees, bushes and flowers;
- embellishment of roundabouts with water fountains and monuments;
- increase in street furniture such as benches, decorative lampposts and railings;
- introduction of litter bins that blend with the overall hue of the surroundings;
- surfacing of the coast roads;
- increase in traffic control measures such as the introduction of more traffic signs, one-way streets, and traffic calming measures;

These improvements were undertaken by the local councils of Mellieha (Segment I), St. Paul's Bay, Bugibba, and Qawra (all in Segment II); the whole stretch from St Julian's to Sliema (Segment IV) and around all the localities of Marsamxett Harbour and Grand Harbour (Segment V), Marsascala, (Segment VII), the localities in Marsaxlokk Bay: Birzebbugia and Marsaxlokk (Segment VIII) and Wied iz-Zurrieq and Ghar Lapsi (Segments IX and X).

Another aesthetic modification involved the increase in the number of flats along the littoral where practically all areas are undergoing progressive change. Two storey houses are being demolished and replaced by six and seven storey buildings in addition to building over with same structures over coastal vacant land. All the localities mentioned above are undergoing this process and in some parts of Malta the process is complete.

The identification of Swimming Zones is another major improvement in the management of the local littoral. These are off-limit areas for speed boats, jet skis and high speed watercraft. The idea is to make the inshore zones safe for swimming. Eighteen bays have been marked with yellow and red coloured buoys at 50 metre intervals and patrol craft monitor infringements. The Bays included are the following: Mellieha Bay, Imgiebah Bay, two sites in St Paul's Bay (Segment II); Birzebbugia (Segment VIII); Ghajn Tuffieha Bay and Golden Sands (Segment XI); in Comino (Segment XII) two bays San Niklaw Bay and Santa Maria Bay together with Blue Lagoon; in Gozo Qbajjar Bay, Marsalforn Bay, Ramla l-Hamra Bay, San Blas Bay (Segment IV) Hondoq ir Rummien (Segment XV) and Xlendi Bay (Segment XVI) (The Times [of Malta] June 14 2003,14).

Segment I falls within the North West Local Plan (Planning Authority, 2001) with the main change being to the stock of boathouses along the Armier Bay area. Some of the illegal structures have been demolished but access to the shoreline is hampered in some areas. In addition, the Solemar Hotel has extended its previous limits and encroached on good arable land and is siphoning potable water from the local water table depleting the resource available to farmers.

In Segment II the main elements noted were the extension of seafront area with flats as noted above however the principal change is the increase in the number of restaurants and recreational establishments together with the competition for space between sites used for aquaculture and sailing routes preferred by windsurfers.

Changes to Segments III and IV have already been noted with the extension of the Maghtab rubbish dump and the Hilton Project. However the dump is to be closed down by the date of European Union accession (1st May 2004) and replaced by an engineered landfill behind Ghallis Tower (Segment III). Meanwhile two landfill sites have been earmarked as a temporary replacement both on the cliffed part of the coast in Segment IX. This issue has prompted the expected debate in the local press (The Times [of Malta] July 10 2003a, p4-5; The Times [of Malta] July 11 2003b, p5). In Segment IV the further intensification of developments with blocks of flats and recreational establishments has gone apace increasing the population density of the area and intensifying traffic problems and congestion.

The major projects that have been initiated since both involve sites in are Segment V. The Cottonera Waterfront Rehabilitation Project where besides the embellishment to the littoral mentioned above, Dock No 1 built in 1868 has been decommissioned and removed, the buildings that accommodated workshops are being refurbished and is to be used as a bank premises, a new yacht marina is being developed, a casino opened and new flats and a hotel are in the process of construction. (Planning Authority, 1997b). This development has also spilt over to other areas in the region where upgrading of street furniture, house facades and attention to the more historical remains, such as chapels street and corner niches and fortifications, is being attended to. With regards to the other major development the Manoel Island and Tigne Point project remains the principal feature of Marsamxett Harbour (Planning Authority, 1992). Although work on the Manoel Island part has not yet started the first phase of the Tigne point development is underway and the area is being marketed as up-market zone with flats and recreational, business and commercial outlets. However there still remains the problem with the site of the former Excelsior Hotel left incomplete along the littoral between the Valletta bastions although in 1992 a three-year time span for completion was given. Another major development along the Grand Harbour littoral is the extension to the Valletta Cruise Passenger Terminal (Planning Authority, 1998) sited under the bastions; work on this project is to commence shortly.

Segments VI, VII and VIII constitute the remaining segments on the east and south east coasts of Malta. The major changes to the coast besides the embellishment projects mentioned above all involved conflict of uses between the location of industrial activities, the supply of fuels to the various hydrocarbon installations, the disposal of liquid waste and fish farming activities. A number of these issues were mentioned in the relevant sections in Chapter 6 especially in section 7.9.4 dealing with Marsaxlokk Bay but although the Local Plan was the first one of the series of Plans to be published one of the major requirements to turn Delimara peninsula into a nature reserve has not been implemented. However the relocation of the fuel installation depots at St. George's Bay (Segment VIII) may soon be implemented as a result of Malta's entry into the European Union and the restrictions to the height of building facing the sea is also being observed.

The remaining segments in Malta (IX, X and XI) occupy the whole south west and western littoral and are broadly classified under the "rural" category. Cliffs, scree slopes, sandy beaches and arable land constitute the principal land uses. Very few changes have been monitored over the past years however the footpath pattern in some areas, notably at Rdum Dikkiena, has been obstructed with bird-trapping hides, limiting access to the area (Schembri and Magri, 2003). Arguably the most important management provision made since has been the scheduling of the coastal areas and no development of any kind can be permitted. However, as mentioned above, the sites for the temporary landfills fall within the boundaries of these segments and therefore one expects that their negative impact will follow suit. In addition, the replacement of an old hotel with new development mentioned in section 7.12 also falls within the boundaries of segment XI. At the time of writing the area consists of one whole rubble mound and is highly visible from the nearby surroundings.

The major change affected to Gozo was in the changes made to the ferry terminal at Mgarr (Segment XV) where car parking and ferry berthing provisions are being extended and enhanced. This has been the result of increasing traffic between the two islands and in line with the MEPA aims to upgrade the harbour. Xlendi valley,and Mgarr ix-Xini are the only two Gozitan sites to be scheduled, the latter done hastily due to an environmental infringement by a quarry owner (cf. Plate 6.5). Other provisions still waiting for the MEPA stamp are the listing of the Dwejra area (Segment XVI) as a World Heritage Site, which is under treat from encroachment of nearby quarry extensions, and the new pipeline for sewage disposal at sea further out than the existing outlet after the building of a sewage treatment plant also at Mgarr ix-Xini.

The main overall coastal issue is therefore one that requires continuous vigilance by the MEPA both in urban areas, where development proposals threaten the intensification of activities, and in rural areas where proposals for recreational land uses threaten to turn "rural" parts of the coast into urban zones. Although the development of industrial zones seems to be confined to two particular areas in Segments V and VIII the landfill issue has now emerged as the main threat to the coast with indecision as to its siting.

Chapter 8 An assessment of the coastal land use distribution

8.1 Introduction

The discussion of the two previous chapters dealt with a description and analysis of the land uses in the coastal zone of the Maltese Islands. The argument was based on the field data captured, and involved the distribution of 16 coastal land use categories in the coastal zone. In Chapter 6 the analysis was based on the land use categories as distributed along the whole littoral of the coast. In Chapter 7 the analysis focused on the land uses in each coastal segment. In this chapter further analysis will be made. Three main purposes are identified. The first purpose is to present a series of histograms, one for each segment, so as to compare the 16 coastal segments with one another (Section 8.2). The second purpose is to examine the physical properties of the coast as they condition land use (Section 8.3). The third purpose is to assess the degree of compatibility or conflict between the coastal segments themselves and between the coastal land uses within particular segments (Section 8.4). Finally, in the conclusion, the degree to which particular segments are prone to development is examined, based on the physical geographical criteria (Section 8.5). The data examined consists of a number of cartometric measurements provided by two major categories: the 16 land uses as distributed in each of the 16 coastal segments, and a number of measurements pertaining to various physical properties of the coast such as cliffs, shore platforms and scree slopes.

8.2 Presentation of results in histogram format

A series of histograms based on the land uses in each segment are presented in Figures 8.1-8.16. The idea is to put in simple format the land uses prevalent in each segment. Each figure shows the distribution of the land uses in one segment. The key to the land uses for all Figures is given at the bottom for Table 8.1. A number of considerations are apparent that show that not all the segments have the same land use properties and therefore a degree of variability of the coast can be gauged. Further general considerations appertain to the size of the segments themselves: a large segment generally has either a long coastal length (Segments V, VIII and XV) or a wide coastal zone (Segment III) or both, such as the case with Segment X. A wide range of land uses per segment is evident from Table 8.1with two segments having the maximum 16 land uses and Segment XIII has only seven land uses. In general the segments that lie within the coastal urban areas have more land uses than the ones in the rural category.

Examining the histograms one finds two main categories. In the first category are the histograms that represent segments where the area covered by a few land uses is far superior to the remaining land uses represented in the same segment, and these are therefore termed 'dominant'. These include Segment I with recreational areas, arable land in use and cliffs as the dominant land uses, whilst the land occupied by public utilities, historical sites, low sloping rock, scree slopes and dilapidated areas is represented by smaller areas. In Segment II arable land, both that which is still in use and that which is abandoned, cliffs and scree slopes are the dominant land uses. In Segment III recreational areas and cliffs are dominant; Segment IV shows that recreational areas dominates the coastal zone; Segments V and VIII are dominated by industrial areas whilst the 'rural' land uses dominate the remaining segments in Malta. These include Segment IX dominated by cliffs, Segment X with arable land, both those that are in use and those that are abandoned, together with scree slopes being the dominant land use, and Segment XI dominated by scree slopes. The Segments that represent Comino and Gozo demonstrate that the arable land uses, both those are in use and those that are abandoned, together with cliffs and scree slopes are consistently shown to be the dominant land uses throughout.

The second type of Segments are those where the distribution of the land uses lies within a low range of values, in general those that have a small coastal zone area, such as Segments IV, VI and VII. However, where only one land use is highly dominant in one of these segments it dwarfs the other land uses in that Segment. Segments V and VIII are clear examples with industrial areas dominating all other land uses.

Figure 8.1 Distribution of land uses in Segment I

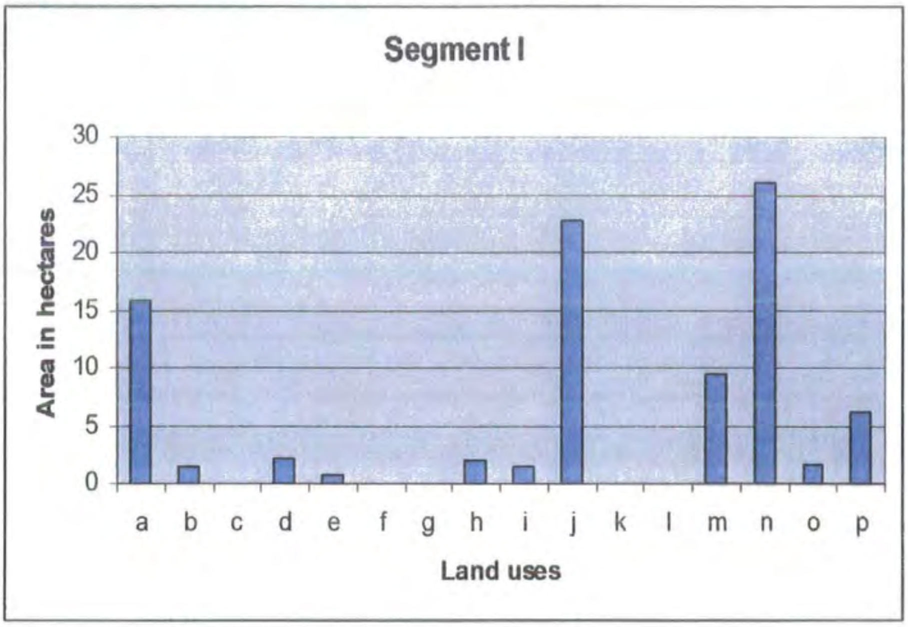
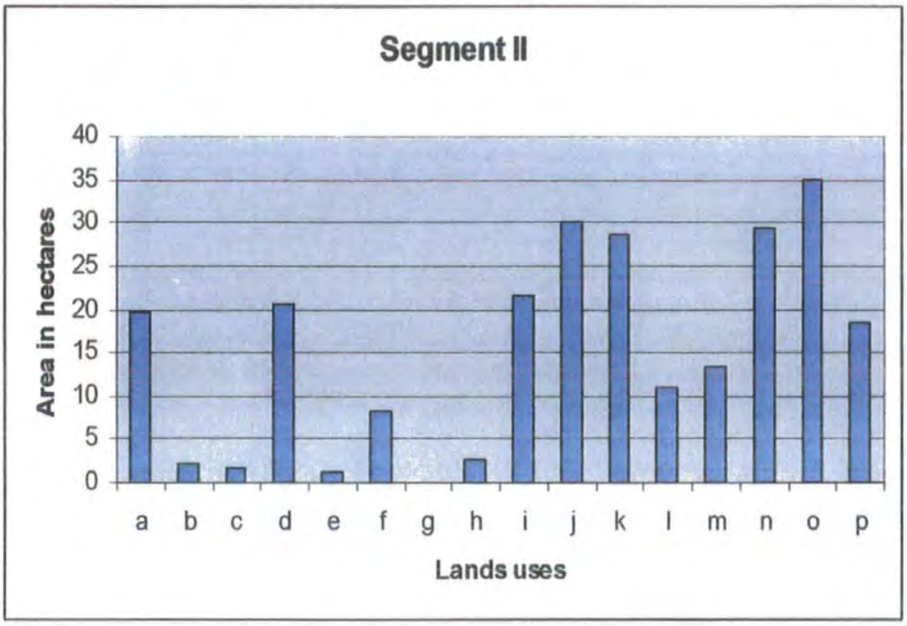


Figure 8.2 Distribution of land uses in Segment II



Key to land uses

a - recreational areas; b - marine servicing areas; c - residential areas; d - public utilities; e - historic sites; f - industrial areas; g - extractive industries; h - depositional environments; i - afforested areas; j - arable land; k - abandoned arable land; l - shore platforms; m - low sloping rock; n - cliffs; o - scree slopes; p - dilapidated areas.

Figure 8.3 Distribution of land uses in Segment III

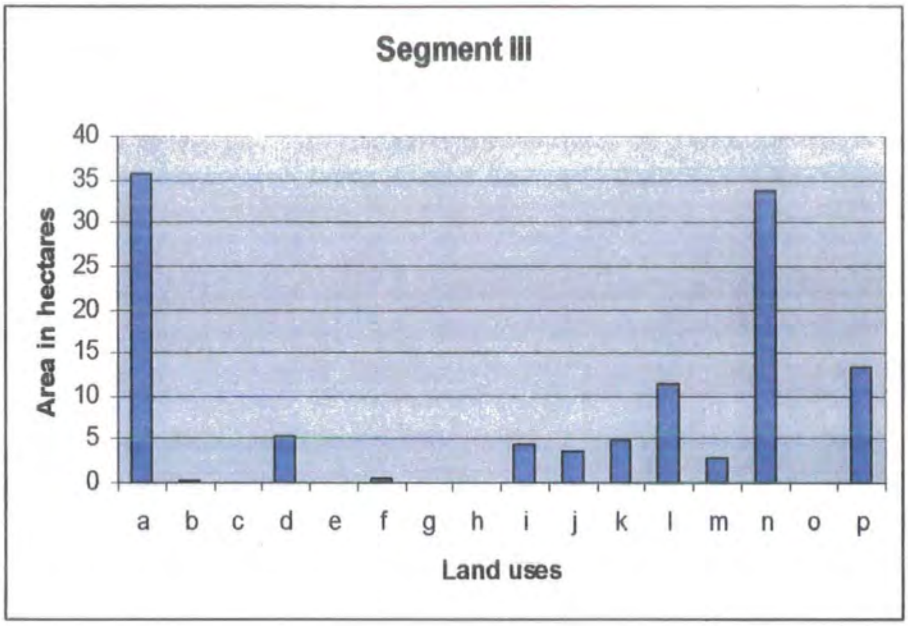


Figure 8.4 Distribution of land uses in Segment IV

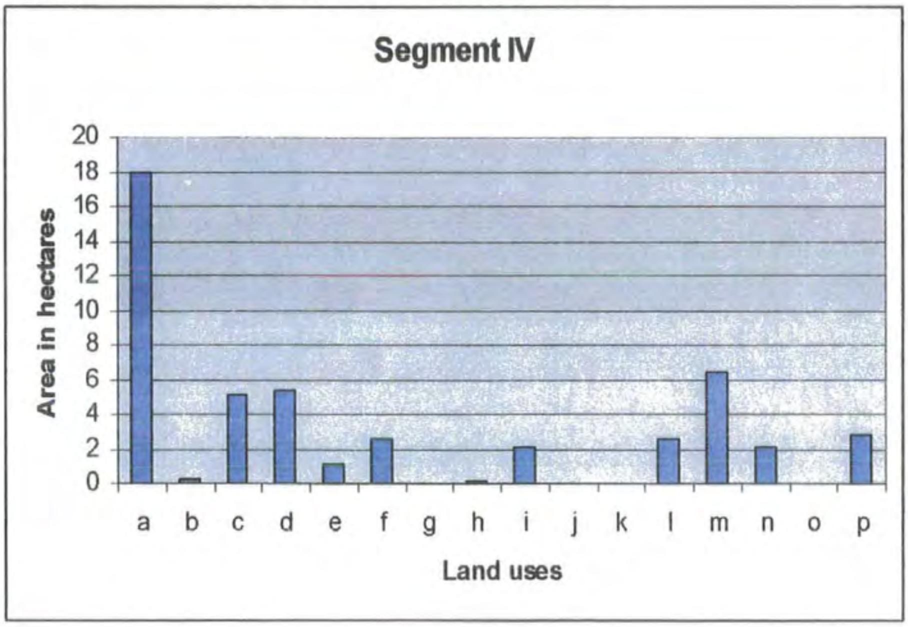


Figure 8.5 Distribution of land uses in Segment V

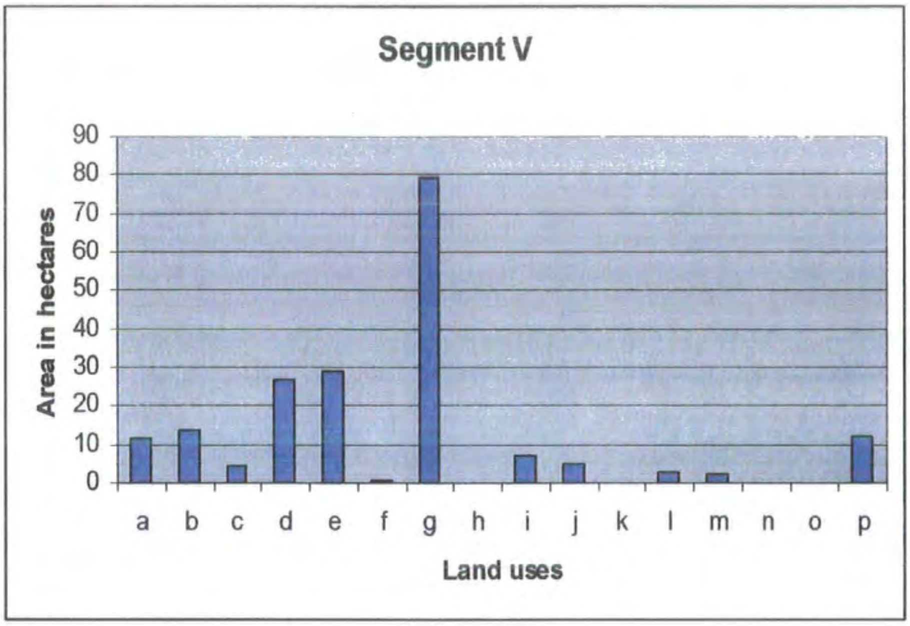


Figure 8.6 Distribution of land uses in Segment VI

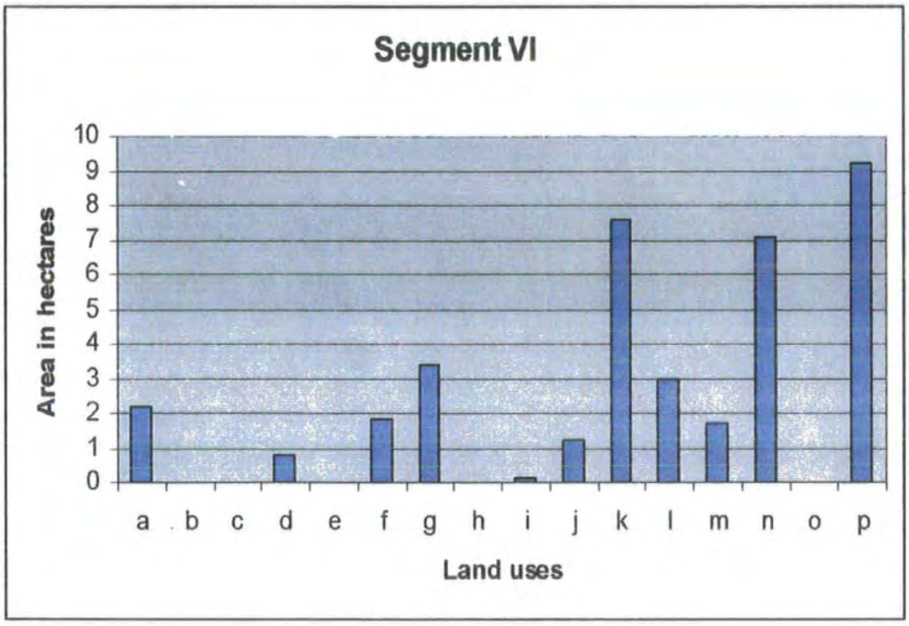


Figure 8.7 Distribution of land uses in Segment VII

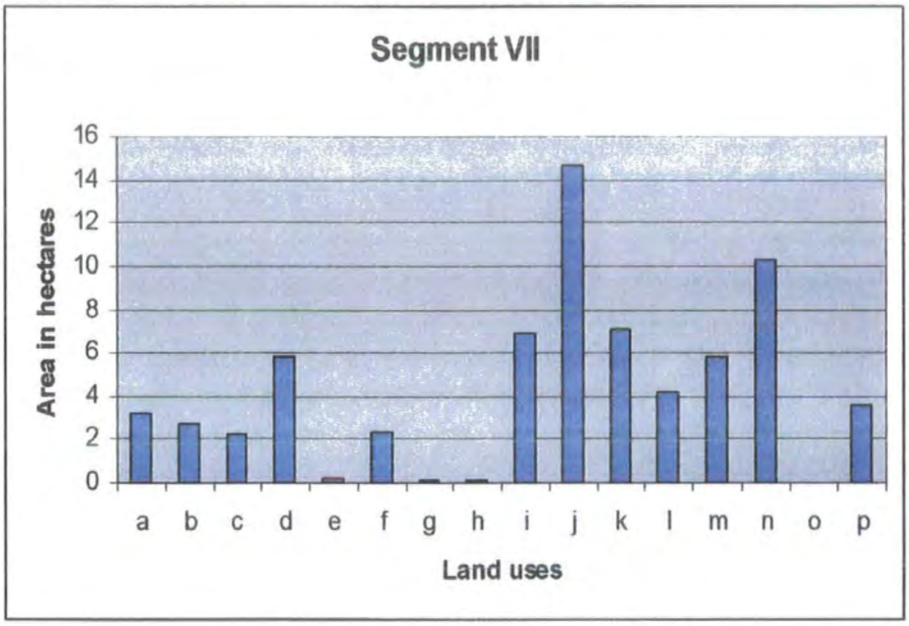


Figure 8.8 Distribution of land uses in Segment VIII

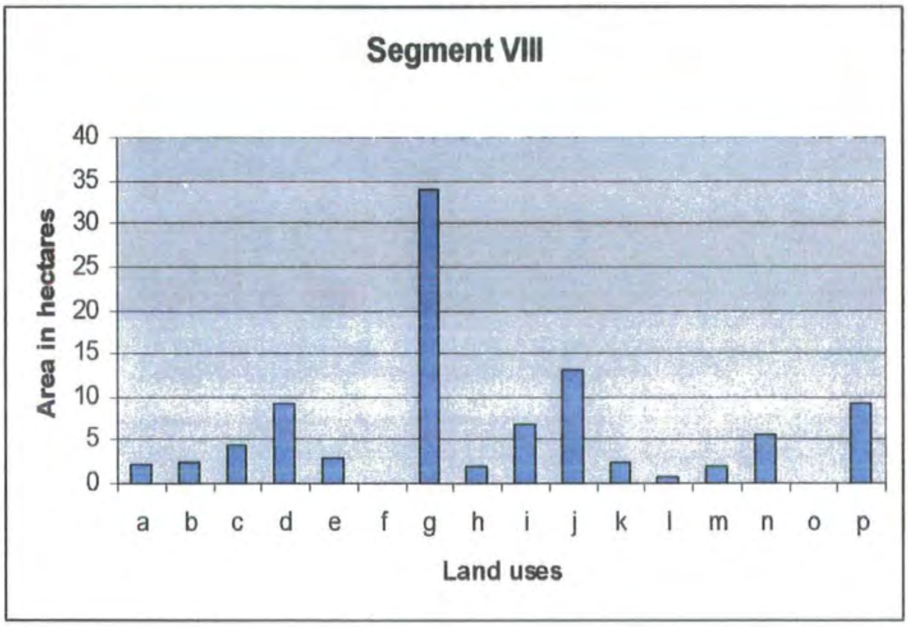


Figure 8.9 Distribution of land uses in Segment IX

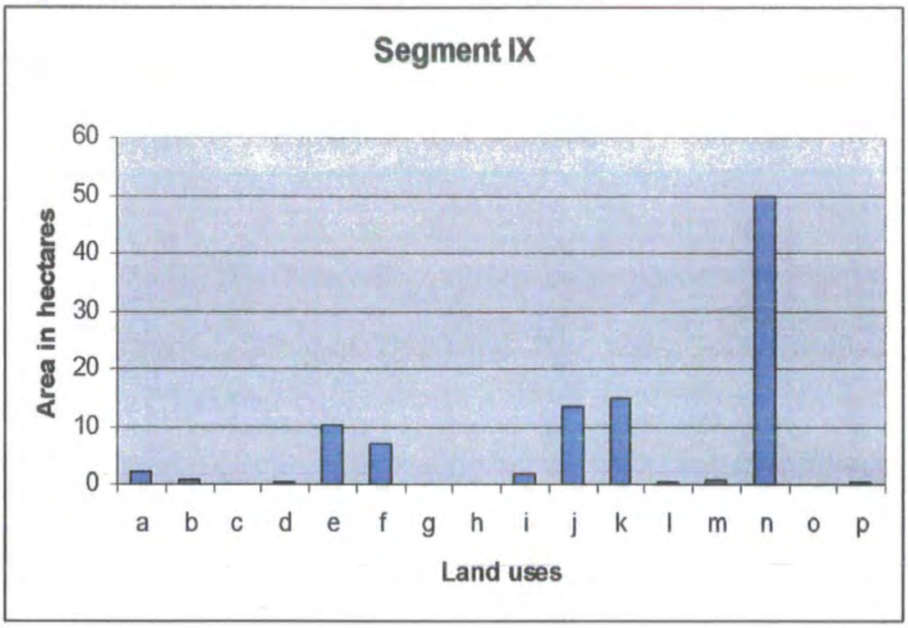


Figure 8.10 Distribution of land uses in Segment X

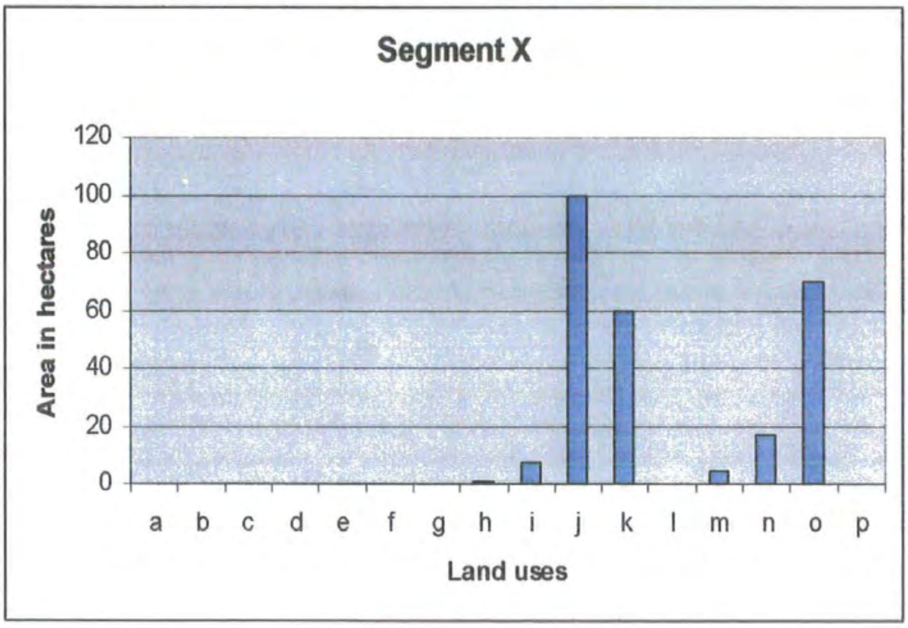


Figure 8.11 Distribution of land uses in Segment XI

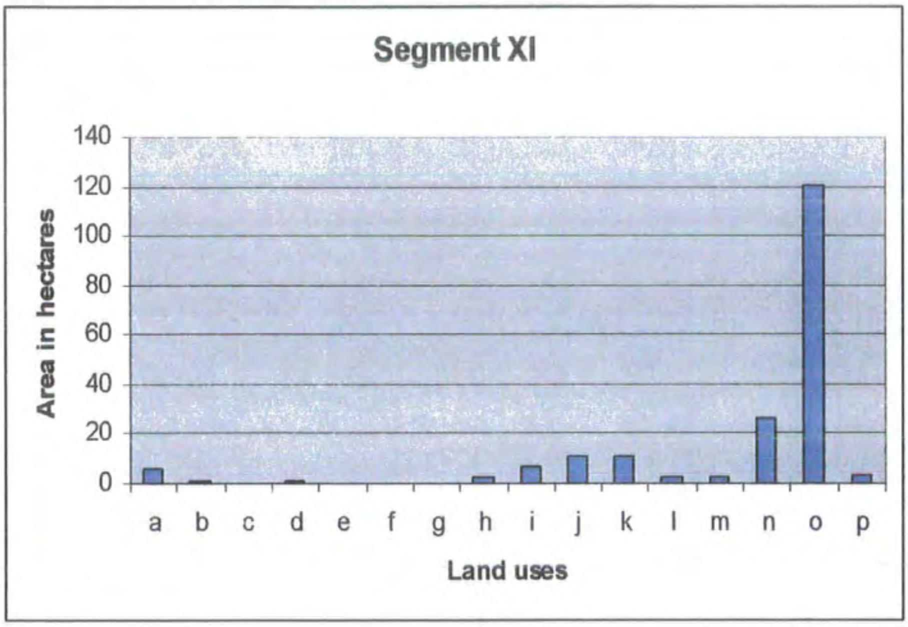


Figure 8.12 Distribution of land uses in Segment XII

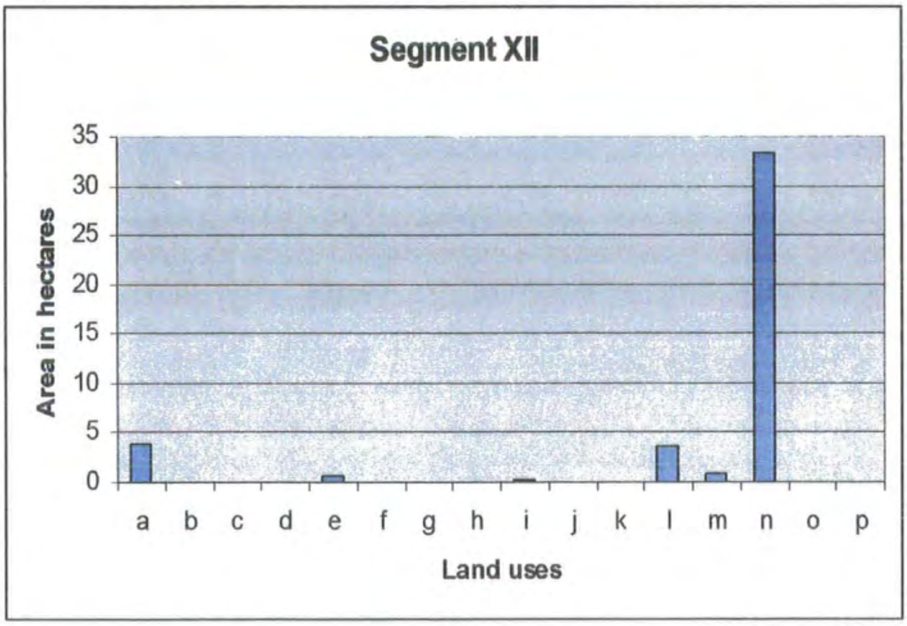


Figure 8.13 Distribution of land uses in Segment XIII

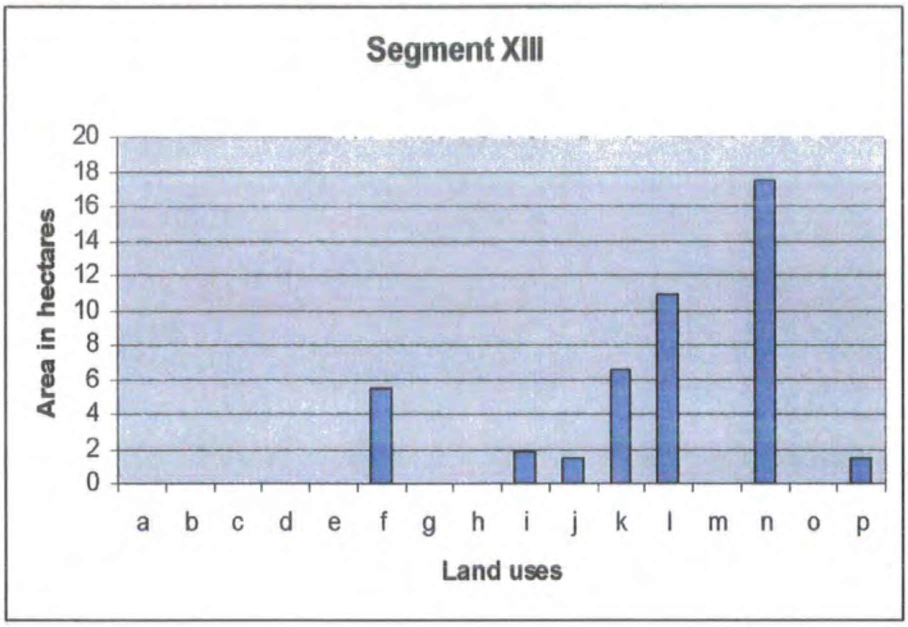


Figure 8.14 Distribution of land uses in Segment XIV

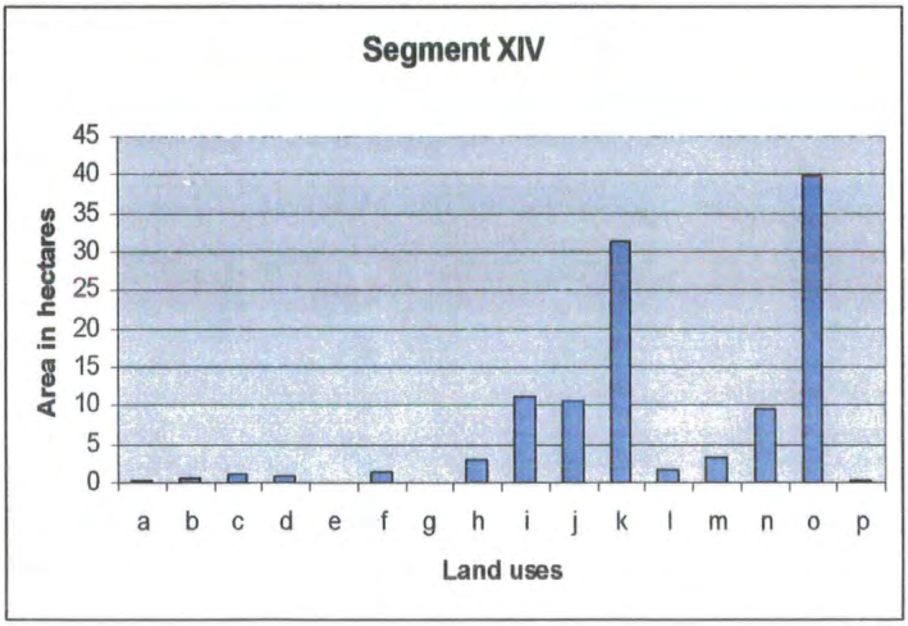


Figure 8.15 Distribution of land uses in Segment XV

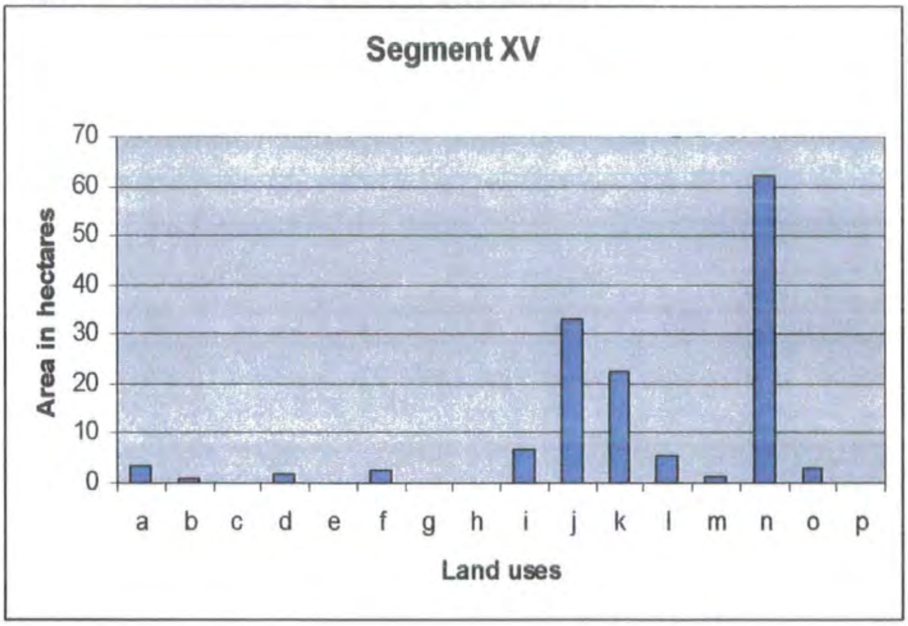
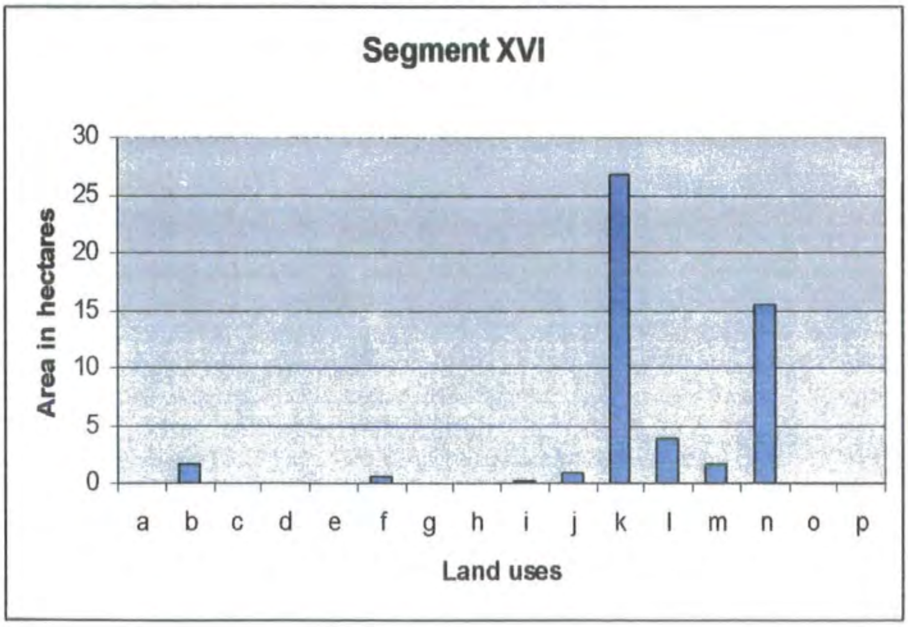


Figure 8.16 Distribution of land uses in Segment XVI



To facilitate interpretation a synoptic table has been provided (Table 8.1). This represents the information given in the above mentioned figures in matrix form. For ease of reference two keys are presented: a key that divides the land uses of each segment into three main types:

(a) the land uses that are highly represented in each segment, and are therefore dominant (highly conspicuous by their presence) in the particular segment where it is located, these are indicated in bold lettering (eg. **a**);

(b) the remaining land uses denoted by an asterisk (*); and

(c) the land uses that are not represented in the segment (-).

The second key denotes the land uses.

Table 8.1 Synoptic table summarizing the results of Figures 8.1 - 8.16

Segment	No. of land uses	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p
I	9	**a**	*	-	*	*	-	-	-	-	**j**	-	-	*	**n**	*	*
II	16	**a**	*	*	*	*	*	-	*	*	**j**	**k**	*	*	**n**	**o**	*
III	10	**a**	*	-	-	-	-	-	*	*	*	*	*	*	**n**	-	*
IV	12	**a**	*	*	*	*	*	-	*	*	-	-	*	*	*	-	*
V	12	*	*	*	*	*	*	**g**	*	*	*	-	*	*	-	-	*
VI	10	*	-	-	*	-	*	*	-	*	*	*	*	*	*	-	**p**
VII	16	*	*	*	*	*	*	*	*	*	**j**	*	*	*	*	*	*
VIII	14	*	*	*	*	*	-	**g**	*	*	*	*	*	*	*	-	*
IX	12	*	*	-	*	*	*	-	-	*	*	*	*	*	**n**	-	*
X	9	-	-	-	-	*	-	-	*	*	**j**	**k**	-	*	*	**o**	*
XI	14	*	*	-	*	*	*	-	*	*	*	*	*	*	*	**o**	*
XII	7	*	-	-	-	*	-	-	-	*	*	-	*	*	**n**	-	-
XIII	7	-	-	-	-	-	*	-	-	*	-	*	*	-	**n**	-	*
XIV	14	*	*	*	*	-	*	-	*	*	*	**k**	*	*	*	**o**	*
XV	14	*	*	-	*	*	*	-	*	*	**j**	*	*	*	**n**	*	*
XVI	8	-	*	-	-	-	*	-	-	*	*	**k**	*	*	*	-	-

Source: Compiled by author from Figures 8.1-8.16

Key to symbols in matrix

Bold lower case lettering indicates dominant land uses within the segment
asterisk "* " indicates the presence of that particular land use, but is not considered dominant
(-) does not indicate the presence of that particular land use

Key to land uses

a - recreational areas; b - marine servicing areas; c - residential areas; d - public utilities; e - historic sites; f - extractive industries g - industrial areas; h - depositional environments; i - afforested areas; j - arable land; k - abandoned arable land; l - shore platforms; m - low sloping rock; n - cliffs; o - scree slopes; p - dilapidated areas.

The general comments regarding this part of the analysis promotes the idea that cliffs are a highly represented land use, featuring in 13 out of 16 segments, and dominant in seven out of the 16 segments i.e. in Segments I, II, III and IX in Malta, Comino (Segment XII) and XIII and XV in Gozo. In the remaining segments it is the recreational areas in Segments I, II, III and IV and the industrial land uses in segments V and VIII that are mostly evident. In addition, it is this latter group of segments that are the most accessible both from land and sea because of the presence of shore platforms and low sloping rock profile in addition to the concrete platforms lining parts of the foreshore. In addition, the fortifications lining the Grand Harbour littoral have masked the natural cliffs that preceded them and adjacent to which they were built; the result is that, in this exercise, it is the historical land use (represented by fortifications) that emerges and not the cliffs. Arable land is present in the "rural" parts of the coast, whilst for segments VI and XVI it is the abandoned arable land that is the dominant land use category. For all the other segments, the presence of a large number of land uses increases the potential for land use conflict to occur especially where:

- a large number of land uses are represented in the segment, especially if these are clustered over a small area such as in the coastal urban zones in the inner parts of bays; this issue is tackled in section 8.4 below;
- dilapidated areas are present, especially if these are concerned with building sites or dumping of domestic waste; this problem is increased when this land use category coincides with the intensive development areas associated with the tourist areas;
- one highly dominant land use in a segment is accompanied by a number of other land uses that are normally clustered together, especially if these land uses are grouped into a small area;
- within a segment it is the proximity to one another of the urban, rural, industrial and dilapidated land uses that can lead to conflicts. In fact land use conflict is the issue to be tackled in section 8.4.

8.3 Selected physical features of the coast

Further analysis on this part of the basic dimensions of the coast of the Maltese Islands has yielded more data which is shown in Table 8.2. This table groups the coastal length, the average width of the coastal zone for each segment, the distribution of land uses and the percentage of the coast that has natural access and an index showing the indentation ratio. The data is given for each Segment, for each separate island and for the Maltese Islands.

8.3.1 Coastal indentation

The factor of indentation mentioned above yields a number of other studies. One such investigation is the indentation ratio for the Islands. Essentially, the degree of indentation, for the purposes of this thesis, refers to the extent or degree to which a particular area around the coastal margin departs from the linear or straight line format. The latter is a line drawn along the perimeter of each island at a parallel distance from the coast but not touching the actual shoreline. For the purposes of this thesis this is called the circumnavigable length.

The importance of this element for this thesis lies in the fact that the greater the indentation of the coastline, the greater is the propensity of that particular part of coast to have a range of activities. The indented parts of the coast provide a greater land/sea servicing interface and a better shelter from adverse maritime conditions such as storms. These areas generally attracted settlement for millennia and therefore possess more historical and archaeological remains and today they attract a higher degree of urban and economic development. As a consequence, land use conflicts are more prone to occur in the highly indented parts of the coast than in the less indented or in the rectilinear stretches. Providing the planner with an index such as the one presented in this thesis is a direct step to predicting future sites that could be earmarked for development.

Table 8.2 Selected estimated dimensions for the Maltese Islands, Malta, Gozo, Comino and the sixteen segments.

Segment	Coastal length km	Circum-navigable length km	Coastal zone area km^2	Average width of coastal zone in metres	Land uses a-m % of segment	Land uses n-p % of segment	Natural access % of segment	Ratio of circum-navigable to coastal length 1:
I	7.4	5.2	0.8	120.8	54.2	45.8	81.2	1.42
II	23.8	6.5	2.4	106.6	63.7	36.3	68.5	3.66
III	8.0	6.2	0.8	144.6	64.4	35.6	99.3	1.29
IV	7.7	3.2	0.5	62.6	75.3	24.7	97.8	2.41
V	25.6	10.5	1.9	75.5	100	0	100	24.38
VI	6.3	5.7	0.5	60.5	64.8	35.2	85.2	1.11
VII	13.8	5.6	0.7	50.1	76.5	23.5	65.3	2.47
VIII	10.8	1.6	0.9	89.7	92.2	7.8	85.9	6.75
IX	17.3	13.6	0.9	58.7	31.6	68.4	24.4	1.28
X	12.5	5.0	2.6	206.4	12.1	87.9	6.0	2.51
XI	21.6	9.6	2.1	90.2	13.2	86.8	28.0	2.25
Total Malta	154.97	63.2	14.1	Mean 96.9	Mean 58.9	Mean 41.1	Mean 67.4	Mean 1:4.5
XII (Comino)	8.1		0.4	52.5	21.7	78.3	62.0	1.07
XIII	5.5	4.2	0.4	82.2	51.2	48.8	17.3	1.30
XIV	13.1	10.5	1.2	87.7	32.0	68.0	51.1	1.25
XV	20.9	12.5	1.4	68.1	25.2	74.8	35.3	1.67
XVI	9.6	5.0	0.5	53.1	33.5	66.5	28.8	1.93
Total Gozo	49.28	32.2	3.5	Mean 72.8	Mean 35.5	Mean 66.3	Mean 33.1	Mean 1.53
Maltese Islands	212.35		18.0	Mean 88.1	Mean 50.2	Mean 49.2		

Source: Author's measurements with 1cm = 25m length on 1:2500 map scale.

Examining the littoral for coastal indentations or rectilinear features shows both properties evident in the Maltese Islands. Marked indentation occurs along the eastern Malta littoral, and the rectilinear features of the Western Malta, Comino and Gozitan (Segments XII to XVI) coastal margins are highly evident. In general, coastal areas having ports, harbours and bays are indented, penetrating inland into the land mass. Areas not possessing these features are termed as having rectilinear properties.

Different characteristics of the Malta coastline emerge from Table 8.2. There are 103.4 km of coastal length from Cirkewwa (Segment I) to Benghisa Point (Segment VIII), passing through the indented northern and eastern parts of the coast, which is twice as much as the 51.5 km of the rectilinear southern and western coasts. The circumnavigable data amount to 35.0 km and 28.2 km respectively, giving an indentation ratio of 1:2.9 for the heavily indented part of the coast and 1:1.8 for the remaining part of the coast. Comparing the above figures with those for Gozo, which has 43.7 km of circumnavigable coastal length and 78.5 km of actual coastal length, an indentation ratio of 1: 1.8 is calculated. This value is similar to that of the south and western Malta margin. Further details show that 84.6 per cent of the whole Eastern littoral of Malta (Segments II-VIII) is taken up by the indented parts of the coastline, whereas only three areas can be identified as possessing an element of linearity in this eastern part of the coastal margin. The latter are represented by Segments III, VI and a short stretch in Segment II, from il-Ponta ta' L-Ahrax to Dahlet ix-Xilep.

A further detail that arose out of this cartometric exercise is the heavy indentation of a number of Segments. Essentially, a simple scale was established where the separate segments were classified into three broad categories of indentation: high, middle or low. The ratio was calculated between the dimensions of circumnavigable length and coastal length with the shorter circumnavigable length always having a ratio of one. Grand Harbour and Marsamxett Harbour making up Segment V, the bays to the North East of Malta in Segment II and Marsaxlokk Bay represented by Segment VIII are the most prominent in this respect. The coastal margin to the north of il-Kullana on the Western coast of Malta up to Cirkewwa, that includes Segments X and XI with the sandy beaches of Gnejna, GhajnTuffieha and Golden Bay and the area between Marsascala Bay and Delimara in Segment VII, present a moderate form of indentation. The remaining segments, having a ratio less than 1: 2.00, possess a low degree of indentation.

The similarity noted between various portions of the coast will emerge again when the land use data gathered is investigated, but for management purposes the coastal dimensions presented can help the planner in at least two ways: the first is in the identification of areas that have 'similar' properties, the second, is at predicting coastal margins that can be earmarked for development, depending on the degree of indentation of the coast. Since such areas are prone to land use conflicts, development briefs must be prepared with a degree of caution. This exercise not only helps to quantify the degree of indentation or otherwise of the coast of the Maltese Islands but also helps to highlight an important coastal geomorphological feature - indentation. Coastal inlets, of all physical dimensions and properties of width, length, and depth have many attributes, some of which have been mentioned above, but they also enhance the mooring of boats, as they present a better shelter from strong winds and sea swell conditions. Cultural development is normally associated with these inlets and in Malta they form a substantial part of the coastline. The data presented in this chapter will form the basis for the concluding remarks for the thesis.

8.3.2 Accessibilty

Table 8.2 also shows the influence of accessibility on coastal land use for the separate segments. The figures give the land uses normally associated with high accessibility (a-m), these include the urban and industrial land uses (a-g), the land uses denoting areas with unconsolidated material (i) and the areas where shore platforms and a low sloping rock profile prevails (l and m). The remaining land uses (n-p) are presented in the adjacent column. These combine the inaccessible parts of the coast and dilapidated areas. Additionally, the percentage values for the accessible parts of the shoreline are provided as a value for each segment based on the coastal geomorphology of the area and shown in the penultimate column as 'natural access.' This combines the values for shore platforms, low sloping rock and reclaimed parts of the coast. The final column presents the ratio of the circumnavigable length (column 2) to the coastal length (column 1), this gives the degree of indentation of each coastal segment. An element of consistency is apparent in the values given: generally segments where a high degree of natural access is evident have a high value for land uses associated with good access (a-m), especially for Segments I-VIII.

8.4 Coastal land use conflict

Price (1989, 11) maintains that land use conflict occurs where "major areas of concentrated resources overlap with heavy use impacts." Carter (1988, 2) identifies "the disruption by Man of the natural coastal system". Viles and Spencer (1995, 17) propose a two-pronged classification to group coastal problems. First they put forward problems that arise out of "natural stresses" and secondly pose those problems that arise due to a significant human input. The latter depend also on the type of human interference and is also scale-dependent. Clark (1995), in suggesting the need for integrated planning of coastal areas, cites the fact that it is the competition and conflict that occurs among a variety of land uses such as "residential, tourist, commercial, industrial, transportation, recreational and agricultural activities" competing within limited space that causes conflict in coastal areas, especially if competition occurs in a limited space. Within the local context Borg (1995) places a number of indicators as demonstrating conflict along the Maltese littoral. These are, the competition for space on land and sea surface, the degradation and eradication of land habitats and benthic (sea bottom) habitats and the degradation of water quality from effluents.

Placing the above quotations within the context of this thesis, and using the case of the Maltese Islands with its high population density and multiple uses taking place in the coastal zone, land use conflict can be considered as a pressing issue. However, the type of conflict varies with the predominant land use prevailing. Within this context, and as mentioned above, especially throughout Chapter VI, three types of conflicts can be proposed, based on the three broad land uses. First there are those conflicts occurring in the coastal rural areas, i.e., those areas where the dominant land use type consists of cliffs, scree slopes and agriculture. Second there are those conflicts in the coastal urban areas, i.e., the land uses associated with the recreational, residential and industrial activities. Third there are those on the rural/urban fringe, i.e., afforestation areas. Considering the series of explanations as to what constitutes conflict (cf. Price (1989), Carter (1988), Viles and Spencer (1995), and Clark (1995)), and using the data obtained for the coastal land use spectrum, as developed in this thesis for the Maltese Islands, a simple classification based on correlation analysis. Before tackling land use conflict *per se* it is helpful to examine the extent to which land uses, on the one hand, and segments on the other possess similarity based on the results obtained in this thesis. This can be done through correlation analysis.

Correlation analysis is a technique used to establish the degree of correspondence between two or more geographical patterns. Robinson (1998, 80) states that this method of investigating interrelationships was utilized first by Rose (1936) and then by Weaver (1943) who as agricultural economists related agricultural production to physical variables through correlation methods. They were followed by McCarty (1953) and McCarty *et al* (1956) who utilized correlation analysis as the principal statistical tool in "his attempt at explaining the location of phenomena by looking at the spatial distribution of different variables" (Robinson, 1998, 80). The method employed here falls under the paradigm of cluster analysis where the correlation matrix depicts similarities between observations "which in geographical terms can be places" (Robinson, 1998, 146) or as in this thesis can also be land uses. Cluster analysis is shown as a branching structure or dendogram. These "branches" are representations of the degree of similarity between observations and also give the numerical value (usually a percentage) at which two or more of the observations possess similar properties, generally the higher the value the higher is the similarity between the observations. In addition, the correlation matrices possess the facility of grouping observations that have occurred within a relatively small numerical range. Dendograms are interpreted in the following manner. First the mutually highly correlated pairs of observations are identified. These pairs are then grouped with each of the unattached observations separately until, at the end of the grouping procedure, all the observations are combined into one group (White, 1984). The method used in this chapter first identified the three broad clusters (A, B and C) under which the land uses appertained to, secondly, the most compatible land uses were paired and finally the linkage is established between the remaining land uses individually and the previous groups. The result is shown in Table 8.3 with the Key at the bottom of the table helpful in explaining the pairing system used.

One such method is the Bray-Curtis Index. Essentially it is a data transformation method that is generally applied to make inferences beyond the purely empirical values presented. These indices allow the measurement of (a) the degree to which populations are distributed differently and (b) the degree to which one population is segregated from the rest of the population (http:// www.sru.edu/depts/artsci/ges/urban). Indices of dissimilarity provide the researcher with a comprehensible figure between 0 and 100 in cases where percentage values are used. The nearer to a 100 that a pair of values is bracketed the greater is their similarity. On the other hand the nearer to 0 the more dissimilar they are found to be. (http:/history.wise.edu/archdeacon/404tja/diss.html). These indices are also employed as "locational indices in comparing the distribution of two different categories of persons or things" (http://www. latech.edu/tech/liberal-arts/geography/courses/440/44exer4.html, p1). A list of dissimilarity measures is to be found in the web site entitled Bray-Curtis Index presented as a dissimilarity measure (http://biover.bio.ub.es/vegana/resources/help/ginkgo/DataOperations.html) with the for distances between quantitative data. The index is ideal as it performs well in situations where there are a low number of categories, as in the case of this thesis where 16 land use categories and 16 segments were being analysed.

In these cases use of the data collected is made and attempts to examine the relationships of the variables made develops into a series of dendograms. As most methods in spatial statistics, the index was utilised by biologists to examine similarities between different categories. In fact, ~~Skokal~~ and Rolf (1975, 1995) present Sokal two substantial volumes on statistics for biologists and although the Bray-Curtis index does not feature in the volumes other similar methods are presented in the texts that give similar results. The Index employed here was in fact suggested to the author by a biologist. As a practical example the index for land uses using Figure 8.17 presents land uses a and d as the most similar with a similarity of index of 62 per cent. These are followed by land use p where the similarity between it and an amalgamation of a and d shows a similarity of 58 per cent. This procedure was repeated for 15 steps taking each land use category in turn and working the similarity between it and an amalgamation of all the previous land uses. The procedure is applied in the same way for the segments.

Correlation among land uses is shown in Figure 8.17 and Table 8.3 and correlation between Segments is shown in Figure 8.18 and Table 8.4. These are presented in the following pages. In the correlation between land uses three groups of clusters are shown (Table 8.3): Cluster A, encompassing the "urban" land uses, Cluster B, made up of mainly "rural " land uses whilst Cluster C groups the extractive and industrial areas. The correlation between land uses in Cluster C and the remaining land uses (Clusters A and B) is very low. Details to the three groups of land uses are as follows:

Cluster A: recreational areas (a), marine servicing areas (b), residential areas (c), public utilities (d), historic sites (e), afforested areas (i), depositional environments (h), low sloping rock (m), dilapidated areas (p).

Cluster B: arable land (j), abandoned agricultural land (k), cliffs (n), and scree slopes (o); shore platforms (l); and

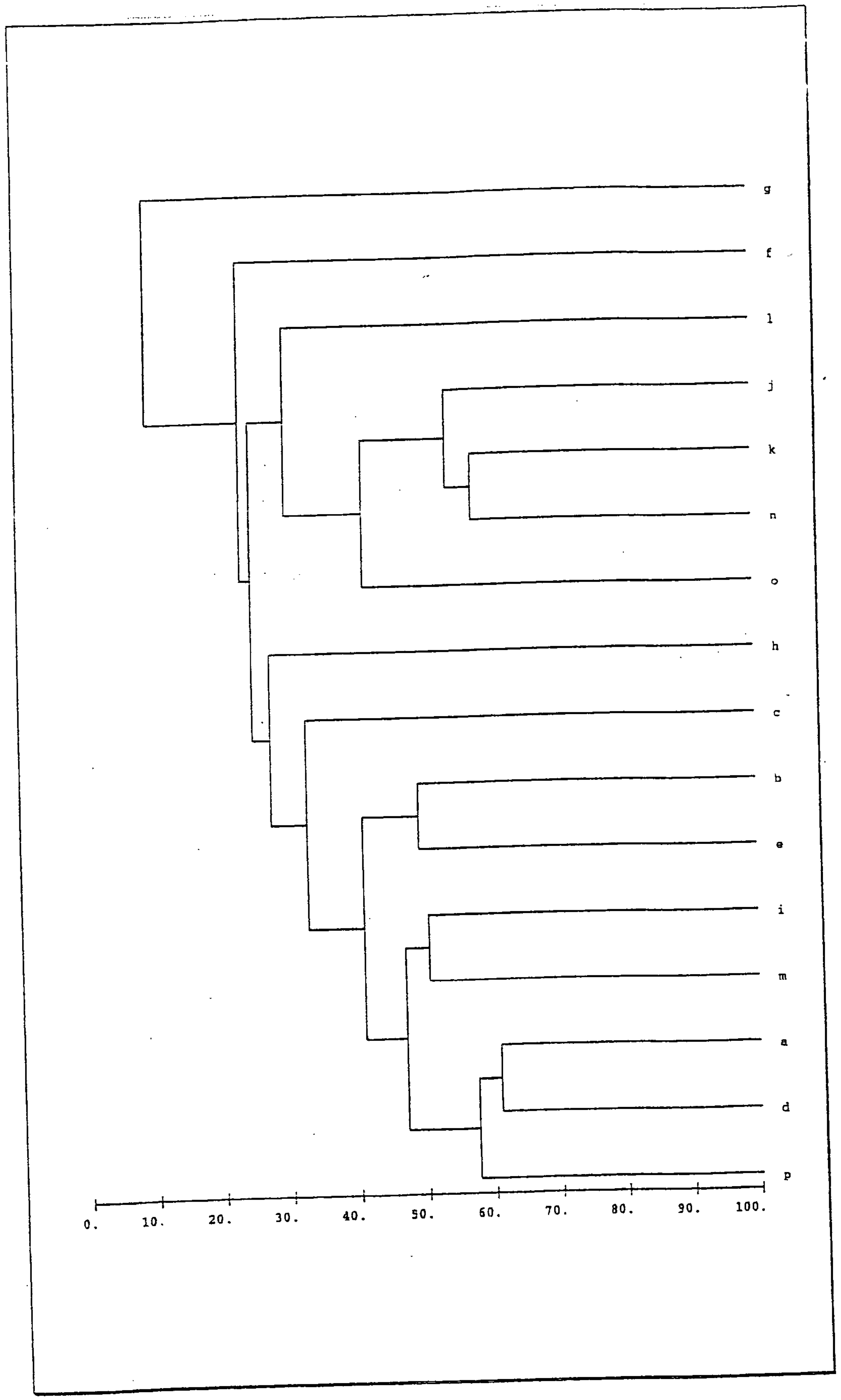
Cluster C: industry (g), extractive industry (f)

As Cluster A has the largest number of land uses it is felt appropriate to deal with this cluster further and propose that it can be subdivided into four groups of land uses:

- a, d, and p (recreational areas, public utilities and dilapidated areas) essentially land uses associated with the urban environment;
- b, e and c (marine servicing areas, historical areas and residential areas) land uses associated with the accessible urban coastal areas; and
- i and m (afforested areas and low sloping rock) essentially land uses associated with the rural and accessible areas but also located in the urban areas; and
- h (depositional environments) found in both urban and rural areas.

Cluster B groups the rural land uses: arable land (j), abandoned agricultural land (k) cliffs (n) and scree slopes (o), and these cluster together denoting a high degree of compatibility. They also provide the best aesthetic coastal areas. Shore platforms (l) are a type of land use that can be considered to fall within the rural category however their correlation index is nearer to Cluster C. Shore platforms provide the most accessible part of the coastline and, in general, are located in areas where the rock type is the Globigerina Limestone formation. In addition, most of the marine servicing industries are located in these areas and are generally found in coastal embayed areas on the south and east of the Malta coastline. In the rectilinear areas where Globigerina Limestone shore platforms are present and exposure to a heavier sea swell than in the embayed areas is prevalent, salt panning is found. This is classified with the extractive industries, within the land use classification system developed for the purposes of this thesis, and this also partly accounts for the shore platforms (l) to correlate at a value nearer the industrial land uses (g) and extractive industries (f).

Figure 8.17 Bray-Curtis Similarity Index for the coastal land uses



Key to land uses

a recreational areas

b marine servicing areas

c residential areas

d public utilities

e historic sites

f industrial areas

g extractive industries

h depositional environments

i afforested areas

j arable land

k abandoned arable land

l shore platforms

m low sloping rock

n cliffs

o scree slopes

p dilapidated areas

Table 8.3 Interpretation of Figure 8.17: similarity between land uses based on percentage values

Land use symbol*	Similarity between land uses: per cent	Cluster
a-d	62	
p-(a-d)	58	
i-m	50	
b-e	47	A
(b-e)-{(i-m) + [(a-d)+p]}	40	
c-{(b-e)+(i-m)+[(a-d)+p]}	30	
h- {c(b-e)+(i-m)+[(a-d-p]}	25	
n-k	55	
j -(n-k)	50	
o-{(n-k)+j}	40	B
l-{o(n-k)+j}	30	
f-(Cluster A)+ (Cluster B)	20	C
g-{f-(Cluster A)+ (Cluster B)}	10	

Source: developed by author from Figure 8.18
- denotes linkage
( ) denotes a pair of land uses
[ ] denotes grouping between three land uses: a pair plus one land use category
{ } denotes a group of more than two land uses
+ denotes amalgamation of pairs or groups of three or more land uses

*Key to land uses
a - recreational areas; b - marine servicing areas; c - residential areas;
d - public utilities; e - historic sites; f - extractive industries
g - industrial areas; h - depositional environments; i - afforested areas;
j - arable land; k - abandoned arable land; l - shore platforms;
m - low sloping rock; n - cliffs;
o - scree slopes; p - dilapidated areas.

Figure 8.18 Bray-Curtis Similarity Index for the coastal segments

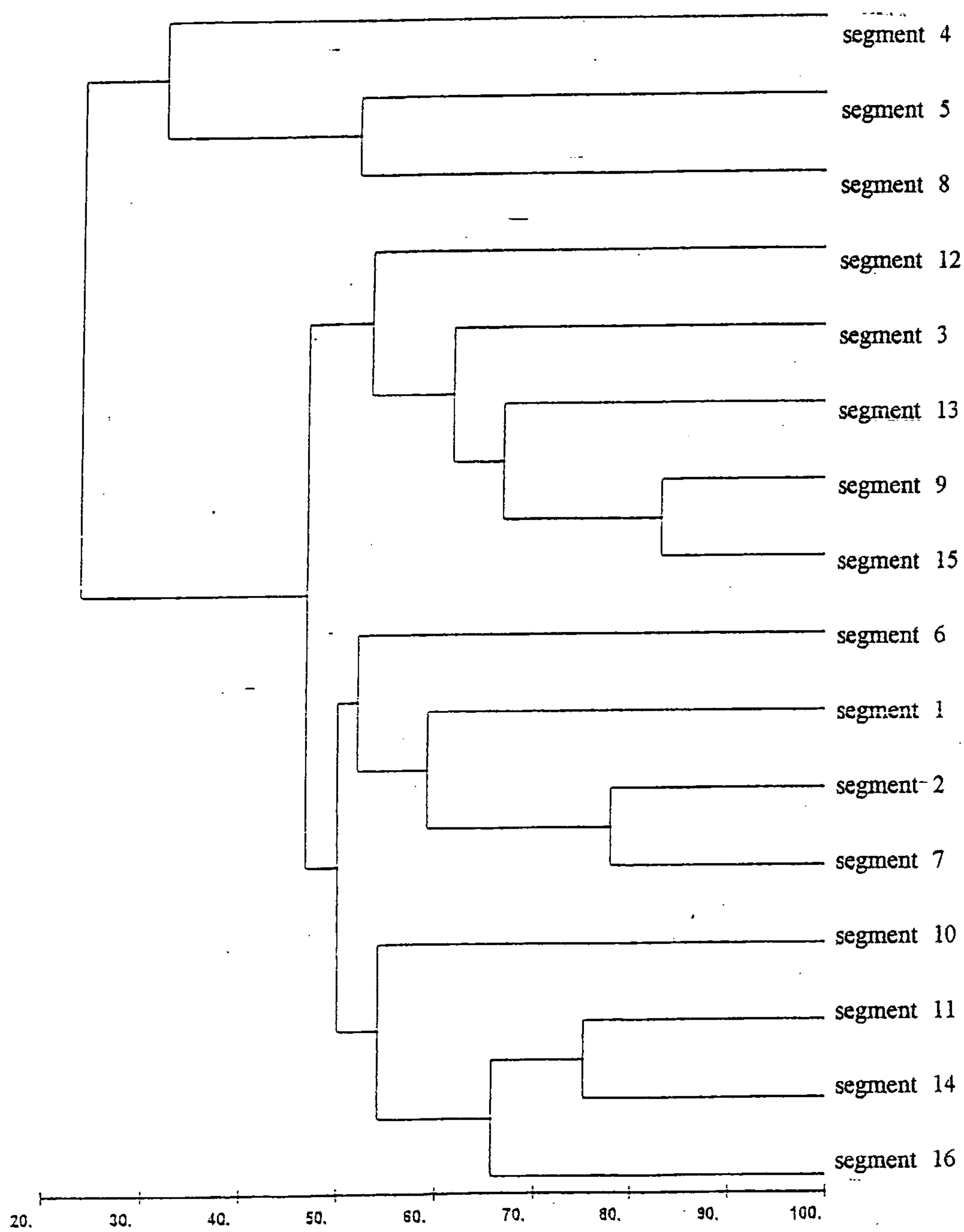


Table 8.4 shows the tabular interpretation of the correlation pertaining to the Segments. Four groups are identified with Clusters 1 and 3 grouping at the higher values, these can be classified as the "rural" segments whilst Cluster 4 is identified with the industrial and urban category of segments. Cluster 2 comprises the segments that fall within the rural/urban category.

Table 8.4 Interpretation of Figure 8.18: similarity between segments based on percentage values

Segment No.	Similarity between segments: per cent	Cluster
XI-XIV	75	
XVI-(XI-XIV)	66	1
VII-II	77	
I-(VII-II)	58	2
VI-[I-(VII-II)]	52	
IX- XV	82	
XIII- (IX-XV)	67	
III-[XIII-(IX-XV)]	61	3
XII-{III-[XIII-(IX-XV)]}	54	
V-VIII	52	4
IV-(V-VIII)	33	

Source: developed by author from Figure 8.19
Key:
- denotes linkage
( ) denotes a pair of segments
[ ] denotes grouping between three segments: a pair plus one segment
{ } denotes a group of more than two segments
+ denotes amalgamation of pairs or groups of three or more land uses

Figure 8.18 further shows that Clusters 1 and 2 are similar at the 50 per cent level, Cluster 3 is 48 per cent similar to the combination of Clusters 1 and 2, and Cluster 4 is only 24 per cent similar to Clusters 1, 2, and 3. This shows that the Segments that exhibit intensive urban/industrial land uses are highly dissimilar to the remaining segments.

Throughout this thesis the broad subdivision of the coastal zone was one between urban and rural land uses and was also a major distinguishing feature. Table 8.5 combines the Segments, the 'main land use type' column and in the third column geomorphology of the group of segments based on the shape of the coast as represented on maps is provided. The synoptic result gives the main character of the particular segments and the end result shows that in deep embayed harbours the major urban and industrial developments have taken place. The identification of coastal areas that have similar properties is very important as it enables planners and managers to rationalize on policies.

Table 8.5 Clustering of segments with main land uses and physical properties

Segments	**Main land use type**	**Geomorphology**
IV V VIII	Urban, industrial	Deeply Embayed harbours
XII III XIII IX XV	Rural	Rectilinear coastline
VI I II VII	rural/urban	Embayed coastline
X XI XIV XVI	Rural	Embayed

Source: compiled by author

Table 8.6 establishes an index whereby the number of actual land uses in a coastal segment was divided by the maximum number of possible land uses (i.e. 16). A high index value suggests a high number of land uses and therefore offers the possibility of a high level of land use conflict. In addition, this Table relates the general geomorphological property of a segment with regards to whether its general features provide a rectlinear or embayed coast, and also denotes whether a coastal segment has a generally accessible or inaccessible coastline.

In general, it is the accessible areas that exhibit a varied land use pattern, and, as a result, more land use conflicts are found in the accessible than in the inaccessible areas, with the Segments where there are both the accessible and the embayed features present having even more land use conflict than those segments where inaccessible and rectilinear areas feature.

Table 8.6 Coastal Segments: land use index, type and accessibility of coast.

Segment	Number of land uses	Number of land uses not represented	INDEX	Rectilinear coastline	Embayed coastline	Accessible coastline	Inaccessible coastline
I	11	5	0.69	*		*	
II	15	1	0.94		*	*	
III	13	3	0.81	*		*	
IV	12	4	0.75		*	*	
V	13	3	0.81		*	*	
VI	11	5	0.69	*		*	
VII	15	1	0.94	*		*	
VIII	14	2	0.88		*	*	
IX	12	4	0.75	*		*	
X	9	7	0.56	*			*
XI	14	2	0.88		*		*
XII	7	9	0.43	*			*
XIII	7	9	0.43	*			*
XIV	14	2	0.88		*	*	
XV	14	2	0.88		*	*	
XVI	8	8	0.50	*			*

Source: Compiled by author from land use data and coastal surveying

* indicates presence of feature

8.4.1 Coastal geomorphology as a component in land use conflict

Land use conflict is intense where most of these land uses occur over a small area such as in coastal urban areas where residential areas and marine recreational areas occur near one another. In the rural areas, it is the extractive industries, especially quarrying, that cause the most land use conflict. Dilapidated areas cause conflict in both the rural and the urban areas. Table 8.7 lists the land uses that cause conflict in all segments. The prevailing pattern shows that Segments I-IX, that make up most of the coast of Malta with the exception of the stretch along the west coast from Wied iz-Zurrieq to Cirkewwa, exhibit land use conflicts, at least at the scale presented by the level of the segments.

The analysis is taken a stage further by introducing three additional elements. The first is the selection of the segments where land use conflict is prevalent by placing the urban land uses in a hierarchy of 'land use conflicts' (Table 8.7). The second is the subdivision of these segments into their component localities (Table 8.8) and thirdly, the distribution of the main geomorphological shoreline characteristics that appertain to each part of the coast are provided (Table 8.7). These tables are being proposed in order to identify with more precision the areas within the segments that are responsible for the prevailing land use distribution, and also to try and narrow down the areas within the segments that are in general responsible for land use conflict. Table 8.5 shows that segments II-VIII are the parts of the coast where most land use conflicts occur. This is because dilapidated areas and industrial areas are present in all of them.

Table 8.7 Coastal Segments I-XVI: conflicting land uses

Segment	Industrial areas (g)	Dilapidated areas (p)	Tourism (a)	Marine recreational areas (b)	Residential areas (c)	Public utilities (d)	Historial sites (e)
I			*	*		*	*
II		*	*	*	*	*	
III		*	*	*	*	*	*
IV		*	*	*	*	*	*
V	*	*	*	*	*	*	*
VI		*	*				
VII		*	*	*	*	*	*
VIII	*	*	*	*	*	*	*
IX		*	*	*	*		
X							
XI							
XIII							
XIV		*	*	*	*	*	*
XV							
XVI							

Source: Compiled by author from land use data

Table 8.6 gives the predominant land use categories (urban, rural and industrial) present in particular segments. The subdivisions within the segments are based on the coastal areas that, in general, exhibit overall uniform geomorphological features, notably embayed or rectilinear features within the segment. In general the table shows that in embayed areas, such as harbours and bays, the urban and industrial land uses are represented with higher values and, as a result, the chances for land use conflict are greater. This is seen especially in segments IV, V and VIII. In Table 8.9 Segments II, VII and VIII have been selected for this test for a number of reasons. Segment II incorporates both rural and urban coastal areas and, as a result, a high degree of differentiation is evident along its littoral. It includes the bays on the north-east coast of Malta. Segment VIII, which includes the whole of Marsaxlokk Bay, has a varied land use base with industrial, urban and rural land uses incorporated into it. Segment VII has a land use set-up part of which includes Marsascala Bay with its urban element and another part which is predominantly both rectilinear for a long stretch of coast, and exhibits overall rural characteristics. The reason for proposing this Table with this particular classification is that, as seen through an examination of the coastal segments, land use conflict occurs mainly in areas where there is a high degree of accessibility, thus, identifying these areas with a greater precision is possible and at a level smaller in size than that given by the data for the coastal segments. In addition, the land use data is reduced to give selected categories only and thus simplify the analysis. The Table shows two main subdivisions: (a) the shoreline geomorphology as measured from the 1:2500 scale sheets, (cf. Chapter 5) and (b) the land uses present as estimated from the field data. The data for each land use and geomorphological variable for each selected locality is presented as two separate percentage values; one representing land uses, the other representing geomorphological variables. Only data for three Segments (II,VII and VIII), those for embayed localities having different overall land use characteristics and also where the change in coastal character is clearly apparent along the littoral of the respective segments, has been presented for the purpose of this exercise. Segment II shows in detail the localities that constitute St. Paul's Bay, namely, the Mistra area, Pwales, Bugibba, and Qawra. Segment VII gives the details for the five sections in Segment VII, namely, two areas along the Marsascala seafront, St. Thomas's Bay, and two areas where development has not yet occurred: the Tumbrell Point area and part of the Delimara peninsula. In general it is the coastal units where concrete platforms and land reclamation have been developed that are the areas where major land use conflicts occur.

Table 8.8 Percentage distribution of land uses in selected areas in all segments in Malta

	Residential and recreational areas (a-e)	Industrial areas (f,g)	Afforested areas and sand (h, i)	Arable land (j,k)	Undeveloped areas (l-o)	Dilapidated areas (p)
	Urban areas		Rural/Urban	Rural areas		*
Segment I						
All segment	21.3	0	3.8	25.5	42.6	6.8
Segment II						
Mellieha	11.3	1.5	10	32.5	38.8	5.9
St. Paul's Bay	43.5	0	9.5	18.4	25.9	2.7
Salina Bay	28.9	13	7.3	4.9	32.1	13.8
Segment III						
Coast Road	7.1	0	7.8	3.2	78.3	3.6
Pembroke	46.1	0.6	2.6	8.8	30.2	11.7
Segment IV						
St. George's Bay	57.3	0	0	0	32.4	10.3
ST. Julian's Bay	71.8	0	4.9	0	16.8	6.5
Tower Road	31.4	23.8	0	0	24.2	20.6
Segment V						
Marsamxett	75.6	0.8	7.7	0	4.8	11.1
Grand Harbour	24.6	66	1.3	4.2	1.1	2.8
Segment VI						
Xghajra	12.8	16.2	0.4	14.5	45.8	10.3
Rest of segment	0	9.5	0	36.8	21.7	32.0
Segment VII						
Marsascala Bay	59.6	3.3	3.3	6.6	15	12.7
Rest of segment to Delimara	4.6	5.6	17.3	25.8	46.7	0
Segment VIII						
Marsaxlokk	32.9	1.6	21.1	27.2	11.5	5.7
Birzebbugia	14.9	49.3	5.6	40.4	4	15.8
Segment IX						
Benghisa Point to Wied iz-Zurrieq	39	9	3.1	10.5	36.5	1.6
Rest of segment	4	6.1	1.6	75	13.3	0
Segment X						
All segment	0.1	0	2.9	61.9	35	0.1
Segment XI						
All segment	4.2	0.1	4.5	11.5	78.2	1.5

Source: Compiled from Appendix 1

* Dilapidated areas are mainly found in urban areas although some rural areas possess their fair share

Table 8.9: Distribution of selected coastal geomorphological properties and coastal land uses for selected segments and localities

Segment and O.S. sheet	Sand	Scree slopes	Low rock	Steep rock	Cliff	Reclaimed land	Urban land uses (a-e)	Industrial Land uses (f & g)	Afforestation and unconsolidated material (h, i)	Arable land (j,k)	Unde-veloped areas	Dilapid-ated areas
Segment II												
4479	6.4	38.2	39.5	10.6	0	5.3	48.3	0	14.4	0	34.4	2.9
4478	4.9	13.9	32.8	11.9	1.6	34.8	51.3	0	22.3	24.8	1.4	0.2
4678	0	0	30.2	11.3	0	58.5	54.9	0	4.3	39.8	1.0	0
4679	0	0	91.3	8.7	0	0	83.7	0	4.9	0	10.0	1.4
Segment VII												
6069	4.4	0	61.4	5.7	0	28.5	83.8	2.5	5.0	5.8	1.5	1.4
6068	2.2	0	76.6	17.4	0	3.8	64.4	10.0	2.5	17.4	3.3	2.4
6067	7	0	47.1	23.8	22.1	0	3.8	0	0	91.3	3.7	1.2
6066	0	0	31.1	7.3	61.6	0	19.2	11.6	0	57.8	11.4	0
6065/64	0	0	77.2	7	15.8	0	0	8.7	55.9	25.7	9.4	0.1
Segment VIII												
6065	0	7.9	78	11.2	2.8	0	59.5	0	0	38.8	1.7	0
5865	0	0	0	5	0	95	82.4	0	0	16.3	1.3	0
5866	0	0	32.2	2.3	0	65.5	56.4	13.6	0	26.3	2.1	1.6
5865	0	0	49.5	15.5	0	5	35.0	0	3.0	61.0	1.0	0
5865	0	0	60.7	31	0	8.3	42.4	5.4	9.0	41.6	1.2	0.4
5665	0	0	46.3	0	0	53.7	42.5	45.0	6.5	0	0	6.0
5664/5864	3.7	0	59.3	0	0	36.9	34.5	10.7	20.0	30.3	2.6	1.9
5863	0	0	74.7	14.7	0	10.5	9.0	43.9	0	35.8	0	11.2

Source: Compiled by author from cartometric measurements

In Tables 8.7 and 8.8 a number of similarities are apparent. The percentage values for the land uses a-e, that in large part make up the urban area, are high in both Tables, where Pwales, Bugibba, and Qawra (O.S. 4479 and 4478) are shown in Segment II and Marsascala (O.S. 6069 and 6068) is shown in Segment VII. Similarly, the same localities show correspondingly high values for low rock and reclaimed land in the part of the Table dealing with geomorphological properties. The southern part of the outer extremity of Marsaxlokk Bay (Segment V), where the Container terminal is located (O.S. 5865), shows a 100 per cent reclaimed zone. The area has been protected from strong sea currents and turned into an all weather area and this has encouraged development. Prior to the construction of the Terminal, 90 per cent of the area was accessible over a low sloping rock face. The exposed nature of the area, located at outer extremity of the Bay, did not encourage development save for a seaplane base constructed by the British in the 1920's and this was only made possible with the construction of a small jetty and breakwater at Kalafrana (Segment V). It was only after the construction of civil engineering works that development of such an area proceeds. In addition, most of the littoral of Marsaxlokk Bay is highly accessible and very little coastal engineering modifications were ever made prior to the 1960's. The historical development of the coastal area of the Bay indicates that the inner recesses were the first parts to be urbanized and industrialized with the provision of oil storage facilities. These areas provided the safest mooring parts of the whole Bay. It was only in the later years of the twentieth century, with the construction of shore protection works, that development could take place in the outer reaches of the Bay.

Another facet that provides evidence for the onset of development is in areas where sandy beaches occur with the presence of unconsolidated material. In addition, these are found in the inner recesses of bays and form part of the accessible areas of the coastal environment. For segments *VII and VIII O.S. sheets 6069 and 6068 for* Marsascala (Segment VII), and O.S. sheet 5865 for the sandy bay at Birzebbugia (Segment VIII), the urban land uses have high values indicating substantial amount development near areas having unconsolidated material.

8.5 Conclusion

The above discussion focused around the fact that it is the degree of access to a shoreline that largely determines the intensity of development along a coast. Access, conditioned by natural factors such as a low sloping rock profile or shore platform, was the primary factor that influenced the urbanization and industrialization of coastal areas. Generally these occurred in the inner recesses of bays and inlets. However, with the use of techniques that helped the construction of civil engineering works such as breakwaters and jetties, development in areas where normally adverse marine conditions prevail or access from land difficult. Two cases in point are the development of the Hilton site at St Julian's bay where the rectilinear coastline was modified into a sinuously embayed feature to accommodate a sheltered yacht marina and the construction of a coastal road along the cliff perimeter of part of Delimara together with the removal of part of the backing cliff to accommodate the Power Station.

Table 8.10 Percentage distribution of selected categories in asssessing coastal accessibility indices

Segment	Land uses a-m	Accessible shoreline	Index of Coastal/ Circumnavigable length
I	54.2	81.2	1:4.20
II	63.7	68.5	1:3.66
III	64.4	99.3	1:1.29
IV	95.3	97.8	1:2.41
V	100	100	1:24.38
VI	64.8	85.2	1:1.11
VII	76.5	65.3	1:2.47
VIII	92.2	85.9	1:6.75
IX	31.6	24.4	1:1.28
X	12.1	6	1:2.51
XI	13.2	28	1:2.25
XII	21.7	62	1:1.07
XIII	51.2	17.3	1:1.30
XIV	32	51.1	1:1.25
XV	25.2	35.3	1:1.67
XVI	33.5	28.8	1:1.93

Sources: Adapted from Table 8.2

Table 8.10 was compiled specifically to show the influence of accessibility on coastal land use for the separate segments. The Table is divided into three columns. The first column shows the land uses normally associated with high accessibility, such as the urban and industrial land uses (a-g), the land uses denoting areas with unconsolidated material (i) and the areas where shore platforms and a low sloping rock profile prevails (l and m). These figures represent the percentage value of the land uses (a-m) as a percentage of the land uses in each segment, in segment I these occupy 54.2 per cent. The second column gives the percentage values for the accessible parts of the shoreline as a percentage value for each segment based on the coastal geomorphology of the area. This includes the total length of shoreline in each segment where the lengths of shoreline occupied by shore platforms, low sloping rock and unconsolidated material are added up together. Thus the 81.2 per cent of the coast in segment I is accessible coastline. The third column presents the degree of indentation of the coastal segment (cf. Table 8.2). A degree of consistency is apparent in the values given: segments where a high degree of natural access is evident (column 2) and possess embayed features (cf Table 8.4) with a strong urban/industrial development have land uses associated with good access. The opposite is true for segments having a rectilinear coastline and possess overall "rural" land uses The Segments are essentially grouped into two sets, the "urban" segments in one group and the "rural" segments in another. The third column in Table 8.10 shows that segments can be grouped into three categories. Those having a definitely urban /industrial character segments IV, V and VIII with a high index value (column 3), embayed features and accessible shoreline. In the second category there are those segments that have a 50-70 per cent range for urban land uses together with high values for the accessible shoreline and a high index. These include segments I, II, III and VII. The rural land uses dominate the remaining segments irrespective of whether they possess embayed or rectilinear features or have an accessible coastline. It is probably their distance from the urban/industrial hub of Malta that led them to have such properties.

It may therefore be proposed that the areas where development will in the future be earmarked are those areas where the conditions explained in Table 8.8 and Figures 8.1-8.16 prevail. Thus the areas within the already highly accessible harbours in Malta could be the likely sites. A good example is the development of Manoel Island located in Marsamxett Harbour (Segment V). In addition, areas whose accessibility could be enhanced such as at the Power Station site (Segment VIII) at Delimara and areas where civil engineering works can transform a rectilinear shoreline into a highly indented one, such as the Hilton site, and the Cirkewwa-Gozo Ferry Terminal (Segment I), will constitute zones where development is possible. In fact, given the facilities and technology that are available to achieve any type of construction, excavation and engineering works in relatively short time-spans, and thus overcoming any physical problems associated with access, any area can be a potential zone for development. It is therefore the element of legislation and enforcement that can assist in the rational development of the local coastal zone. This issue will form part of the concluding chapter.

Chapter 9 - Conclusion

9.1 Introduction

The coastal zone is very important for the Maltese Islands. In the first instance, most of the population lives around the harbour conurbation as the traditional location of the marine servicing industries. The administrative fulcrum of the country at Valletta and the older core of the tourist industry are located around Grand Harbour and Marsamxett Harbour. Some of the newer residential and recreational developments are also occurring along the coast with the localities of Birzebbugia, Marsaxlokk and Marsascala in the south, Pembroke, St. Julian's and Paceville in the north east and Salina Bay, St. Paul's Bay, Bugibba and Qawra in the north being prominent. Gozo too attracts its fair share of attention. Thirdly, the fast pace of economic development has been geared towards marine services, ship repair, the container industry and coastal tourism with the building of hotels and restaurants. Fourthly the development of second homes along the coast has seen the proliferation of new building blocks of flats to accommodate summer residents and tourists. Since the establishment of the Structure Plan for the Maltese Islands there have been tangible efforts to control the haphazard development in most spheres and along the coast. These efforts can be monitored through the publication of the Local Plans and Area Plans. In addition, the introduction of Local Councils in 1992 is today providing tangible evidence in a number of spheres among which are the infrastructure changes along most coastal localities with the embellishment and upkeep of promenades, playing fields and the overall maintenance of the area.

The problems of over-development of the coast of the Maltese Islands have been identified through the last four decades via four sources. *Din l-Art Helwa* (Agius Muscat, 1968) was the first with the publication of the Conference Proceedings held in Malta. The other three major instances were the 1989 survey and the reports and the 1998 survey conducted especially for this thesis. A 2003 assessment was done by the author to check on the extent to which the various coastal management proposals by MEPA were actually done.

Allied to the problems of over development, or the indirect result of it, are the problems generated due to the small size of the islands. In all probability the high indices related to population density, and the indices developed for this thesis such as the area of land per kilometre of coast, are the indirect result of the small size of the islands. However, this adverse situation is partially balanced out by the additions to the coastal serviceable length through the construction of jetties, breakwaters, and yacht marina pontoons. These engineering constructions normally mark out areas of intensive land use such as ports, harbours and bays and also coincide with areas of intensive land and hinterland development. As a result, these areas provide a greater marine serviceable area for each unit length of coast. The sites at the Cirkewwa Gozo Ferry Terminal, the Cottonera Waterfront Project, Manoel Island and Tigne Point development and the Hilton Project and the yacht marinas are cases in point.

9.2 The frameworks

The thesis can be placed within a number of frameworks: a temporal, a spatial, a planning and management frame, and finally within a location and future development framework. The first, the temporal, is dealt with in Chapter 4, where a brief history of the land use changes spanning the Colonial influence and the post-1964 Independence period is given. The latter were mainly a result of the changes experienced when Malta relinquished its socio-economic dependence upon military bases, a 400-year legacy that stretched to the occupation of Malta by the Knights of St. John and the British, and strengthened its manufacturing industry and focused on tourism as a foreign exchange earner.

The second, a spatial frame, is probably the most important and is dealt with in Chapters 6, 7 and 8 where the distribution of the coastal land uses is examined. In ~~Chapters~~ Chapter 6 the discussion was first based on identifying the coastal "urban" and the coastal "rural" areas, then the focus was on a systematic analysis of the sixteen land uses. In Chapter 7 a regional approach was used and each segment was examined as separate entity. In Chapter 8 a series of histograms and cartometric measurements formed the basis of the discussion. The histograms provided a pictorial comparative assessment of the distribution of the different land uses in each segment whilst the data developed from the cartometric measurements shows the properties of the Maltese coast in a different light from the traditional approach of just emphasizing coastal length. In fact, the data estimated for the geology and the geomorphology of the coast helped to identify the influence that these physical features had on coastal land use. Further details are provided in Chapter 8, these pertain to the coastal physical features that were used to identify the contribution of the geomorphological properties to parts of the coast within selected coastal segments. The exercise showed the relationship of physical features to the areas of development. In addition, factors such as shoreline length and the relationship of these with the coastal zone area produced two indices (Table 8.2: Ratio of circumnavigable length to coastal length; Table 8.6 number of land uses divided by the maximum number of land uses i.e. 16) that indicate that the higher the indentation ratiofor the coast the higher is the land use conflict and therefore sites for future development lie in the coastal areas where few land uses occur.

The management framework can be divided into three time frames. The first is the Colonial phase (up to ca 1945). In this phase the needs of the political occupier of the islands determined the type of modification to the coastal character. This was done for three purposes: for defence from military attack (e.g. fortresses and watch towers); for defence against sea storms in inclement weather conditions by engineering constructions (e.g. breakwaters); and for the enhancement of coastal facilities for all types of sea craft (e.g. pontoons, slipways). The second time frame consisted of the attempts at coordinating resource use through the commissioning of a number of reports by non-Maltese experts with coastal issues only indirectly (1945-1989; Table 4.2) involved. This theme is developed in Chapter 4. A third time-frame (post-1992) occurred with the establishment of the Planning Authority, which was later merged with the Environment Protection Department to form the MEPA in 2002. This political decision showed the importance that environmental protection has on planning and development.

The final framework concerns location and development. If there is one singular thread that runs throughout these frames, it could be concerned with location. The areas that attracted attention for development are the highly accessible coastal areas. In fact, the series of maps developed for this thesis and found mainly in Chapters 2 and 6, and Tables 5.3, 7.1, 8.2 and 8.6 with their associated commentaries highlight the fact that accessibility, sinuosity of the coast (possessing embayed or rectilinear features) and coastal engineering works are the three main elements that determine the extent to which a coastal area is prone to development.

As with all matters dealing with environmental issues, it is the physical/human interaction that is of central importance. The method proposed (Chapter 5) and used in this thesis is a simple one: mapping the whole coastal zone area by using a key composed of sixteen land uses, measuring the area of coverage of each land use, reducing this data to manageable proportions, and, presenting the results in synoptic formats as done in Chapters 6 and 8 and detailed in Appendix 1. The main outcome of this is that scientists on the one hand and other interest groups on the other, can examine in mutually intelligible and mathematical representation, the viability of the state of, or the changes made to, a coastal zone. In addition, the mutual influences and impacts that can occur between the physical and human parameters are also considered. Thus a management framework can be established to safeguard against excessive development of a particular area using the method proposed in this thesis: the 16-key mapping method, the combination of the results into a matrix format and subsequent analysis, could be a standard procedure by which a base-line study for a coastal management framework can be proposed.

9.3 Spatial subdivisions

The description and analysis followed in this thesis marked out two sets of major regional subdivisions: a north-south one based on the position of the Great Fault and an east-west one based on the different coastal land uses located on either side of Malta's littoral.

The first set is based on the limits set by the Great Fault (Victoria Lines), with human influence largely determined by physical boundaries. In the area to the north of the Great Fault, the geological stratification has produced the surface exposure of four of the five main local rock types, giving a varied geology (cf. Figure 2.2). In the southern area the largely predominant Globigerina formation is practically the only stratum exposed at the surface. The predominant geomorphological property of the north is the undulating landscape. This was brought about as a result of the high density faulting system that produced the Horst and Graben formations characterized by rugged topography and deep incised valley systems these are accompanied by lush natural vegetation and intermittent streams. In the south an undulating landscape of low relief is the main physical feature. The resultant coastal property is one where the northern areas are characterized by limited access both from the sea and from the land, whilst the south eastern areas possess a higher degree of access.

In the northern area (including Gozo) a low population density prevails and coastal development is geared principally towards tourism development. Three large bays in Malta are found here. The southern area has high population density and industrial development. The three main harbours in Malta are located in this area. The land uses that predominate in the North are the areas known for high aesthetic qualities: agriculture, undeveloped areas of rugged topography, high cliffs and scree and clay slopes. Sand beaches are also a feature of these areas. Land uses in the south are dominated by residential and industrial development. This situation has prompted the author to differentiate between the coastal areas that have a predominant "urban" and those that have a "rural" label throughout the thesis. A marked difference exists between the areas that have a good accessibility associated with the location of the southern "urban" areas. In the northern coastal areas the degree of access is limited to the sandy beach areas, unless otherwise modified by engineering structures. Effectively, in Malta, coastal segments I, II, III and XI mark out the northern areas whilst the rest mark the southern areas. This subdivision follows the general topographic pattern established in Malta with the Great Fault (Victoria Lines) separating Malta into northern and southern areas.

The second set of observations relate to the spatial division of Malta into an eastern coastal area with segments II, III, IV, V,VI, VII, and VIII and a western coastal area with segments IX, X, and XI. The segments on the east side include those segments that are generally considered to have a predominantly urban character, whilst those on the west possess more rural characteristics. In the former are located most of the harbours and bays with practically all residential, touristic and industrial development occurring along the littoral of this section. This area is marked by a high degree of access along most of its coastal length. The western area is identified by the coastal cliff and scree slope areas and a limited degree of access both from the land and from the sea. This land use situation is highly compatible with the situation for the physical environment where the indentation of the coast and the accessibility of the shore from the sea on most of the eastern seaboard have influenced land use.

9.4 The four key findings of the thesis

This study can be regarded as a baseline for future reference. Its main findings are:
The use of boundaries to establish the study matrix of the thesis is considered as the first contribution. There are three boundaries. The first the boundary that is referred to in the thesis as "the coastal zone boundary" which separates the coastal zone from its hinterland and runs almost parallel to the shoreline. Developed on the field for the 1989 Survey, confirmed through secondary literature (cf. Chapter 2), and applied for the survey used for this thesis. The identification and demarcation on the Ordnance Survey sheets of this boundary is important for three reasons. First, it is an additional contribution to the variety of coastal zone boundaries used for a number of states and regions as listed in Tables 2.9 and 2.10. Secondly, the boundary has proved its worth and the MEPA is still using this boundary as the limits for the Maltese coastal zone; therefore, a degree of comparability can be attained with future surveys. Thirdly, a number of small islands have had problems identifying their coastal zone due to the smallness of the land mass. In fact, the whole extent of the land area of some islands is considered to be the coastal zone. However, with the identifying features developed in this thesis it can be shown that small islands can actually have a coastal zone boundary of their own as much as larger territories.

Another boundary runs perpendicular to the coast and was developed for the purposes of this thesis and identifies sixteen coastal segments. These are based on selected large-scale coastal geomorphological properties and the compass orientation of the particular stretches of coast (refer to Table 5.3. The Maltese coast was thus subdivided into sixteen terrestrial parcels that helped to develop the analysis for this thesis and can be used for the practical side of coastal zone management.

The third type of boundary was again one perpendicular to the coast and subdivided each coastal segment into a number of coastal units. Using the O.S. sheets as a base the coast was divided into 136 coastal units (Appendix 1; Table 5.6) although there are some exceptions to this general rule as shown in Table 5.7.

The second key finding of this thesis is the identification of the 16 land uses that together complete the coastal zone. The development of this method evolved over a number of surveys and coastal mapping exercises spanning a decade. The contribution of the main use of this method is in the practical nature of the mapping exercise. When used in conjunction with the Ordnance Survey sheets, the mapping key affords a very quick mapping procedure. Although the actual field identification of cultural features has to be performed, the undeveloped coastal areas and areas with arable land conform greatly with the contour lines and general geomorphological features presented on the sheets thus facilitating and hastening the mapping pace. The land use classification can therefore be easily interpreted by a wide range of individuals with different levels of experience on the field following a short briefing. In addition, the key can be used on older series of Ordnance Survey sheets to identify former land use distribution, aided by means of aerial photography and old photographs, and thus examine, in greater detail than that presented in Chapter 4, the historical development of the coast. Use of the mapping key in future is guaranteed as long as the general principles of Ordnance Survey cartography are followed.

As this thesis is essentially a baseline study of the properties of the Maltese coastline the data captured through simple cartometric methods is the third key contribution. As explained in Chapter 5 this thesis is an exercise in cartometry as much as it is on coastal land use. This thesis provides new data for the coast of the Maltese Islands. These include the physical length of the shoreline, the circumnavigable length, the percentage distribution of the types of rock (geology) and features (geomorphology), that are found on the coast, all presented synoptically in Chapter 2, in addition to the land use data utilized in Chapters 6 and 7. The contribution of these cartometric results to this thesis can be considered from two aspects. The first is that the method is very simple to use and apply and no expensive equipment is involved. Another theme that emerged during the cartometric exercises was that the length of coast varied with the scale of the maps used and the width of the dividers used in taking the measurements. In addition to the arguments, examples and data presented in Chapters 2 and 5, this issue is of great importance for planning and management purposes in that precise quantification of the littoral length should be the basic property on which all else follows. First, because the actual length of the coast as estimated must invariably be accompanied with the scale of map and the instrument used. Secondly a culture in this regard should be initiated in that all linear coastal data presented anywhere should at least conform to this criterion following on the seminal work of Galloway and Bahr (1979) and Mandebrot (1967). Thirdly, comparative coastal lengths between different regions can only be done properly if this criterion is applied throughout.

This data is needed by MEPA for a number of reasons first because the coastal land uses have never been quantified before, secondly, as presented in this thesis, the data is given at a number of regional scales, and at increasing levels of detail. The sequence that follows shows the scales at increasing levels of detail: the Maltese Islands, the three separate islands of Malta, Gozo and Comino, each of the 16 segments and each of the 136 coastal units as presented in Appendix 1. The data given refers to a snapshot of the coastal land uses of the Maltese Islands as examined in 1998. Therefore using the same coastal zone boundary and the same units of measurements one can develop a sequence of the changes to those that occurred along the coast. It is also possible, after identifying the changes that occurred in the past, to propose retrospectively the pattern of changes that occurred over the previous decades. The mapping key that was developed and the subsequent measurements made conform also to the features presented on the Ordnance Survey sheets. The data presented for the actual length of coast is also of significance in that the actual length of functional coast and the changes made to the littoral can be monitored accurately and future changes quantified.

The third contribution is the development of the mapping key and the maps presented with this thesis. The key itself developed over a number of sessions (Section 5.12 explains the development of this process) and consists of 16 variables. Two main attributes can be associated with the key, the first is that it is adapted to map coastal areas in any environment not only in the local or the Mediterranean contexts as most features mapped are located anywhere on the coast. Secondly, the key can be modified according to the scale that needs to be used and as presented in Table 5.11 the mapping key can be used to monitor land uses at selected detail. It can accommodate three (urban, rural and rural/urban), eight (A to H) or 16 (a to p) land uses. Table 5.12 explains part of this process. The important feature of the key is that it was done with the use of the Ordnance Survey sheets in mind. This feature decreased substantially the time used for field mapping in that a number of land use categories are clearly recognizable features on the sheets themselves. These include the following: residential areas, shore platforms, low sloping rock, scree slopes and cliffs. In addition the detailed contours presented (every 2.5 m and accentuated every 10 m) suggest whether arable land is in use (widely spaced contour lines) or probably abandoned (crowded contour lines). In addition, this mapping contributes to the rapid-assessment procedure used for the coastal zone.

The actual maps presented with the thesis are also important contributors. In the first category I would place the group of synoptic maps that identify each land use category as distributed in the Maltese Islands, and shown in Chapter 6. In the second category of importance I would place the more detailed maps showing the land use distribution at selected sites. Thirdly, another map of significance (Figure 5.5) is that which identifies the 352 coastal place names. This is the first time that a map of the sort is being presented locally. Its importance lies in the fact that for planning and management purposes the identification of the precise locations is of great importance.

The fourth contribution is the method used in the analysis. The physical and human properties operating in the coastal zone have already been placed on the same scale of values by being converted into spatial entities (hectares). In this thesis, the same attributes are being analyzed using histograms and in two cases using the Bray-Curtis Similarity Index. Through this method the land uses were classified into those that are compatible with one another and those that are not. The same conditions apply for segments, with those segments that have a similar land use distribution and those that have a different distribution. In addition, two physical properties of the coast, geology and geomorphology, are placed within the context of the land use categories and spatial relationships are deduced. The overall conclusion that can be drawn is one that shows that the overall land use pattern followed in the Maltese Islands is one conditioned by the extent of coastal development.

It will be interesting in the context of Malta's membership of the EU to monitor future change. Present trends, modified in the light of changing political circumstances, may lead to on the one hand more emphasis on coastal protection for areas of outstanding natural and scientific interest. These sections of the coast may attract greater development pressure for a variety of services including heritage/marine tourism such as Vittoriosa, and from industrialization /utility development such as Marsaxlokk Bay. Gozo and Comino seem likely to witness lower levels of pressure though recent discussion of a proposed hotel/marina development for a disused quarry near Qala Point indicate towards the fact that the smaller islands may not be immune from the attention of seeing some form of tourism development especially as Malta seems to offer very few such opportunities. Stringent planning controls will need to be exercised in the smaller island if there is the political and planning will to limit such development (cf. Times [of Malta] June 30 2003).

9.4 Conclusion

Effectively the best guarantee of safeguarding the coastal environment and instilling a greater awareness towards conserving the historical, cultural and natural assets of the Maltese Islands is through a sustained educational campaign in schools and the media and the collaboration of all stakeholders concerned with the coast. The best way forward would be the involvement of the local communities. The key elements that need to be addressed for the future management options of the coastal zone in the Maltese Islands lie in two recent publications: Borg (2001) and The State of the Environment Report (2002). Essentially the first highlights identifies issues and development objectives that need to be addressed over the next 20 years in the light of the Structure Plan review Borg (2001) lists a series of proposals for the Planning Authority to follow regarding the efficient management of the coast (Appendix 8). These include guidelines for future projects, regulations for the better management of specialized recreational activities such as underwater diving and bird trapping sites, land reclamation for agriculture and the siting of aquaculture activities, the smoothing of rock surfaces by concrete, guidelines for marina development on urban waterfronts, and the need to conduct the necessary studies prior to any action. A commentary on the Structure Plan policies that affect the coastal zone is included. . It places emphasis on nine sectorial issues:

Natural resources: the control of development in ecologically sensitive sites and areas designated as scientifically important has been largely successful in Malta with legal protection given to a number of sites. However more protection is called for to Gozitan sites and the marine environment.

Cultural resources: legal protection has been provided to a wide spectrum of historical and archaeological artefacts such as megalithic temples and fortifications but underwater and marine heritage sites still need protection.

Tourism: three main areas of attention include the protection of popular tourist areas from incompatible development, ensuring access to all parts of the coast and the identification of suitable sites for off shore leisure development.

Agriculture: The abandonment of coastal agricultural land intensifies soil erosion and degrades the overall landscape scenery. Measures are called for to encourage cultivation in these areas.

Aquaculture and fisheries: Three suggestions are put forward. The relocation of fish farming cages away from the nearshore areas to offshore sites; the relocation of the fish market; and, the protection from uncompatible development in areas where the fishing fleet is moored and serviced .

Maritime activities: Site-specific proposals for Grand Harbour, Malta Freeport, Cirkewwa and Mgarr harbours were put forward with the emphasis on the need to protect their historical and natural heritage due to development. Offshore bunkering sites still need to be identified.

Mineral extraction: The restoration of coastal quarry sites should be in line with the surrounding environment.

Infastructure: this relates to the sites where fuel is stored and energy and water produced together with their associated distribution networks. Energy, desalination plants, sewage and waste disposal sites, land reclamation, roads, pipelines and cables.

Other development: the development of residential and industrial units in undeveloped coastal areas should be restricted.

Source: Borg (2001)

The State of the Environment Report is essentially environmental reporting intended to "provide a compilation and evaluation of technically valid information about the state of the environment" (The State of the Environment Report, 2002, 1). The Report provides the main components that make up the local environment, identifies areas of pressure and the response measures, assess trends and recommends measures for improvement. The coast features in a number of sections in the Report with a strong emphasis on the health and resources of the marine areas. However, in the terrestrial part of the coast comments on coastal erosion especially along the scree slope margins (Segments X, XI, XIV in this thesis), loss of material from sandy beaches and unprofessional attempts in beach reclamation were the main problems physical problems cited (Birzebbugia, Segment VIII in this thesis). With regards to coastal zone management and the overall degradation of the coastal environment the reasons given were the "interests of the various stakeholders" (p 30) and the "independent status" (p 30) of the Maltese Islands. The report suggested that the present sectoral management approach be substituted with a more organic and inclusive approach.

Land use designations will be affected with the accession of Malta into the European Union. In addition to the designations affording protection to sites and features of heritage importance, such as Areas of Ecological Importance, and Sites of Scientific Importance, Scheduled Property Sites and Nature Reserves, and to the planning designations that essentially identify areas where development is acceptable, designations governed by E U legislation will come into force. This implies that land can become eligible for specific EU grant aid (State of the Environment Report, 2002). In fact the negotiations concerning Malta's accession to the EU especially the part dealing with the environment provides for financial assistance regarding the relocation of the Liquefied Petroleum Gas Bottling Plant from at il-Qajjenza (Segment VIII) to Benghisa (Segment VIII), the Marsa Power Station (Segment V) to conform to EU standards regarding emissions, and the Maghtab rubbish dump (Segment III) will have to close down (Aggornat 144, euinfo.mic@gov.mt, 5 October 2002). In fact, land use changes in coastal areas will in future be determined by the extent of to which a particular use needs a coastal environment for its operation and also the extent of the population density surrounding that particular use (Schembri, 2002). In addition, the

MEPA follows a policy of not allowing any new coastal developments that do not belong to the coastal setting and that can be accommodated inland.

The effective management of the coastal zone continues to be a much discussed political issue. From the debate that emerged as a result of the siting of the Power Station in Delimara (Government of Malta, 1988a, b, c) to the most recent controversy that emerged with the replacement of the Maghtab dump (Section 7.18 p 306) with two temporary landfills utilizing disused quarries near to Malta's prized megalithic temples of Hagar Qim and Mnajdra (Segment X) with an engineered landfill at Ghallis (Segments II and III). The latter is at a visual distance from one of Malta's main tourist venues at Qawra (Segment II). The debate has brought in MEPA, the Local Councils that are directly affected, a number of Non-Governmental Organizations such as *Fondazzjoni Wirt Artna, Din l-Art Helwa* (concerned with historical and archaeological heritage), Nature Trust and the Malta Hotels and Restaurants Association and all the political parties. It is only once that the small size of the islands, the high population density and the broad urban spread and the pressures that these factors exert on the coast that a broad consensus can be reached regarding the problems of coastal land use with the participation of the community, local councils, stakeholders and Non-Government Organizations under one Coastal Authority.

Appendix 1: Distribution of coastal land uses

Sheet	No.		a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	total sheet
I	3882	1	2.5	0.3	0	0.8	0	0	0	0	0	0	0	0	1.9	0	0	1.4	6.9
	4082	2	5.4	0.9	0	0.9	0.3	0	0	0.1	0.1	8.8	0	0	2.5	7.1	0.6	3.1	29.6
	4083	3	5.1	0.2	0	0	0.3	0	0	1.9	0	3.8	0	0	1.3	0.3	0	0.6	13.5
	4283/4284	4	2.8	0	0	0.4	0.1	0	0	0	1.3	10.4	0	0	3.7	18.6	1.1	1	39.4
			15.8	1.4	0	2.1	0.7	0	0	2	1.4	22.8	0	0	9.4	26	1.7	6.1	
II	4282/4281	5	0	0	0	0	0	0	0	0	3.1	0	0	0	0.5	2.6	6.4	2.5	15.1
	4081	6	4.5	0	0	1	0	0	0	1.4	1.8	5	13.7	0.4	0.4	0	1.1	0	29.3
	4080	7	3.8	0	0	1.5	0	0	0	0.8	2.8	6	0	0.3	0	1.6	0	0	16.8
	4280/4281	8	4.4	0.7	0	2	0	0	0	0	0.2	0	0	5.1	0	2.4	1.1	3.3	19.2
	4480/4481	9	0	0	0	0	0	2	0	0.1	2.9	4.5	13.6	1.8	0.1	4.9	16.7	2	48.6
	4680	10	0	0	0	0	0	0	0	0	0	0	0	0	0.9	0	5.2	0	6.1
	4479	11	0.1	0.1	0	0.6	0.9	0	0	0.1	0.4	0	0	0.6	0	4.7	4.3	0.8	12.6
	4478	12	0.2	0.9	0.9	4.5	4.5	0	0	0.2	4.6	5.3	0	0.9	0.4	0	0	0.2	22.6
	4678	13	4.7	0.4	0	2.5	2.6	0	0	0	0.8	7.3	0	0.6	0.3	0	0	0	19.1
	4679	14	0.6	0	0	2.5	3.8	0	0	0	0.4	0	0	0	2.8	3.1	0	0.8	14
	4879/5029	15	1	0.2	0.8	1.2	0.3	0	0	0	0.5	0	0	1.1	2.3	2.8	0	0.5	10.7
	4878	16	0	0	0	0.9	0	0	0	0	0	0	0	0	0.5	0	0	0.7	2.1
	4678	17	0	0	0	1	0	2.3	0	0	1.8	0.5	0	0	0	0	0	3.7	9.3
	4677	18	0	0	0	0.4	0	0	0	0	0.1	1.4	0	0	0	0	0	0	1.9
	4878	19	0.3	0	0	1.4	0	3.9	0	0	0.9	0	0.7	0	0.8	4.9	0	3.9	16.8
	4879/5079	20	0	0	0	1	0	0	0	0	1.3	0	0.5	0	4.4	2.3	0	0	9.5
			19.6	2.3	1.7	20.5	12	8.2	0	2.6	21.6	30	28.5	10.8	13.4	29.3	34.8	18.4	
III	4878	21	0	0	0	0.8	0	0	0	0	0.8	0	0.5	0.9	0.4	6.3	0	1	10.7
	5078	22	0	0.1	0	1	0	0	0	0	0.2	0	0.4	1.3	1.3	3.8	0	0	8.1
	5078	23	0	0	0	0	0.1	0	0	0	1.2	0	0	2.1	0	5.9	0	0	9.3
	5077	24	3.6	0.2	0	1.5	0	0.5	0	0.1	2.1	3.6	3.9	0.1	1.2	0	0	2.3	19.1
	5277	25	7.3	0	0	0	0	0	0	0	0	0	0	3.8	0	2.4	0	0	13.5
	5276	26	24.7	0	0	1.5	0	0	0	0	0	0	0	2.6	0	13.5	0	10	52.3
	5476	27	0	0	0	0.5	0	0	0	0	0	0	0	0.5	0	1.7	0	0	2.7
			35.6	0.3	0	5.3	0.1	0.5	0	0.1	4.3	3.6	4.8	11.3	2.9	33.6	0	13.3	
IV	5476	28	1.5	0	0	0.5	0	0	0	0	0	0	0	0.5	0	1.7	0	0.7	4.9
	5276	29	0.8	0	1	0.1	0	0	0	0	0	0	0	0	0	0	0	0	1.9
	5275	30	1.3	0.3	0.5	1.3	0.8	0	0	0.1	0.1	0	0	0	0	0	0	0.9	5.3
	5476	31	2.1	0	0	0.5	0	0	0	0	0	0	0	0.9	0	0.4	0	0	3.9
	5475	32	7.2	0	1.1	0	0.1	0	0	0	1.2	0	0	0	1.8	0	0	0.3	11.7
	5474	33	0.5	0	1	0.9	0	0	0	0	0	0	0	0	0	0	0	0.1	2.5

Key to land uses

a recreational areas

b marine servicing areas

c residential areas

d public utilities

e historic sites

f industrial areas

g extractive industries

h depositional environments

i afforested areas

j arable land

k abandoned arable land

l shore platforms

m low sloping rock

n cliffs

o scree slopes

p dilapidated areas

	5475	34	4.4	0	0.4	0	0.1	0	0	0	0.1	0	0	0	2.1	0	0	0.4	7.5
	5474	35	0.1	0	1.1	1.5	0	0	0	0	0.7	0	0	0	2.5	0	0	0.3	6.2
	5673	36	0	0	0	0.5	0.1	2.5	0	0	0	0	0	1.1	0	0	0	0.1	4.3
			17.9	0.3	5.1	5.3	1.1	2.5	0	0.1	2.1	0	0	2.5	6.4	2.1	0	2.8	48.2
V	5474	37	1.2	0	0.3	0.5	0	0	0	0	0	0	0	0.2	0	0	0	0.8	3
	5474	38	1.2	1.8	0.1	1.4	0	0	0	0	0.4	0	0	0	0	0	0	0.8	5.7
	5473	39	0.9	0.6	0.5	2.6	0	0	0	0	1.8	0	0	0	0	0	0	1.1	7.5
	5473	40	2.2	3.6	0.2	1.1	2.8	0	0	0	1.4	0	0	1	0	0	0	5.1	17.4
	5472	41	1.8	1.5	0	4.5	4.2	0	0	0	1.6	0	0	0	0.3	0	0	0.4	14.3
	5473	42	0.3	0	2.5	3.8	1.5	0	0	0	0.4	0	0	0	0.3	0	0	0	8.8
	5673	43	0.4	0.4	0.5	0.7	5.7	0	0	0.1	0	0	0	1.4	0	0	0	0	9.2
	5672	44	0.3	0.9	0	0.6	0	0	0	0	0	0	0	0	0.3	0	0	0	2.1
	5472	45	1.6	1.2	0	1.1	0.5	0.6	0	0	0	0	0	0.1	0	0	0	0	5.1
	5471	46	0.8	0	0	2.6	0	0	34.6	0	0.1	0	0	0	0	0	0	0.5	38.6
	5470	47	0	0	0	1.1	0	0	0	0	0	0	0	0	0	0	0	0	1.1
	5471	48	0	0	0	0.9	0	0	0	0	0	0	0	0	0	0	0	0	0.9
	5470	49	0.3	0	0	0.1	0	0	24.1	0	0.1	0	0	0	0	0	0	0.3	24.9
	5671	50	0	0	0	1.1	0	0	7.9	0	0	0	0	0	0	0	0	0	9
	5671	51	0	0	0	1.1	0	0	8.6	0	0	0	0	0	0.3	0	0	0	10
	5672	52	0.1	0.5	0	0	0.6	0	0	0	0.1	0	0	0	0.3	0	0	0	1.6
	5671	53	0	0	0	2	3.1	0	2.8	0	0.1	0	0	0	0	0	0	0	8
	5672	54	0	0.5	0	0.7	2.8	0	0	0	0	0	0	0	0.7	0	0	0	4.7
	5672	55	0.1	0.4	0	0.7	0	0	0	0	0.2	0	0	0	0	0	0	1.1	2.5
	5672	56	0	2.1	0	0	7.9	0	1	0	0.9	5	0	0	0	0	0	2	18.9
			11.2	13.5	4.1	26.6	29.1	0.6	79	0.1	7.1	5	0	2.7	2.2	0	0	12.1	193.3
VI	5872	57	0	0	0	0	0	0	2.8	0	0	0	0	0.6	0	0	0	0	3.4
	5872	58	0.5	0	0	0	0	0	0.6	0	0	0	0	0.9	0	2.4	0	4.6	9
	5871	59	1.7	0	0	0.8	0	0.4	0	0	0.1	0.8	2.6	0	1.4	0	0	3.2	11
	6071	60	0	0	0	0	0	0	0	0	0	0	0.8	0.2	0	0.4	0	0.1	1.5
	6070	61	0	0	0	0	0	0	0	0	0	0	4.2	1.3	0	4.3	0	0	9.8
	6069	62	0	0	0	0	0	1.4	0	0	0	0.4	0	0	0.3	0	0	1.3	3.4
			2.2	0	0	0.8	0	1.8	3.4	0	0.1	1.2	7.6	3	1.7	7.1	0	9.2	38.1
VII	6069	63	1.6	1.4	1.6	5.4	0.1	0.3	0	0.1	0.5	0.1	0.6	0	1.3	0	0	1.2	14.2
	6068	64	1.6	0.4	0.3	0.2	0.1	0.4	0	0	0.1	0	0.7	0	1.1	0.8	0	1.4	7.1
	6067	65	0	0.2	0	0.2	0	0	0	0	0	6.9	2.5	1.4	0	1.4	0	0.9	13.5
	6066	66	0	0.7	0.3	0	0	0.6	0.1	0	0	3	0	2.8	0.4	2.5	0	0	10.4
	6065	67	0	0	0	0	0	0.2	0	0	1.3	1.6	3.3	0	1.4	3.2	0	0.1	11.1

	6064	68	0	0	0	0	0	0.8	0	0	5	3	0	0	1.6	2.4	0	0	12.8
			3.2	2.7	2.2	5.8	0.2	2.3	0.1	0.1	6.9	14.6	7.1	4.2	5.8	10.3	0	3.6	69.1
VIII	5964	69	0	0	0	0	0	0	0	0	5	0.4	0.3	0	0	0.6	0	0	6.3
	6065	70	0	0	0	0.1	1.9	0	0	0	0	0	1.3	0.5	0.3	0.5	0	0	4.6
	5865	71	0	0	0	0.5	0	0	1.7	0	0	0	0.1	0.2	0	0.1	0	0	2.6
	5866	72	1.2	1.7	1.2	1.6	0.1	0	0.4	0	0	2.7	0	0	0	1.8	0	1.4	12.1
	5865	73	0.1	0.4	0	1.8	0	0	0	0	0.2	3.5	0.5	0.1	0.2	0.5	0	0	7.3
	5865	74	0.1	0	0	1.4	0.8	0	1.5	0	0.5	2.3	0	0	0.5	0.3	0	0.3	7.7
	5665	75	0.1	0.4	1.3	1.4	0.1	0	3	0.1	0.4	2.8	0.2	0	0	0	0	3.5	13.3
	5664/5864	76	0.8	0	1.9	1.8	0	0	4.8	1.8	0.8	1.4	0	0	1	1.8	0	1.4	17.5
	5863	77	0	0	0	0.5	0	0	22.5	0	0	0	0	0	0	0	0	2.5	25.5
			2.3	2.5	4.4	9.1	2.9	0	33.9	1.9	6.9	13.1	2.4	0.8	2	5.6	0	9.1	96.9
IX	5762	78	0	0	0	0	10	2	0	0	0	0	0	0	0.2	1.9	0	0.4	14.5
	5562	79	0	0	0	0	0	0	0	0	0.1	0	0	0	0.2	0.7	0	0	1
	5463	80	0	0	0	0	0	0.3	0	0	0.6	0.2	0.1	0	0	3.9	0	0	5.1
	5263	81	0	0	0	0	0	0	0	0	0.1	2.3	0	0	0	2.2	0	0	4.6
	5264	82	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0.3	0	0	0.4
	5064	83	1.5	0.4	0	0.1	0	0	0	0	0.4	0	1.1	0	0.4	16.6	0	0.1	20.6
	4864	84	0	0	0	0	0	0	0	0	0	0	0	0	0	6.3	0	0	6.3
	4865	85	0.3	0.1	0	0	0.1	0	0	0	0.3	0	0	0.4	0	7.8	0	0	9
	4665	86	0.3	0.1	0	0.1	0	4.6	0	0	0.5	3.2	6.9	0	0	8.3	0	0	24
	4666	87	0	0	0	0	0	0	0	0	0	7.5	6.7	0	0	1.8	0	0	16
			2.1	0.6	0	0.2	10.1	6.9	0	0	2	13.3	14.8	0.4	0.8	49.8	0	0.5	101.5
X	4466	88	0	0	0	0	0	0	0	0	0.3	0.6	7.1	0	1	0.9	5.2	0	15.1
	4467	89	0	0	0	0	0	0	0	0	2.1	7.5	6.3	0	0.6	3.4	17.9	0	37.8
	4267	90	0	0	0	0	0	0	0	0	1.4	1.1	0	0	0	1.6	0		4.1
	4468	91	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0.2	0.3	0	0.6
	4268/ 4267	92	0	0	0	0	0	0	0	0	1.1	17.3	10.4	0	0	0	10.6	0	39.4
	4269	93	0	0	0	0	0	0	0	0	0.1	3.9	4.2	0	0	1.3	3.3	0	12.8
	4069	94	0	0	0	0	0	0	0	0	0	0	10.6	0	0	1.5	0	0	12.1
	4070	95	0	0	0	0	0	0	0	0.4	1.6	15.8	14	0	0	3.8	0	0.1	35.7
	4071	96	0	0	0	0	0	0	0	0	0.4	24.7	5.2	0	0	0	5.8	0	36.1
	4072	97	0	0	0	0	0	0	0	0	0.1	13.7	1.8	0	0	1.1	9	0	25.7
	3872	98	0	0	0	0	0	0	0	0	0	5.6	0	0	1.6	0.1	8.5	0	15.8
	3873	99	0	0	0	0	0.1	0	0	0	0	9.4	0.4	0	1.1	2.8	9	0	22.8
			0	0	0	0	0.1	0	0	0.4	7.1	99.7	60	0	4.3	16.7	69.6	0.1	258

XI	4073	**100**	0	0	0	0	0	0	0	0	0	0.5	0	0.1	0	1.2	0.3	0	2.1
	4074/3874	**101**	0	0	0	0	0	0	0	0.1	1.1	2.4	0.5	0	0	2.1	15.3	0.1	21.6
	4075/3875	**102**	0.5	0.4	0	0.8	0	0	0	0.6	1.4	0.3	4.3	0	0.1	0	26.3	0	34.7
	4076	**103**	2.9	0	0	0.3	0	0	0	0.4	1.6	3.8	1.2	1.6	0.1	1.1	9.6	0	22.6
	4077	**104**	1	0.1	0	0	0.2	0	0	0.9	0.9	0	1.1	0	0	3	5.9	0.1	13.2
	3877/3878	**105**	0	0.1	0	0	0	0	0	0	0	0	0	0.3	0.1	1.3	17.9	0	19.7
	4078	**106**	0	0	0	0	0	0	0	0	0.5	2.5	0.5	0	0	3.1	10.9	0	17.5
	4079	**107**	0.4	0.1	0	0	0	0	0	0.1	0	0	0.1	0.4	0.1	2.3	5.3	0.8	9.6
	4080	**108**	0.8	0	0	0	0	0.1	0	0	0	0.5	0.3	0	0	3.1	2	1.9	8.7
	4081	**109**	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0.1	0.1	0	0.3
	3880	**110**	0	0	0	0	0	0	0	0	0	0.3	0.3	0	1.6	3.9	0	0	6.1
	3881	**111**	0	0	0	0	0	0	0	0	0.9	0.5	1.6	0	0.7	3.8	21	0	28.5
	3883	**112**	0.6	0	0	0	0	0	0	0.1	0.1	0.3	1.3	0	0	1.4	6.3	0.1	10.2
			6.2	0.7	0	1.1	0.2	0.1	0	2.2	6.5	11.1	11.3	2.4	2.7	26.4	120.9	3	194.8
XII	XII	**113**	3.9	0	0	0	0.6	0	0	0	0.2	0.1	0	3.6	0.9	33.2	0	0	42.5
XIII	2892	**114**	0	0	0	0	0	0	0	0	1.8	0	0.8	1.8	0	0	0	0	4.4
	2893	**115**	0	0	0	0	0	0.3	0	0	0	0.7	1.4	6.3	0	5.9	0	0.3	14.9
	3093	**116**	0	0	0	0	0	5.2	0	0	0	0.8	4.4	2.8	0	11.5	0	1.2	25.9
			0	0	0	0	0	5.5	0	0	1.8	1.5	6.6	10.9	0	17.4	0	1.5	45.2
XIV	3932/2293	**117**	0	0.4	1.1	0.6	0	1.2	0	0.4	1.9	0.6	3.6	0	2.9	3.1	4.7	0.3	20.8
	3491/3492	**118**	0.3	0	0	0	0	0	0	2.5	4.8	1.4	12.3	0	0.4	0	8.1	0	29.8
	3691	**119**	0	0	0	0	0	0	0	0	0	0	5.3	0	0.1	0	7.8	0	13.2
	3690/3870	**120**	0	0	0	0	0	0	0	0	2	8.7	7.3	0	0	0	17	0	35
	3689	**121**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0.1
	3889	**122**	0	0.2	0	0.1	0	0.2	0	0	2.5	0	2.9	1.6	0	6.4	2.1	0	16
			0.3	0.6	1.1	0.7	0	1.4	0	2.9	11.2	10.7	31.4	1.6	3.4	9.5	39.8	0.3	114.9
XV	3887/4087	**123**	0	0.1	0	0	0.1	1.7	0	0.1	0.6	3.8	4	1.9	0	8.6	0	0	20.9
	3689	**124**	1.2	0	0	0.2	0	0	0	0	2.5	5.4	2.4	1.2	0	1	1.6	0	15.5
	3686	**125**	0	0.1	0	0.5	0	0.2	0	0	2.6	2.4	2.3	1.9	0.6	0	1.4	0.1	12.1
	3486	**126**	0	0.2	0	0.1	0	0.8	0	0	0.1	10.6	0.4	0	0.5	9.4	0	0	22.1
	3888/4088	**127**	0	0	0	0	0	0	0	0	0	0	0.1	0.4	0	8.6	0	0	9.1
	3286/3285	**128**	0	0	0	0	0	0	0	0	0	8.4	4.1	0	0	20.3	0	0	32.8
	3086	**129**	0	0	0	0	0	0	0	0	0	0.5	3.3	0	0	3.8	0	0	7.6
	2887/2886	**130**	2.1	0.3	0	0.8	0	0	0	0	0.9	0.8	1.6	0	0.1	8.1	0	0.1	14.8
	2888	**131**	0	0	0	0	0	0	0	0	0	1.1	4.1	0	0.1	2.1	0	0	7.4

			3.3	0.7	0	1.6	0.1	2.7	0	0.1	6.7	33	22.3	5.4	1.3	61.9	3	0.2	142.3
XVI	2688	132	0	0	0	0	0	0	0	0	0	0.9	6.3	0	0	4.1	0	0	11.3
	2688	133	0	0	0	0	0	0	0	0	0	0	2.7	0	0	5.5	0	0	8.2
	2690	134	0	1.6	0	0	0	0.6	0	0	0	0	6.7	1.6	1.6	1.7	0	0	13.8
	2691	135	0	0	0	0	0	0	0	0	0	0	5	0	0	3.3	0	0	8.3
	2692	136	0	0	0	0	0	0	0	0	0.2	0	6.1	2.2	0	0.9	0	0	9.4
			0	1.6	0	0	0	0.6	0	0	0.2	0.9	26.8	3.8	1.6	15.5	0	0	51

Appendix 2: Coastal terrestrial indicator vegetation

1.	Elymus Farctus (= Agropyron junceum) p 459, Plate LIX	Mediterranean couch	very strong and wiry deep rooted, sand dune stabilizer
2.	Phragmites Australis p 478, Plate LXIV	Reed Qasbet ir-rih	small reed marks areas where saltwater mixes with freshwater, grows in salt- marshes
3.	Atriplex halimus p 28, Plate V	Shrubby Orache Haxixa mielha, Bjanca	Large perennial shrub, grows both in wild and cultivated areas thrives in deeper soil found also on bastion walls in coastal regions
4.	Mesembryanthemum nodiflorum p 38 Plate VII	Round-leaved Mesembryanthemum Kristallina tal-Blat	low-growing annual-often takes on a brick-red colouration, grows in sandy and rocky places
5.	Inula crithmoides p 323, Plate XLIV	Golden Sapphire Xorbett	small, perennial shrub grows in moist, rocky coastal localities

Source: Haslam, S. M., Sell, P. D., and Wolseley, P. A. (1977)

Appendix 3: Coastal maritime indicator vegetation

1.	Enteromorpha 'sp'	associated with high levels of sewage pollution	bright - green translucent tubular thallus
2.	Ulva 'sp'	associated with high levels of sewage pollution bright - green sheltered places	bluish-green leaves with stiff stems
3.	Cystoseira 'sp'	in exposed rock habitats - intolerant of phosphate pollution	tough texture
4.	Acetabularia Acetabulum	whitish - intolerant of sewage pollution	stiff white stalk
5.	Cyrnodocea Nodosa	like posidonia but in more sheltered conditions - also more tolerant	brick - red creeping stems
6.	Posidonia Oceanica	in open well aerated and unpolluted sea - on muddy bottom	shaggy bases

Source: Lanfranco, E (1975) Unpublished mimeo report, pers. comm..

APPENDIX 4:
Publications on the coast as listed in Ulrich's Periodicals Directory

Name of Publication	Year Public Commenced	Frequency per Year	Description	Circulation
Coast	1955 -1989	10		
Coast (Bay Head)	1984	10	Covers the Jersey shore. Provides informative feature articles on the shore's rich history and lifestyles, as well as what's new in art and science, profiles of personalities, poetry, fiction, photographic essays. Includes up-to-date guides on dining, nightlife, real estate and bed and breakfast inns	
Coast & Country	1984	6	Contains articles on human and personal issues, the home, money management, health, business, dining wine, leisure, area issues, travel and personalities	75000
Coast Business	1989	6	Covers the business news, people and opportunities on the Mississippi Gulf West	
Coast Guard Eng. Digest	1933	4	Aimed at sharing lessons learned and advancing engineering in the Coast Guard	
Coast Marine & Transportation Directory		1		
Coast to Coast	1986	4	Covers issues in national sport, government actions in sport. Coastal Bend Council of Governments, Box 9909, Corpus Christi; TX 78469	1000
Coast to Coast Management		8	Coast to Coast Resorts	362,992
Coastal Bend Council of Governments. Monthly Update	1969	4	Examiner regional planning	1,100
Coastal Cruising US		4	Formerly Carolina Cruising: advertising book reviews	25,000
Coastal Engineering	1977	6	For engineers working in the field of marine and coastal technology	

Coastal Engineering : Japan	1958	8		
Coastal Engineering Research Council Proceedings	1952	irregular every two years	American Society of Civil Engineers	
Coastal Farmer	1981		New Natal Farmer (until 1983)	3000
Coastal Law Memo	1980 - 1988			
Coastal Management	1973	4	explores the technical, legal, political, social and policy issues surrounding the utilisation of valuable and unique coastal environments and resources. Formly CZM Journal	
Coastal Research	1962	every three years	Science, engineering and other matters of coastal interest	
Coastal Research Notes				
Coastal Zone Management	1969	every ten days	specialises in reporting on federal - state relationships in the U.S. Coastal Zone and EEZ, including information on oil, gas, and mineral activities on the outer continental shelf; also covers technical side of coastal management community development, and certain aspects of tourism	
Coastal Zone Management Journal				
Coastguard	1946	4	Dept. of Transport. Advertising; book reviews; film reviews; illustrations, statistics. Dept. of Transport; HM Coastguard;	15,000
Coastlines		4	Pacific Stock Exchange (news & activities); the securities industry, trading highlights and related topics	
Coastwatch	1970		Formerly: Univ. of N. Carolina. Sea Grant College Newsletter	

Bowker's R.R. Serials Bibliography Department (2000)

Appendix 5: Classification Key

Symbol	Land use	Symbol	Land use
A	AGRICULTURE	G	GARDEN
Ac	Agriculture: cereals	Gpri	Garden: Private
Av	Agriculture: vegetables	Gpub	Garden: ,public
As	Agriculture: sulla		
		H	HUNTING
B	BOATS	Ha	Hunting: shooting
Ba	Boat: amature	Ht	Hunting: trapping
Bf	Boat: fishing	Hrto	Hunting: reserved area
Bg	Boat: grounded		
Bh	Boat: hired	I	INDUSTRY
Bm	Boat: moored	Ih	Industry: heavy
Bp	Boat: park	Il	Industry: light
Bt	Boat: trailer	Isp	Industry: salt pans
By	Boat: yacht		
		INF	INFRASTRUCTURE
C	COMMERCIAL	INFb	Infrastructure: broadcasting
Cb	Commercial:bar	INFe	Infrastructure: electrical power
Ck	Commercial: kiosk	INFp	Infrastructure: pipeline
Co	Commercial: office	INFs	Infrastructure: sewage
Cs	Commercial: shop	INFw	Infrastructure: water supply
Cst	Commercial: tourist shop		
		J	JETTY
CA	CAR	Jb	Jetty: breakwater
CAa	Car: access	Js	Jetty: Services
Cabs	Car: bus stop		
CAp	Car: park	K	CONCRETE
CAr	Car: route	Kfp	Concrete: footpath
		Kp	Concrete: promenade
D	DIMENSIONS	Ks	Concrete: steps
Da	Dimension: altitude		
Dl	Dimension: length	L	LEISURE
Dn	Dimension: number	Lbc	Leisure: beach concession
Dt	Dimension: thickness	Lc	Leisure: club
Dw	Dimension: width	Ls	Leisure: sports
E	ECOSYSTEM	M	MILITARY ESTABLISHMENT
Eb	Ecosystem: beach	Mb	Military: barbed wire site
Ee	Ecosystem: ecologically imp	Mf	Military: fortification
Er	Ecosystem: erosion		
Erc	Ecosystem: rocky coast	N	INTEREST
Esd	Ecosystem: sand dune	Na	Interest: Aesthetic
Esm	Ecosystem: salt marsh	Ne	Interest: Ecological
Est	Ecosystem: stream	Nee	Interest: Economic
Evm	Ecosystem: valley mouth	Nh	Interest: Historical
		No	Interest: Other, specify
F	FISHING	Ns	Interest: Scenic
Fa	Fishing: area	Nsc	Interest: Scientific
Fe	Fishing: farm		
Fl	Fishing: flora		
Fp	Fishing: point		
FA	FAULT		

NC	INTEREST (geomorphological)	X	ACCESS
NCB	Interest: Beach	Xf	Access: footpath
NCBr	Interest: Beach rocky	Xs	Access: steps
NCBS	Interest: Beach Sandy	Xv	Access: vehicular
NCc	Interest: cliff	Xx	Access: inhibited
NCr	Interest: Creek		
NCR	Interest: Rdum	Y	BLANK NOTATION
NCs	Interest: Semcircular inlet		
		Z	SIZE OF ROCK
O	HOUSE	Zl	Boulders
Oo	House: old	Zc	Cobbles
Or	House: residential	Zg	Gravel
Ot	House: transient	Zp	Pebbles
Och	House: church, chapel	Zs	Sand
		Zm	Mud
Q	QUARRY		
Qc	Establishment under construction		
Qd	Establishment in need of repair		
Q50	State of repair, per cent		
R	ROCK		
Rbc/gs	Rock: blue clay/greensand		
Rg	Rock: globigerina		
RLCL	Rock: Lower Coralline Limestone		
RUCL	Rock: Upper Coralline Limestone		
RUCL/F	Rock: Fault		
S	SLOPE		
Sco	Slope: concave		
Scx	Slope: convex		
S5o	Slope: 5o		
Sl8o	Slipway: 8o		
T	Tourist		
Th	Tourist: hotel		
U	UNDERWATER FEATURE		
Udp	Underwater: diving point		
Ua	Underwater: archaeology		
V	VEGETATION		
Vg	Vegetation: garrigue		
Vm	Vegetation: maquis		
Vh	Vegetation: halophytes		
Vi	Vegetation: indicator		

Source: developed by author

Appendix 6: List of Government Notices, Legal notices, Regulations, Codes and Acts pertaining to the Maltese coasts.

- Sand (preservation) Act, 1949 (act. no. XVI of 1949)
- Protection of Birds and Wild Rabbits Regns. 1980. LN 68 of 1980 amended by 25 of 1983
- Disembarkation of Animals (Min. Standards) Regulations, 1963. LN of 1963
- Place of Landing of Foreign Animals. GN 9 of 1946
- Disembarkation of Bullocks Directions GN 425 of 1933
- Bathing of Animals Regulations LN 31 of 1960; amended by LN 90 of 1975; 45 of 1977
- Of Boats. Code of Police laws, Part XXII, Sec 243 - 304
- Continental Shelf Act, 966 (Act No XXXV of 1966)
- Of Fishing, Sale of Fish, Fishing Boats. Code of Police Laws, part XXII, Sec 305 -306
- Territorial Waters and Contiguous Zone Act, 1971 (Act. No XXXII of 1971)
- of Territorial Waters, Harbours, and Wharves. Code of Police Laws, part XX, Sec 224 -234
- Int. Convention on the Safety of Life at Sea (Ratification) Act, 1981. Act No XXV of 1986
- Continental Shelf (Designation of Area) Order 1971. LN 36 of 1971; 113 of 1974
- Fishing Boats Regulations. GN 212 of 1937
- Merchant vessles on fure or with a damaged hull prohibited to enter any harbour. GN257 of 1938
- Safety of boats used for passenger traffic Regulations GN 104 of 1880
- Sea traffic during petrol handling in certain places Regulations. Gn 340 of 1911; 122 of 1913
- Small craft (speed) Regulations, 1961. LN 26 of 1961
- Speed boats & Water Skiing Regulations, 1985. LN 190of 1985
- Boatsman's Fees Regulations, 1957. GN 572 of 1957
- Boats plying for hire at any landing place in the harbours in Malta, or at Mgarr or Marsalforn, Gozo. GN 189 of 1894; amended by GN 38 of 1920; Police Notice 15.1 of 1921
- Comino Passenger Service (Time-Table) Regulations, 1973. LN 66 of 1973; amended by LN 39 of 1974
- Gozo Boats Carrying Passengers. GN 239 of 1942
- Malta/Gozo Hydrofoil Boat Passenger Service (Time-Table) Regulations, 1966. LN 26 of 1966; amended by LN 69 of 1966, 68 of 1967
- Mechanically driven boats (Passenger & Cargo) Regulations 1955. GN 704 of 1955; amended by GN 626 of 1957, LN 116 of 1975
- Steam boats plying for hire or touring lighters in the harbours or bays or between the islands. GN 230 of 1909 amended by GN 49 of 1910; vide GN 19 of 1911
- Tariff of fares for steam-boats plying between the Islands GN 507 of 193-7
- Wied iz-Zurrieq Coastal Boats (Tariff of fares) Regulations 1979 LN 70 of 1979; amended by LN 41 of 1981
- Berthing regulations 1975 LN 117 of 1975
- Berthing of Vessels & Boats in Harbours Regulations GN 791 of 1957
- Landing Places for Boats carrying Passenger Regulations GN 380 of 1935
- Mooring of Boats in French Creek GN 130 of 1899
- Berthing (Amendment) regulations, 1986 LN 33 of 1986
- Berthing (Amendment) No 2 regulations , 1986 LN 51 of 1986
- Swimming pools (Control) Regulations 1974 LN 74 of 1974; amended by LN 81 of 1974
- Marine pollution (Prevention & Control) Act, 1977 (Act. No XII of 1977)
- Material Discharge Outside Harbours Regulations. GN 24 of 190?
- Petroleum ships entry and discharge of petroleum in harbours. GN 397 of 1936; amended by GN 427 of 1936; 127 & 451 of 1937
- Transfer of Cattle, Animals or Eggs between Malta and Gozo & removal of manure or other filth. GN 402 of 1911; GN 242 & 483 of 1944
- Special Development Areas Act, 1956 (Act No IX of 1956)
- Town and Country Planning Schemes. Code of Police Laws, Part I, Sec 1-2
- Town and Country Planning Act 1969 (Act No IX of 1956)
- Building Development Areas Regulations, 1983. LN 23 of 1983

Appendix 7: A century of legislation pertaining to coastal matters in Malta, 1880-1990: list of laws, government notices, legal notices and regulations.

	LAW	GN	LN	REG	AM
1880		F		F	
1881					
1882					
1883					
1884					
1885					
1886					
1887					
1888					
1889					
1890					
1891					
1892					
1893					
1894		F		F	
1895					
1896					
1897					
1898					
1899		B			
1900					
1901					
1902					
1903					
1904					
1905		P			
1906					
1907					
1908					
1909		F		F	
1910		F		F	F
1911		F		F	
1912					
1913		F		F	
1914					
1915					
1916					
1917					
1918					
1919					
1920		F		F	F
1921				F	
1922					
1923					
1924					
1925					
1926					
1927					
1928					
1929					
1930					
1931					
1932					
1933	F				
1934					
1935		B			
1936		P			
1937					
1938					
1939					
1940					
1941					
1942	F		F		
1943					
1944		P			

1945					
1946					
1947					
1948					
1949					
1950					
1951					
1952					
1953					
1954					
1955		F		F	
1956					
1957		FFF		FFF	F
1958					
1959					
1960					
1961					
1962					
1963					
1964					
1965					
1966		F		F	
1967		F		F	
1968					
1969					
1970					
1971					
1972					
1973		F	F	F	
1974	PT	F	T	F	F
1975		F		F	
1976			T		
1977	PT				
1978			TTT		TTT
1979		F		F	F
1980			TT		TT
1981		F	TT	F	TT
1982					
1983					
1984	T		T		T
1985					
1986	TTTT		TTTBBT		TTT
1987					
1988					
1989					
1990					

KEYS:

LAW	-	Law / Act of Parliament	B	-	Berthing
GN	-	Government Notice	F	-	Ferries
LN	-	Legal Notice	P	-	Pollution
REG	-	Regulation	T	-	Tourism
AM	-	Amendment			

Source: Compiled by author from Government Gazette Publications, 1880-1990

Appendix 8 Existing Structure Plan Policies relevant to the coastal zone

Structure Plan Policies for Coastal Zone Management

POLICY CZM 1: A professionally staffed and adequately resourced coastal zone management unit will be established as a matter of high priority.

POLICY CZM 2: A Subject Plan will be prepared for coastal zone management, to include both conservation of this important resource, and improved facilities for its enjoyment by the public.

POLICY CZM 3: Public access around the coastline immediately adjacent to the sea or at the top of cliffs (including in bays, harbours, and creeks) will be secured. This will include taking shorelands into public ownership, Government acquisition of illegal developments and encroachments, and suitable construction works. In the few cases where this is not practical (for example where security considerations are paramount), nearby detours will be established. All the coastline will be brought into public ownership within a specified period.

POLICY TOU 15: The Planning Authority in co-operation with the Secretariat for the Environment and other relevant bodies will define a comprehensive policy for the coastal zone. This policy should aim at enabling Government to:

1. Assess the different components of the coastal zone considered as a unique ecosystem

2. Identify permissible uses, development criteria, and standards

3. Promote and enforce policies

4. Include the coastal zone as an area requiring mandatory Environmental Impact Assessment procedures

Structure Plan policies on natural and cultural resources

POLICY RCO 10: In identifying and designating Areas of Ecological Importance in Local Plans, one or more of the following habitat types must be present:

1. Permanent springs
2. Saline marshlands
3. Sand dunes
4. Forest remnants
5. Semi natural woodland
6. Natural freshwater pools and transitional coastal wetlands
7. Deep natural caves
8. Coastal cliffs
9. Representative examples of typical Maltese habitats such as garigue, maquis, valley sides, watercourses, and gently sloping rocky coasts.

POLICY RCO 11: In identifying and designating Sites of Scientific Importance in Local Plans, one or more of the following features must be present:

1. The only known locality in the Maltese Islands where certain endemic and/or non endemic species are found
2. A locality where certain endemic and/or non endemic species with a restricted distribution in the Maltese Islands occur ('restricted distribution' is taken to mean occurrence in five localities or less)
3. The type locality of an endemic species
4. An important bird nesting site or of some other major ornithological interest
5. A locality of special palaeontological interest
6. A lithostratigraphical type section
7. A locality of particular geomorphological interest
8. Some other specific feature of scientific importance not listed above

POLICY RCO 16: No form of permanent construction will be allowed in sandy coastal areas and existing constructions will be removed wherever practicable. The removal of sand from sandy beaches is prohibited, and the extension and creation of sandy beaches for recreational use will be encouraged. Sandy beaches include shallow inshore seabeds. All beach and seabed enhancement will be the subject of Environment Impact Analyses.

POLICY RCO 17: Overnight camping on sandy beaches, and any camping on sand dunes will be prohibited, and access of vehicles to sandy beaches and dune areas will be prevented.

POLICY RCO 18: Without prejudice to any other policy or regulation protecting dune areas, the Planning Authority will actively prevent the removal of sand binding vegetation from such areas.

POLICY RCO 19: The Planning Authority will carry out surveys in order to identify sites where the habitat and/or landscape has degraded. Such surveys will be reviewed every two years.

POLICY RCO 20: Positive action will be taken to rehabilitate identified areas of degraded habitat and landscape, and proposals from Government agencies and non governmental bodies for rehabilitation schemes for these areas, provided that such schemes do not conflict with other policies and/or regulations concerning these areas, will be supported subject to scrutiny and approval by competent experts.

POLICY RCO 21: There is a general presumption against development in areas prone to erosion.

POLICY RCO 22: Positive action will be taken to prevent further loss of sandy beaches, sand dunes, coastal clay slopes, soil, and cliff edges.

POLICY RCO 23: Developments connected with the construction of coastal defences, the enlargement of existing beaches, and the creation of new ones will only be allowed following a scientific study by competent persons of their short term and long term environmental, social, and economic impact, and provided that it is clearly demonstrated that there is a real need for such development and that the benefits outweigh any negative impacts.

POLICY RCO 24: Existing regulations concerning excavation and transport of sand and soil will continue.

POLICY RCO 34: Without prejudice to any other policy or regulation protecting the environment of the minor islands of the Maltese archipelago, the Planning Authority will have a general presumption against any new physical development on these islands. The minor islands of the Maltese archipelago are: St. Paul's Islands (Selmunett Islands), Ghallis Rocks, rocks off Xrobb il-Ghagin, rocks off Delimara Point, Filfla Island, Cominotto, rocks in the Blue Lagoon area, Gebla tal-Halfa, Il- Hnejja, Tac-Cawl Rock, Fessej Rock, and Fungus Rock (General's Rock).

POLICY RCO 36: Efforts will be made to declare the Qawra area including the Inland Sea and Dwejra Bay, in Gozo, a Natural World Heritage Site in terms of the Convention Concerning the Protection of the World Cultural and Natural Heritage.

POLICY RCO 37: A management authority for the Qawra National Park will be established. This management authority will formulate detailed management plans which take into consideration the type, location, size, traditional human use and activities, and the presence of features of natural, historical, archaeological, scientific, or aesthetic interest in the Qawra area including the Inland Sea and Dwejra Bay, so that the public may enjoy these features without their suffering any degradation or harm.

POLICY RCO 38: Without prejudice to any other policy or regulation governing the Qawra area including the Inland Sea and Dwejra Bay, Conservation Areas, including Marine Conservation Areas, may be designated within the Qawra National Park, and policies relevant to such designated Conservation Areas are applicable in addition to any applicable to the National Park as a whole.

POLICY REC 9: As from the commencement date of the Structure Plan, no structure other than tents, windbreaks, and shading devices, used by day visitors, will be permitted in coastal areas. All such temporary structures will be demounted and removed by midnight. The owners of all huts and other makeshift (shanty) structures on coastlines or adjacent areas, without building permits, will be served with eviction notices, requiring the removal of the structures within a period of three months and the restoration of the land to the satisfaction of the Planning Authority. Any structures remaining on these sites after the expiry of the notices will be demolished and the land restored, at the occupier's expense.

POLICY MCO 1: The following general vicinities are designated as candidates for the status of Marine Conservation Areas. Following further analysis, these and other possible areas will be categorised and given protection accorded to defined categories:

1. Dwejra, Gozo
2. Qbajjar, Gozo
3. Ramla Bay, Gozo
4. Mgarr ix-Xini Bay, Gozo
5. Comino Island
6. Filfla Island
7. Cirkewwa
8. St. Paul's Islands, Mistra Bay
9. Qawra Point
10. St.George's Bay vicinity, Paceville
11. Outer Marsamxett Harbour
12. St. Thomas Bay to Delimara Point
13. Blue Grotto to Ghar Lapsi
14. South of Fomm Ir-Rih Bay to Ras il-Wahx.

POLICY MCO 2: The Planning Authority will, as far as possible, include marine archaeological sites and structures within the boundaries of Marine Conservation Areas. Access to archaeological sites and wrecks will be strictly regulated.

POLICY MCO 3: A Maritime Geographic Information System will be established, designed to integrate data related to coastal zone management and Maltese territorial waters.

POLICY MCO 4: The Planning Authority, in conjunction with the Secretariat for Environment, will conduct an underwater survey of infralittoral ecosystems for the Maltese Islands.

POLICY MCO 5: The Planning Authority will establish a national system of Marine Conservation Areas within the shortest possible time but only after full consultation with interested Government institutions, environment groups, maritime resources users groups, and the general public.

POLICY MCO 6: It will be the policy of the Planning Authority to site, as much as possible, Marine Conservation Areas contiguous with land based Conservation Areas. This will guarantee the protection of the marine zone from any land activities likely to pose threats to the marine environment and vice versa.

POLICY MCO 7: The system of Marine Conservation Areas will include representative areas of all existing marine and coastal ecosystems as outlined in the infralittoral habitat survey.

POLICY MCO 8: Candidate sites for Marine Conservation Areas, which exhibit a wide variety of ecosystems and habitats over a relatively small area, will be accorded preference during the selection process. This will ensure greater ecological stability in the protected area and offer greater scope for a wide variety of activities.

POLICY MCO 9: All categories of Marine Conservation Area will conform to international categories.

POLICY MCO 10: The Planning Authority will establish a priority list of all Marine Conservation Areas, and rank sites by importance.

POLICY MCO 11: The traditional rights of fishermen to utilise resources is recognised. Wherever jobs may be threatened, fishermen will be given first option for suitable jobs and services related to site protection.

POLICY MCO 12: Marine Conservation Areas that benefit other nations or worldwide interests will be designated, as for example where migrating species pass through or breed in a particular coastal area.

POLICY MCO 13: A management authority for Marine Conservation Areas will be established, and detailed management plans prepared and followed.

POLICY ARC 4: As a matter of priority, the Planning Authority will designate Hagar Qim/Mnajdra and Ggantija as Areas of Archaeological Importance and will collaborate with other agencies to develop them as National Parks.

Structure Plan Policies relating to yachting and shipping development

Policy TOU 13: In conjunction with the appropriate agencies the Planning Authority will prepare a Subject Plan including Environmental Impact Assessments to determine the advisability and feasibility of various types of harbours, moorings and facilities for yachts and other boats. Each potential location shall be studied and planned

Policy IIT 1: Ferry services between Gozo and the Inner Harbour will be made more frequent and generally improved, including the introduction of fast services. Studies will be undertaken into the advantages and disadvantages of allowing competitive ferry services between mainland Malta and Gozo.

Policy IIT2: Suitable ferry terminal facilities for passengers and freight will be provided in the Inner Harbour area.

Policy IIT 4: Ferry terminal facilities providing bad weather alternatives to Cirkewwa will be fully established. Ghadira (Mellieha Bay) is suitable nearby location.

Policy IND 5: The Planning Authority will prepare a Subject Plan aimed at establishing the potential for the longer term relocation of heavy port/industrial uses from Grand Harbour to the Marsaxlokk Bay area. In the interim period, no new industrial uses will be permitted in the vicinity of Grand Harbour.

Policy IND 15:A local plan shall be prepared for Marsaxlokk Bay and the surrounding area. The plan will be based on studies of the long term requirements of all industrial activities related to deep water port uses, including security aspects, safety, and environmental impacts. Major gas installations liable to explosion shall be located away from urban areas, including the removal of existing installations. To assist the early preparation of the local plan, oil companies shall supply particulars of their requirements, including especially requirements in the event that oil is discovered in commercial quantities. The efficient use of the deep water port potential at Marsaxlokk Bay, and the visual quality of new development shall be particular features of the local plan and development permits.

Structure Plan policies relevant to development

POLICY SET 11: No form of urban development will be permitted outside existing and committed built-up areas, and primary development areas as designated in the Structure Plan even where roads and public utilities are available. Permitted forms of non urban development outside such areas are restricted to the categories referred to in Paragraph 7.6.

Paragraph 7.6 : The term `urbanisation' means the creation of new built-up areas containing all or most urban uses: houses, shops, offices, factories, and all the built support facilities which these accumulate. In seeking to prohibit urbanisation of existing non urban areas it is not the intention to prohibit built structures of various kinds which are normal and legitimate inclusions in the non urban scene - farmhouses and other genuine agricultural buildings, reservoirs, picnic area toilets and car parks, and control buildings and walls/fences at archaeological and ecological sites. Nevertheless, the provision of such structures must be controlled in order to preserve and enhance the environmental quality of the countryside.

POLICY SET 12: Notwithstanding the policy against any form of urbanisation outside areas designated for urban uses in the Structure Plan, the Planning Authority will consider applications for permission to develop which ostensibly infringe Policy SET 11. In any such case the onus will be on the applicant to present evidence as to why the policy should be infringed, giving reasons why from a planning point of view such proposed use cannot be located in areas designated for development.

POLICY BEN 5: Applications for development permits outside urban areas will be judged against the policies and design guidelines of the Local Plans for Rural Conservation Areas, and in the interim period, to Structure Plan policies and the guidelines contained in the Explanatory Memorandum.

Structure Plan policies on illegal development

POLICY REC 10: Low cost holiday home villages or other similar developments will not be permitted. Holiday villages will conform to Structure Plan policies.

POLICY REC 11: Sites at White Rocks and Marfa are designated for overnight accommodation of mobile caravans and tents. Each site will have a management and maintenance team. Regulations will be introduced to ensure the best use of sites, and to avoid permanent occupancy of any pitch. Overnight caravans shall only be permitted to occupy designated mobile caravan sites. Permanent residential caravan sites will not be permitted.

POLICY REC 12: The owners of all illegal constructed property sited on Government or other land will be served with eviction notices requiring that the offending structures be demolished and the site restored within a period of one year from the serving of the notices. Any structure remaining on expiry of the notice will be demolished and the site restored at the occupier's expense. No fines will be imposed on illegal occupiers and no compensation will be payable to them.

POLICY CZM 3: Public access around the coastline immediately adjacent to the sea or at the top of cliffs (including in bays, harbours, and creeks) will be secured. This will include taking shorelands into public ownership, Government acquisition of illegal developments and encroachments, and suitable construction works. In the few cases where this is not practical (for example where security considerations are paramount), nearby detours will be established. All the coastline will be brought into public ownership within a specified period.

POLICY TOU 5: The Planning Authority will give favourable consideration to the development of tourist accommodation replacing shanty and illegal development between Vendome Battery and White Tower on the northern coastline of the Marfa peninsula.

Structure Plan Policies relating to coastal uses

Fisheries and aquaculture

POLICY AHF 1:Major improvements in agriculture, horticulture, and fisheries will be encouraged, so that:

1. The sector assists the overall economy of the country through reduced imports and increased exports
2. Better quality products are available to domestic consumers
3. The countryside land resource is used efficiently and does not become derelict
4. Food supplies are safeguarded in the event of natural, accidental, or deliberate calamities
5. The countryside is safeguarded for the benefit of future generations

POLICY AHF 13:Government will promote efficiency in agriculture and fisheries through land availability measures, including:

1. Establishing access rights of way for agricultural vehicles and machinery, and improving rural roads and tracks, in a manner which improves the appearance of the countryside

2. Making land available on long leases to secure capital investment in agriculture, including for livestock, forage, and organic farming

3. Introducing measures to encourage the formation of larger more viable farms and farming businesses

4. Identifying sites for the establishment of secure boat storage with maintenance facilities, near to but not on the coastline

POLICY AHF 14:A small fisheries centre and fishing boat berthing facilities will be promoted in the north of mainland Malta, and a deep sea fisheries centre at Marsaxlokk Bay.

POLICY AHF 15: Marine based aquaculture units will be encouraged so as to make best use of land and sea resources. Production units will be located well away from the coast to avoid any significant visual impact. Detailed planning criteria and permit conditions will be developed to ensure suitable safeguards.

POLICY AHF 16: Large land based aquaculture units will be restricted to industrial estates and former quarries, and multi storey structures used where feasible. Small units will be permitted on forms in conformity with Policy AHF 5. All offsite water supply and discharge pipes will be underground, and the reuse of water, other than seawater, is mandatory. Detailed planning criteria and permit conditions will be developed to ensure suitable safeguards.

Mineral exploitation

POLICY IND 16: Government will ensure that permissions for offshore operations will include measures for the safety of navigation, safeguards for the natural environment, and satisfactory abandonment measures.

POLICY MIN 5: There will be a presumption against surface mineral working in or near areas of acknowledged interest for ecology, archaeology, and in areas of high quality agricultural land. The extraction of significant amounts of Blue Clay will not be permitted.

POLICY MIN 6: The extension of existing workings and the merging of adjacent workings will be given preference to the development of new mineral workings. In support of any application for new or extended mineral workings, evidence will be required to demonstrate that the existing site has been worked to the maximum practicable depth.

Transport

POLICY PTR 5: The Planning Authority will ensure the provision of transport interchanges between different modes of transport (car, bus, mini bus, taxi, passenger ferry, vehicle ferry, aircraft, rapid transit system, foot) where appropriate.

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