Validation and Assessment Report

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(c) Assessment of the Territorial Reference Units (RMM units)
for the Gozo Study Area

Formulation of Impact Scenarios using the SAGE methodology for the Gozo Study Area

1. Tourism statistics for the Gozo Study Area during the past 10 years

Tourist accommodation in Gozo ranges from five star hotels to third class guesthouses and self-catering establishments. The majority of these hotels and guesthouses are found in the northern part of the island while there are approximately 6 in the south with only one guesthouse in the central part of the island. It is thus evident that most of the tourist complexes are located around the coast of Gozo.

According to the 1991 statistical records, an average of 1,887 visit Gozo per day, but in summer this figure is greatly increased. There are no reliable statistical values for the number of registered beds in the Gozo Study Area for this year.

For the year 1994, the number of registered beds in the Gozo Study Area was only 5.2% of total bed capacity in the Maltese Islands and although this figure must be very inaccurate due to a large number of unlicensed apartments, this percentage was expected to increase to 5.4% by 1997. There were an average of 300 beds for each of the 5* to 3*hotels, and tourist complexes. The number of beds within self-catering establishments was approximately 1,000.

About 780,000 out of 1 million visitors to the Maltese Islands went to Gozo during 1994, with 690,000 just spending the day and between 80,000 and 100,000 tourists staying on for longer. About 70% of the surveyed tourists staying for more than one day, spent 8-15 bed-nights in Gozo, 20% spent more than 15 bed-nights and 10% stayed for only 1-7 bed-nights during the summer months. As shown in Figure 1, during the winter months, 70% stayed for 8-15 bed-nights, 28% stayed for 1-7 bed-nights and only 2% stayed for more than 15 bed-nights.

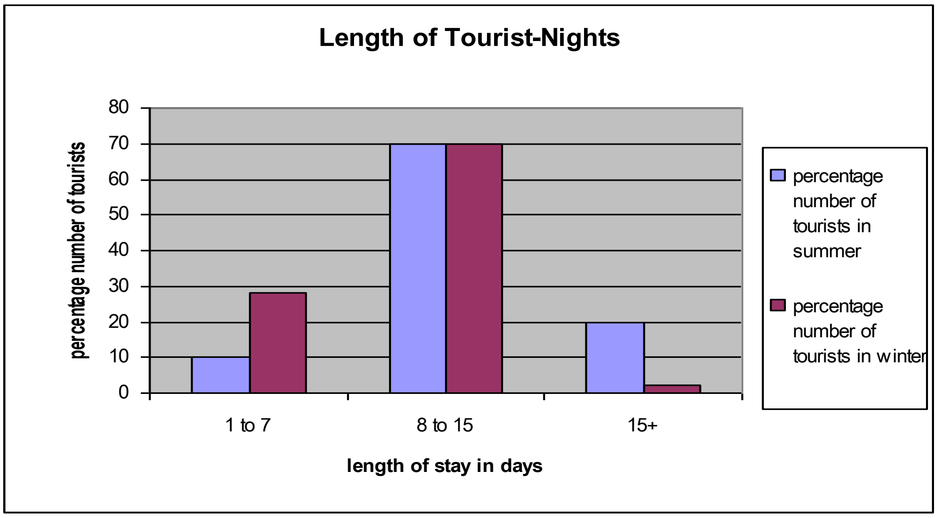

Figure 1 Length of Tourist-Nights

Figure 2 demonstrates that over half of these tourists (57%), preferred to stay in self-catering establishments during the summer months, and (45%) during the winter months. Only 20% of the tourists in summer and 30% in winter, preferred 4* and 5* hotel accommodation. 14% and 13% of the tourists preferred 3* accommodation during summer and winter respectively. The remainder of the tourists preferred other (unspecified) types of accommodation.

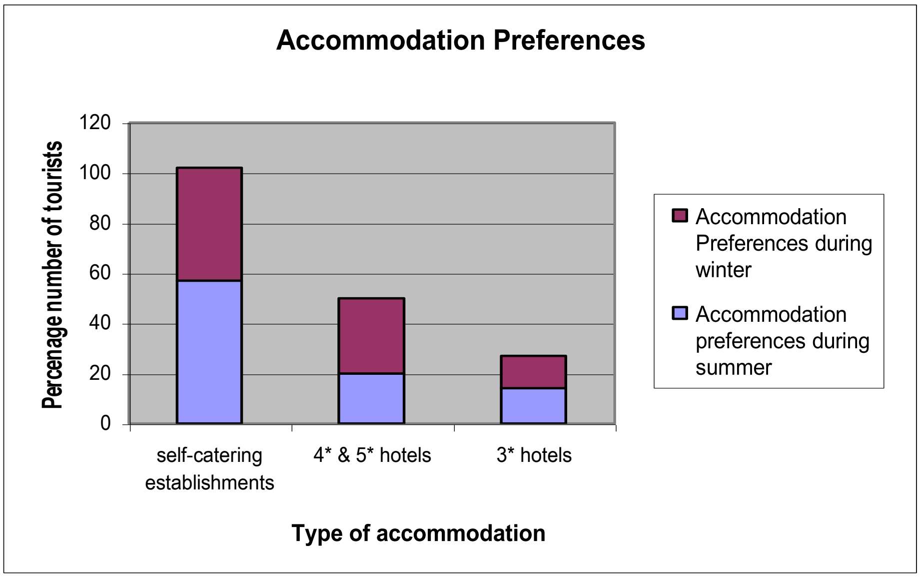

Figure 2 Accommodation Preferences

In the second week of August 2000, a total of 69,085 passengers and 13,927 cars crossed over from Malta to Gozo. In 1998, the totals for the same week were 62,271 passengers and 13,573 cars. The busiest day in 1999 was on Monday 16th August when a total of 13,413 passengers and 3,149 vehicles traveled between the islands.

To meet the demand and the rise in passengers over this week, Gozo Channel operated a boat shuttle service from Cirkewwa to Mgarr, performing 300 scheduled and 68 extra trips using four vessels. The celebration of St. Mary's feast on the 15th of August, which is also a public holiday, is the reason why such an aggregation of visitors travel to Gozo for a short break during the second week in August.

Of the 29,477 tourists who visited Gozo and stayed in hotels between January and June 2000, 14,509 were from Malta, an increase of 716 compared to the same period last year.

The number of foreigners staying in Gozo during the same period decreased by 3,136 to 14,938. Although there was a decrease in the number of tourists staying in Gozo during the first six months of the year, the total of bed-nights increased by 6,736 to 97,520. The Maltese visitors took up 36,178 bed-nights and foreigners took up 71,342.

The total number of bed-nights in 1999 totaled 460,000, those in hotels and guesthouses totaled to about 252,000.

These numerical values lead to a firm understanding that most of the influx of tourism occurs during the last six months of the year (mostly the summer months). This creates a periodical shortage of beds during the summer months, which in turn causes a greater pressure towards further urbanization for tourist accommodation to satisfy the demand created during those months.

From the above, it can also be concluded that the already great number of beds (which is constantly on the increase) found in the Gozo Study Area, are not evenly occupied during the whole year. During the first six months of the year, the beds are occupied for a low average of 40 days only. This translates to only 28% of the tourist influx for a whole year. The yearly occupancy percentage for the Gozo Study Area stands at 34%.

The occupancy percentage and the average length of stay of tourists who visit the Gozo study area, leads to the conclusion that tourism in Gozo is highly transitory and seasonal.

It is important to steer the tourism industry in the Gozo Study Area out of this trend towards a future based on the high quality natural, cultural and heritage resources, which are in part, different to the mainland of Malta. Ultimately, the Gozo tourism product has much intrinsic strength and attractive characteristics, which strongly appeal to emerging tourism markets, including eco-, cultural- and agro-tourism.

2. The Effects of Tourism on the Gozo Study Area

The Gozo Study Area generally appears to be a lot greener and also cleaner than the main island of Malta, however it does have environmental pressures related to tourism, mainly the rate of uncontrolled urbanization and the ever increasing seasonal influx of tourism. The earmarking of Gozo as an ideal tourist location has already brought about a number of undesired effects due to unplanned development that does not incorporate considerations with regard to the sustainability of the island under study.

The following sections, i.e.

2.1 The Rapid Growth in Urbanization and

2.2 The Influx of Tourism,

incorporate the direct and indirect negative effects of tourism.

2.1 Rapid Growth in Urbanization

It can be derived from the above statistics that the tourism industry has significantly increased in Gozo over the past 10 years, bringing about an increase in hotels, apartments and guesthouses. Even old and authentic farmhouses are being leased as holiday residences, with extrinsic/exotic additions such as swimming pools and other recreational facilities.

The physical mass and treatment of the (high-rise) back elevations of these new developments are often unrelated with regard to their prominent position, thus disrupting the skyline of towns and villages.

This type of village extensions, if unabated, will in the very near future compromise more environmentally sensitive areas. A prime example of a village extension that is starting to affect a sensitive valley system is Xlendi Village. Its extension over the past 10 years - and its possible continued extension over the coming years have been assessed using the SAGE methodology.

2.1.1 Loss of Traditional Village Development

The island of Gozo is well known for its peace and tranquility with tourists and Maltese alike. A place where one can relax in the unspoiled countryside and marvel at the traditional, easy-going lifestyle of the local inhabitants.

The sites encountered by the visitor as the ferry enters the Gozo harbour at Mgarr already convey a message that some of the Island's natural and scenic beauty is being lost. Fringing the rocky cliffs on the right hand side are mass elevations of modern hotels, while directly ahead of the harbour is the development within the historical monument of Fort Chambray. The white building stone used to erect this new development of a tourist complex, clashes with the authentic, aged stone making up the fort.

The quaint old traditional villages of Gozo offer the best locality for tourists who want to wind down and escape from the hectic everyday life style back home, where the peace and quiet is now a thing of the past. Recent years have witnessed a previously alien type of development: a kind of ribbon development along the main roads, joining one village to another. This form of development disrupts the entire layout of the island and also the traditional setting of the village itself, upsetting the custom of having villages developing around the square, the heart of the village.

Another similarly disturbing type of development affects several towns and villages such as Zebbug, Nadur and Qala are on ridges and plateaus, where continued extension of the village up to the fringes has now become very visible from the valleys below. A type of development which is again impacting dramatically on the scenic beauty of the valley systems.

2.1.2 Increase in demand for Quarrying Supplies and Related Problems

The quarries are essentially of two types: Softstone quarries provide an easily workable building stone from the Globigerina Formation while Hardstone quarries (from areas with Upper Corralline outcropping) provide a substitute for gravel). Clearly, the erection of new urban development relies heavily on the supply of building material that is obtained from these local limestone quarries. The scars in the landscape resulting from quarrying that the Malta mainland has long been bingeing on are now becoming a common site in Gozo too.

Quarrying techniques irreversibly damage the environment by removing layer upon layer of sedimentary rock, exposing the underlying rock layers to physical and chemical weathering. This is accompanied by large-scale soil erosion and the rerouting of rain run-off flow along valley systems.

Hardstone quarrying is generally more destructive of landscape and habitats, since most of the Upper Coralline areas are found covered with natural garigue. Once destroyed, the original habitat cannot be reinstated.

For softstone quarrying a major impact concerns the potential impact on the underlying aquifers. Indeed, potential damage to the underlying aquifers becomes imminent if quarrying is taken too deep, as infiltration times are being reduced significantly and the likelihood of polluting the aquifer increases.

The most recent limestone quarries are in close proximity to one of the most beautiful bays in the Gozo Study Area: Dwejra Bay, the beauty of which lies in the unspoiled natural geological and aesthetic features including the famous Azure Window and the Inland Sea. The site aspires to be included in the list of World Heritage Sites.

Clearly, the extent of quarrying which was started only recently in this part of Gozo, has already stumped any chances of having this unique area accepted as a Natural World Heritage Site in the World Heritage Convention.

It should also be born in mind that the impacts of quarrying are not limited to the area being quarried only, but also extend beyond. Such negative impacts include dust and noise pollution and the ancillary landtake requirements associated with quarrying operations.

2.1.3 Construction Waste Generation

Uncontrolled urbanization on the Malta mainland produces a large quantity of pre- and post-construction material that is then dumped in a landfill. It has been recently estimated that 80% of all material entering the largest dumpsite in Malta is of construction origin. Such a value should be reduced significantly through more stringent and specific legislation necessitating construction waste material reuse either on or off site. Construction waste debris can be reduced further if there is more control on the *extent* of urbanization through the formulation of legislation restricting unnecessary urbanization.

These problems are already becoming synonymous with the Gozo Study Area, and were confirmed by the application of the SAGE methodology, which identified the issue of uncontrolled urbanization as a major issue. Over the years, this trend has caused the sprouting of more and more illegal dumpsites. Most of the material making up illegal dumpsites consists of construction material. Such waste sites are found to prevail in valleys (Wied Ilma valley) and the coastal areas (Pinu Point to Xwieni bay). The waste dump locations mentioned are among the most important ecological habitats apart from being key features of the landscape appreciated by locals and tourists alike.

Moreover, the legally accepted waste dumpsite for Gozo at Qortin (limits of Xaghra village) is presently viewed as a potential health hazard to the several hundred residents in its vicinity. These residents are at the time of writing this report considering to take legal action against the government.

2.1.4 Loss of Differentiated Landuse

There is also an additional problem whereby special areas which should be preserved for the aesthetic, historic, geological or natural resources, are sacrificed for the development of tourist complexes, which from an economic view point are thought to generate more revenue. The conversion of Fort Chambray into a tourist complex is a prime example in this regard. With this development, a historical fort (a cultural asset) is being sacrificed to the jaws of development for tourist accommodation.

It is clearly very important for Gozo to strike a sustainable balance between an island of legend, tradition and folklore and an island that has to keep on moving with the exigencies of modern tourism.

2.2 Influx of Tourism

From the figures quoted in Section 1 of this report, it is evident that the number of tourists visiting the island of Gozo is on the increase every year. If such an influx of tourists is to be properly managed and catered for, the resources being affected by this external factor have to be identified.

2.2.1 Resource Use and Overuse

The larger the population and hence population density, the larger is the pressure on the environmental resources, because the greater is their use/mining. The Maltese Islands have the highest population density in Europe, second only to Gibraltar.

Tourism adds to this problem, especially if for example, drainage systems, roads, power stations, etc. have not designed to provide for the large population which the locals and tourists add up to during the summer months. For the Gozo Island, the total population and hence population density effectively double during the summer months.

Power requirements increase dramatically during the hot summer months because of the widespread use of air conditioners and/or fans to keep the heat at bay. The problem could be replicated to wintertime, when electric power is needed for heaters.

Water is an even more important issue since there are already problems with producing and distributing an adequate supply for the resident population. Not only is water, as a natural resource, scarce, but about 60% of the water made available to households is produced by desalination of seawater using reverse osmosis plants which require a great input of electrical power to function.

Fortunately, the Gozo Study Area does not have a power station on the island, but makes use of the two power stations situated in the southern part of the Malta mainland. The negative side to this is the fact that Gozo suffers the inconvenience of unreliable and uneven supply of electricity due to deficiencies in the distribution system from the Malta mainland.

2.2.2 Solid Waste Generation and Illegal Dumping

Waste presents a serious problem in Gozo, since there is only one official dump site in Gozo, situated in the proximity of two prime tourist areas – Marsalforn bay to the West and Ramla bay to the East. Besides the obvious impacts of land-take requirements, air pollution by volatile organic carbons, pests and a decline in aesthetic value, the fact that there is only *one* official dumpsite creates scope for illicit dumping elsewhere.

Most of these illegal dumping sites are found in remote places where natural and sometimes even cultural heritage is at stake.

Considering the extent of waste generated by a yet larger influx of tourists would worsen this already serious problem and further demote the value of the Gozo Study Area as a tourist destination.

2.2.3 Sewage Overflow due to System Overload

Accidental sewage discharge into the surrounding sea, is another problem which infallibly seems to occur especially in the summer months. This is most probably due to overloading of the system. Although the discharged sewage is untreated, there is a low impact on the nutrient level of the sea due to its oligotrophic (low concentration of dissolved nutrients in the water column) nature.

The impact is more of an aesthetic and microbiological one. The main sewage discharge point at Ras il-Hobz, on the southern coast, is close to a popular tourist locality and bathing area, Mgarr ix-Xini. When the sewage outfall pipes are damaged and sewage leaks out relatively close to the shore, the bay has to be declared unfit for bathing, until an acceptable coliform level is achieved.

A further increase in the number of tourists during the popular summer months would overload the drainage system further and increase the frequency of declaring certain bays unfit for bathing.

2.2.4 Decrease in Bathing Water Quality

Most of the Gozo coastal zone is rocky in nature and can be used for bathing purposes. The Harbour/Fishing boat area in Mgarr and the surrounding bays are the only exceptions to this. As explained in the previous section, a further two bathing areas are known to have been proclaimed unsuitable for bathing during certain periods in summer due to possible sewage overflow. One of these two bathing areas is Xlendi bay, among the most popular with tourists and Maltese alike during the summer months (also earmarked for further study as one of the future SAGE methodology scenarios).

2.2.5 Habitat depleting Infrastructure catering for Tourism Influx

The plight to attract more tourists, even via direct flights to the Island of Gozo, has sparked a renewed interest in the development of an airstrip in Gozo. Evidently, such a development would seriously impact on the environmental resources in the Study Area.

The land-take requirements of an airport vary according to whether the airport will be used for domestic purposes i.e. to ferry visitors to and from Malta mainland (approximately 1500m in length), or for international flights where one (possibly two) fully-fledged runway of about 2000m will be needed.

Since the topography of the study area is mostly hilly, prime agricultural land is found in the valleys in between these hills, on the few relatively flat areas available.

Development of one or more runways for aeroplanes would therefore likely be at the expense of valuable arable land, already in use to grow agricultural produce.
The Gozo Study Area is already suffering from the destruction and disturbance of habitats. So, undoubtedly these problems will be aggravated by the development of an airstrip, which can be expected to lead to a further decrease in biodiversity and density through further habitat destruction. The potential impacts of this potential future development have been assessed further using the SAGE methodology.

Perhaps, the most badly affected habitat in Gozo, due to the extent of influx of tourism are the sand-dune habitats. The highly unstable and delicate ecology of the (only) sand dunes in Gozo is found within the most sought after sandy bay. Needless to say, these sand dunes are constantly regressing due to trampling by people, vehicles, camping kiosks and beach cleaning. If no action is taken to prevent further regression, these sand dunes will soon be lost.

2.2.6 Economic Impact

The impact of an increase in tourism on the Gozo economy has never been properly measured. Solely from observation one can speculate that tourist expenditure generates considerable income and employment on the island, but as yet there are insufficient data available to adequately quantify this economic impact.

For a proper assessment, there must be a clear distinction made between *tourist industry* and *tourist expenditure*.

Tourist industry covers hotels and other establishments, which operate mostly for tourists and have direct and indirect influences on the economy.

Tourist expenditure on the other hand, covers expenditure for products and services related to the tourist industry, and is a major source of foreign exchange inflow. The multiplier effect of tourist expenditure gives rise to new rounds of spending and re-spending and therefore to a further increase in the income of residents. This multiplier effect shows that tourist expenditure has had an impact on other sectors, with the highest impacts being on both private and public services, agricultural produce, beverage industry and the textile industry (in that order).

The impact of tourism on the Gozo economy is likely to be very large, since it generates income and employment not only in hotels, but also in many other sectors, including agriculture and fishing, retail trade, printing, transport services and banking.
It is evident that although there have not yet been any definite calculations on the impact of tourism on the Gozo economy, economic models excluding environmental value suggest that money will ultimately be generated.

If the value of the environmental resources, which tourists themselves look for in the Gozo Study Area, have to be given monetary value and included within the economics of sustainable development, the picture would be more realistic and complete.

Although no studies related to this topic have been carried out so far, it is safe to assume that depletion and/or destruction of these environmental resources would in the longer term result in Gozo becoming a less attractive tourist destination. In this scenario, the longer term results would include a decrease in the economic flow from tourist expenditure and hence a decrease in the earnings of the tourism industry. This deduction is based simply on the fact that the Gozo Study Area would have lost its unique green, quiet, clean allure, which are increasingly the qualities today's tourists are looking for when choosing their holiday destination.

Validation of Trends and Scenarios
Identified using the SAGE methodology for the Gozo Study Area

1. Introduction

The analysis of trends and the drawing up of, intentionally chosen, very contrasting, scenarios is the third step in the SAGE philosophy. This step is designed to provide essential information for the next two steps, i.e. the choice of a strategy and the formulation of guidelines. (For a complete description of the various steps in the SAGE methodology, see Annex *Test Methodology Formulation - adaptation of the SAGE methodology to the Gozo Study Area*).

Obvious scenarios would make use of an extrapolation of any trends noticed. However, with the SAGE approach, a second, entirely different type of scenario can be created using the matrices which will be expanded in this chapter. In these type of scenarios it is possible to give one group of actors, and their interests, priority over other groups of actors (stakeholders).

Each of these so-called “actors” is represented in the local commissions, which are then responsible for the elaboration and implementation of a Planning and Management Scheme. Until these commissions are actually formed and operational, SAGE recommends the preparation of a Preliminary Planning and Management Scheme by an informal steering group, whose additional task is to create favourable conditions for the eventual introduction of the methodology.

In the SAGE methodology, which concerns the water resources only, the territorial reference unit is the hydrological basin and Local Water Commissions are established for the catchments within each larger basin. Since the present research deals with all environmental resources, an equivalent 'optimum' territorial reference unit has been researched. This will be dealt with in the chapter **Assessment of the Territorial Reference Unit (RMM Unit)**.

2. Adaptation to the Gozo Study Area

At the Beirut meeting, IRM Co. put forward the interest to study two impacts of particular relevance to the Gozo Study area. These concern uncontrolled urbanization and the major influx of tourists during the summer season.

To assess either of these impacts (qualitatively or quantitatively) required a “reference” basis. Such reference basis must give a picture of the state of the environmental resources, at a given point in time. (An in-depth review of the Environmental Resources of Gozo can be found in the *First Annual Progress Report, Annex 1, Section 3*).

The SAGE methodology, as adapted by IRM Co., specifically targets the establishment of such a reference basis. As explained in the Annex "*Test Methodology Formulation*:

Adaptation of the SAGE Methodology to the Gozo Study Area" (included in this Final Report), this does not in any way conflict with the originally intended purpose of the diagnosis phase. It simply directs the scope of the diagnosis phase to those environmental stresses that are considered to be the most relevant to the Gozo Study Area.

The schematic presentation below demonstrates how the SAGE Methodology has been used to link examples of each Impact Scenario to a known Trend in the Gozo Study Area. The table then extrapolates these trends into the future, forming a Scenario.

The trend of uncontrolled urbanisation, as witnessed in the case of Xlendi village can be extrapolated into a further, extended urbanisation of the village, which will be affecting the more sensitive parts of the area's environmental resources. Similarly the 'seasonal influx of tourism - trend' which has caused a rapid increase in the number of hotels, including the conversion of a historical fort, has been extrapolated to the scenario where an airstrip would be built in Gozo to enable direct access to the Island.

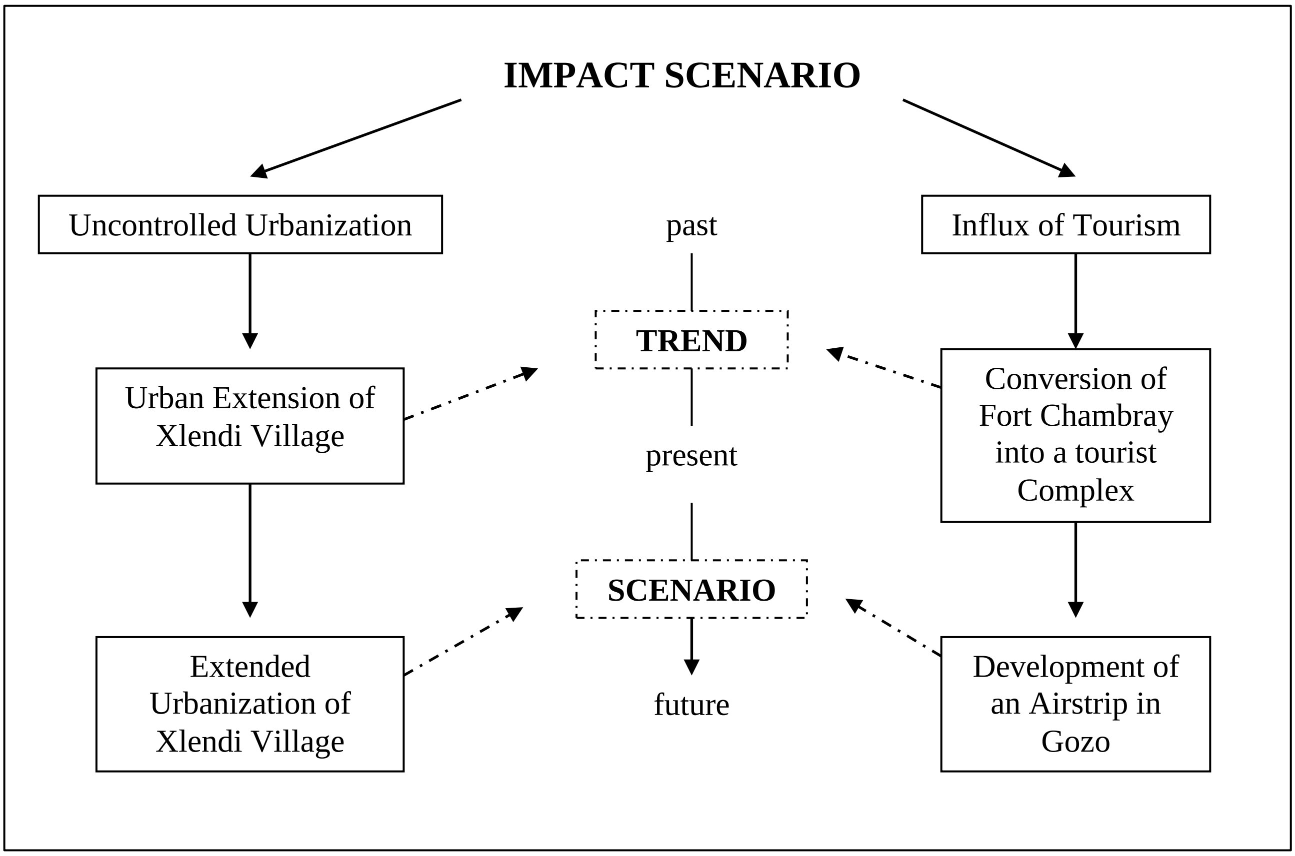

Table 1 Schematic presentation of Impact Scenarios selected for the Gozo Study Area

3. Trends and Scenarios identified in the Gozo Study Area

3.1 Urban Extension of Xlendi Village

The urban extension of Xlendi Village has been selected as a prime example of uncontrolled urbanization due to the very rapid urbanization witnessed during the past 10 to 15 years. This urban extension has been driven by a demand for accommodation during the summer period and is considered to be one of the major impact scenarios for the Gozo Study Area.

Xlendi Village is equally popular with Maltese holidaymakers and tourists alike and hence the village has been growing at an exponential rate. There were never more than a few local residents, which gives the out-of-season visitor the impression of entering a ghost town. The urban extension has occurred to a large extent along the roads leading into the village, providing a linear development pattern. Due to the local topography, these roads, and now also the houses are built along one of the island's most scenic valleys. This development follows the trend of uncontrolled urbanization – one of the impact scenarios referred to in table 1.

This trend can be extrapolated into a scenario where uncontrolled urbanization will extend directly into the valley itself, causing an impact on the ResManMed environmental resources, namely:

- Water – including surface water, groundwater, and seawater (bathing quality)
- Soil
- Geology
- Forest (not applicable in this case)
- Karst heritage.
- Biodiversity (habitats and protected species).

In the example of Xlendi Village, urbanization brings about a multitude of negative effects on these resources. Among the major negative effects are included:

- Polluted runoff from roads into the nearby bay compromising bathing water quality,
- Increased runoff from hilltop areas, causing flooding at the downstream end (Xlendi Bay),
- Modification of natural watercourse flow disrupting the valley habitat,
- Reduction in fertile agricultural land along the valley,
- Loss of scenic value of the valley.

3.2 Conversion of Fort Chambray

The controversial conversion of Fort Chambray, one the island’s unique historical monuments, into a major hotel resort/tourist complex is a prime example of developments to satisfy the demand created by a greater influx of tourists to the Gozo Study Area.

The original development dates back to 18th Century, when the flat ridge surrounded on three sides with high cliffs, was earmarked for the development of a Fort. Some attempts at revitalizing the site, during the latter part of the 20th Century did not bring the desired results. The damage done to the few historic items on site, outweighed any real profit or benefit. This latest conversion project into a major hotel resort/tourist complex has gone along without proper assessment of what is actually being achieved and what is being lost.

The conversion was promoted as a means to offer a setting whereby whoever entered the site through the old gatehouse and over the original bridge structure, would be transported back in time. Unfortunately, an otherwise intact rock curtain wall has been irreversibly breached to provide access for trucks and heavy machinery. An unsightly (and probably permanent) bridge has been built to provide access through this opening.

The delicate eco-geographical and archeological balance achieved between the settling clay and the heavy 18th Century fortifications above, has been seriously compromised. There are now gaps showing due to unprecedented land movement through constant and excessive use of heavy machinery. The deep ditch surrounding the site is being used as a dumping area. There is the fear that the ditch will be eventually filled in to provide a ring road. The historic value of the Fort is being compromised because of its conversion into yet another tourist complex.

This type of development is just one of many tourist complexes that are emerging in the Gozo Study Area, and is directly tied to another important impact scenario - the increasing influx of tourism. Such a trend has already been identified. Commercial and touristic projects are essential, but should not be at the cost of the loss of historic or environmental heritage of the area.

The effect of a greater influx of tourism can be translated into more than just developments for tourist accommodation, but also into the possible scenario of the development of an airstrip to transport tourists directly to the Island of Gozo. Most of these developments cause irreversible damage if badly planned. In the case of the proposed airstrip - with a runway of at least 1000 meters as required for the landing of fixed wing aircraft up to possibly 2500 meters if an international airport would be envisaged - the effects would be on every of the environmental resources.

4. Validation using the SAGE Matrices

The identification and analysis of trends, allows to establish whether there is already any clear degradation of a resource, which would also be an indication that the actual (present) use of the resource is not sustainable. Future scenarios can then be built on these trends and previous mistakes can be avoided.

The matrices (adopted from the SAGE methodology) of the two developments discussed above, provide an insight on the actors (stakeholders) involved and the actions that each is responsible for.

Crossing matrices containing the actors not only highlights which actors should be consulted in the planning process, but also the relationship between them. (See also the Annex: *Test Methodology Formulation: Adaptation of the SAGE methodology to the Gozo Study Area*). Most importantly however, the Matrices can be used to reveal which of the stakeholders may not have been consulted in the planning process as will be shown in more detail for the selected impact scenarios.

Secondly, the matrix Actors - Actions can be used to identify which actors have the major influence in the planning process. This result can then be used to develop a different type of impact scenario, where stakeholders are assigned different weights - for example by assigning a greater weighting to the more 'environmentally concerned' stakeholders.

Finally the crossing of the matrices can be used to assess the interaction between (or the sometimes alarming lack of communication between) the different actors.

4.1 Validation using Actors-Actors Matrix

In this matrix, the different Actors (stakeholders) are listed in both horizontal and vertical direction. For the Gozo Study Area, eleven (11) main stakeholders have been identified. The Matrix is then filled on the basis of the Question "How do the actions of Actor X compare with those of Actor Y". It is reminded that in the adaptation of the SAGE methodology to the Gozo Study Area (see Annex *Test Methodology Formulation*), the filling of the Matrix Actors-Actors did not prove feasible unless a specific development had already been specified.

As shown in Table 1, the Scenarios defined in relation to the Uncontrolled Urbanization and the Seasonal Influx of Tourists can be linked to example developments of the Urban Extension of Xlendi Village and the Conversion of Fort Chambray, respectively. Tables 2a and 2b, inserted at the end of this Chapter, provide the filled-in matrices Actors-Actors for both these developments, while a summary of the results is given in Table 4. The table is filled in response to the Question: "How do actions of Actor X compare with those of Actor Y?" using 6 possible replies.

Matrix Actors/Actors	Urban Extension of Xlendi Village	Conversion of Fort Chambray
Strongly Convergent	22	23
Convergent	14	3
Neutral	-	20
Strongly Conflicting	16	20
Conflicting	6	9
Not Consulted	52	35

Table 4 Summary results for the Matrix Actors - Actors

An almost identical number is found next to the "Strongly Convergent" category. It must be pointed out however that this should not be interpreted as "Strongly in Favour". Likewise, "Strongly Conflicting" does not necessarily imply "Strongly Against". On the contrary, the categories simply reflect whether the Actions of the different stakeholders with respect to a development are seen to be converge, i.e. whether these are in agreement, or not.

Therefore, the purpose and use of the Actors-Actors Matrix is rather to obtain an assessment of which of the Actors, and how many, share a similar attitude and/or view with respect to the development. By grouping the "Strongly convergent" and "Convergent" categories, and likewise for the "Strongly conflicting" and "Conflicting" categories, it can be concluded that with regard to the Urban Extension of Xlendi Village a similar view is held 36 times as opposed to the registration of 22 conflicting views. In the case of Fort Chambray the corresponding figures are 26 (augmented to 46 by adding the "Neutral" category) and 29. As can be seen from Table 2b, the "Neutral" entries correspond entirely to the Actors "Farmers", who in this instance were neutral towards the development since the development did not involve agricultural land-take.

The most important result from this first Matrix is the very high number of "Not Consulted" stakeholders, especially in the case of the Urban Extension of Xlendi Village, where this category accounts for 52 entries. The non-involvement of environmental researchers is seen to pertain to both developments.

The matrix gives a clear indication how the planning process should be improved to ensure a widest, active involvement of all the stakeholders. In turn, this can be expected to lead to a significant decrease in the number of actors who hold a conflicting or even very strongly conflicting view on a proposed development through more extensive and wider communication and dialogue. This should directly result in improved planning for sustainable development.

4.2 Validation using the Actors-Actions Matrix

The second Matrix is used to assign a rating for the effect of the actions of each of the stakeholders with respect to the following:

- Resource protection measures
- Use of resource for recreation
- Overexploitation of resource
- Pollution generation
- Alteration of environmental resource

The above sequence was chosen intentionally as it becomes possible to interpret these as starting from "Protective" to ultimately "Aggressive" actions towards the environmental resources.

For each of these potential actions by the individual stakeholders (actors), the following ratings are used:

0 = Neutral
1 = Very Weak
2 = Weak
3 = Strong
4 = Very Strong

Similar to the use of the previous Matrix, it did not prove possible to assign ratings unless a specific development had already been defined. In addition, it is clearly necessary to also define the specific environmental resource for each Actors-Actions Matrix, i.e. an individual matrix should be filled for *each* of the environmental resources. With respect to the Impact Scenario - Urban Extension of Xlendi Village, the most significant impact is on the Water Resources, while for the second Impact Scenario - Conversion of Fort Chambray the Heritage Value of the site was used to demonstrate the use of the Matrix Actors-Actions. The results are presented in Tables 3a and 3b respectively.

As can be seen from these Tables, the ratings obtained for these two selected scenarios have been added up in two distinct ways:

- (row by row) giving a Score to each of the Stakeholders
- (column by column) giving a Score to each of the Actions defined above

This permits to draw several important conclusions. The Scores for the Stakeholders with regard to the Urban Extension of Xlendi Village demonstrate that this development has been driven mostly by the Leisure Industry (Score=16), the Developers (Score=16) and Other Public Entities (in this case the Ministry of Tourism, Score=12). With respect to the Conversion of Fort Chambray, the development is seen to have been driven (i.e. allowed permission for development) by the Leisure Industry, Developers, the Hotels and Catering Establishment Board (HCEB), the Planning Authority and other Public Entities, in that order of importance.

For both developments the Score for the Environmental Researchers remained at zero (0), i.e. they had zero effect in the planning process. This comes as no surprise, the previous Matrices demonstrate that this group had been completely left out of the planning process.

Looking next at the Scores obtained column by column, i.e. the total of the ratings from all the stakeholders with respect to each type of Action listed in a horizontal direction, it is seen that with regard to the Urban Extension of Xlendi Village, the Use of the Resource for Recreation comes first, followed by Pollution Generation and the Alteration of the Resource. For the Conversion of Fort Chambray, the Over-exploitation of the Resource tops the list, followed by the Use of the Resource for Recreation and the Alteration of the Resource. These findings match perfectly the priority impacts that were identified with respect to Uncontrolled Urbanization and the Seasonal Influx of Tourists.

For both developments a much lower Score (column by column) is found with respect to Actions concerning 'Resource Protection Measures'. Clearly, a sustainable development and management of the environmental resources would - as a basic minimum - require a far more balanced rating between the 'Progressive' and the 'Aggressive' type of Actions. Indeed, the weaker the effect (and hence the lower the Score by column) on the aggressive part of the matrix coupled with the stronger the effect (and hence the higher Score) on the protective side, should point to a more sustainable use of resource.

THE MATRIX ACTORS - ACTORS

Development: <u>URBAN EXTENSION OF XLENDI VILLAGE</u>

Question: *How do the actions of Actor X compare with those of Actor Y?*

Actors / Actors	Planning Authority	Other Public Entities	Local councils	HCEB	Local residents	Tourists	Farmers	Devel-opers	Leisure Industry	Environm Research	NGOs
Planning Authority		+	?	++	?	?	-	++	++	?	--
Other Public Entities	+		?	+	?	?	?	++	++	?	--
Local Councils	?	?		?	+	?	-	-	+	?	?
HCEB	++	+	?		?	?	?	++	++	?	--
Local residents	?	?	+	?		+	?	+	+	?	?
Tourists	?	?	?	?	+		?	++	++	?	--
Farmers	-	?	-	?	?	?		--	--	?	++
Developers	++	++	-	++	+	++	--		++	?	--
Leisure Industry	++	++	+	++	+	++	--	++		?	--
Environm. Researchers	?	?	?	?	?	?	?	?	?		?
NGOs	--	--	?	--	?	--	++	--	--	?	

22	**Strongly Convergent**	**++**	**16**	**Strongly Conflicting**	**--**
14	**Convergent**	+	**6**	**Conflicting**	**-**
-	**Neutral**	0	**52**	**Not Consulted**	?

Table 2a The Matrix Actors - Actors

THE MATRIX ACTORS - ACTIONS

Development: <u>URBAN EXTENSION OF XLENDI VILLAGE</u>

Environmental Resource: **WATER**

Question: *Rate the effect of the actions of actor X on each of the following*

PROTECTIVE ← → **AGGRESSIVE**

Actions Actors - X	Resource protection measures	Use of resource for recreation	Over exploitation of resource	Pollution generation	Alteration of environmental resource	*SCORE*
Planning Authority	Weak 2	Very weak 1	Neutral 0	Neutral 0	Weak 2	5
Other Public Entities	Very weak 1	Neutral 0	Very strong 4	Strong 3	Very strong 4	**12**
Local councils	Weak 2	Strong 3	Neutral 0	Very weak 1	Strong 3	9
HCEB	Very weak 1	Very strong 4	Neutral 0	Strong 3	Neutral 0	8
Local residents	Weak 2	Very strong 4	Neutral 0	Strong 3	Neutral 0	9
Tourists	Very weak 1	Very strong 4	Neutral 0	Very strong 4	Neutral 0	9
Farmers	Neutral 0	Neutral 0	Very strong 4	Strong 3	Strong 3	10
Developers	Very weak 1	Very strong 4	Strong 3	Very strong 4	Very strong 4	**16**
Leisure Industry	Very weak 1	Very strong 4	Strong 3	Very strong 4	Very strong 4	**16**
Environmental Researchers	Neutral 0	Neutral 0	Neutral 0	Neutral 0	Neutral 0	0
NGOs	Very strong 4	Strong 3	Neutral 0	Neutral 0	Neutral 0	7
SCORE	15	**27**	14	**25**	**20**	(101)

Neutral 0 / Very Weak 1 / Weak 2 / Strong 3 / Very Strong 4

Table 3a The Matrix Actors - Actions

THE MATRIX ACTORS - ACTORS

Development: <u>CONVERSION OF FORT CHAMBRAY</u>

Question: *How do the actions of Actor X compare with those of Actor Y?*

Actors Actors	Planning Authority	Other Public Entities	Local councils	HCEB	Local residents	Tourists	Farmers	Devel-opers	Leisure Industry	Environm Research	NGOs
Planning Authority		+	-	++	--	?	0	++	++	?	--
Other Public Entities	+		-	++	-	?	0	++	++	?	--
Local Councils	-	-		--	++	?	0	--	--	?	++
HCEB	++	+	-		--	?	0	++	++	?	--
Local residents	-	-	++	-		?	0	--	--	?	++
Tourists	?	?	?	?	?		0	?	?	?	?
Farmers	0	0	0	0	0	0		0	0	0	0
Developers	++	++	--	++	--	?	0		++	?	--
Leisure Industry	++	++	--	++	--	?	0	++		?	--
Environm. Researchers	?	?	?	?	?	?	0	?	?		?
NGOs	--	?	++	--	++	?	0	--	--	?	

23	**Strongly Convergent**	**++**	**20**	**Strongly Conflicting**	**--**
3	**Convergent**	**+**	**9**	**Conflicting**	**-**
20	**Neutral**	0	**35**	**Not Consulted**	?

Table 2b The Matrix Actors - Actors

THE MATRIX ACTORS - ACTIONS

Development: CONVERSION OF FORT CHAMBRAY

Environmental Resource: **HERITAGE SITE**

Question: *Rate the effect of the actions of actor X on each of the following*

PROTECTIVE ← → **AGGRESSIVE**

Actions / Actors	Resource protection measures	Use of resource for recreation	Over exploitation of resource	Pollution generation	Alteration of environmental resource	*SCORE*
Planning Authority	Very weak 1	Very strong 4	Very strong 4	Neutral 0	Very strong 4	**13**
Other Public Entities	Very weak 1	Strong 3	Very strong 4	Neutral 0	Very strong 4	**12**
Local councils	Weak 2	Weak 2	Very weak 1	Very weak 1	Very weak 1	7
HCEB	Very weak 1	Very strong 4	Very strong 4	Very weak 1	Very strong 4	**14**
Local residents	Weak 2	Very weak 1	Very weak 1	Weak 2	Very weak 1	7
Tourists	Neutral 0	Very strong 4	Very strong 4	Very strong 4	Neutral 0	**12**
Farmers	Neutral 0	Neutral 0	Neutral 0	Neutral 0	Neutral 0	0
Developers	Very weak 1	Very strong 4	Very strong 4	Very strong 4	Very strong 4	**17**
Leisure Industry	Very weak 1	Very strong 4	Very strong 4	Very strong 4	Very strong 4	**17**
Environmental Researchers	Neutral 0	Neutral 0	Neutral 0	Neutral 0	Neutral 0	0
NGOs	Very strong 4	Neutral 0	Very weak 1	Very weak 1	Very weak 1	7
SCORE	13	26	27	17	23	(106)

Neutral 0 / Very Weak 1 / Weak 2 / Strong 3 / Very Strong 4

Table 3b The Matrix Actors - Actions

5. Validation Results

a) By adopting the SAGE Methodology it was possible to investigate the role and perception of the different stakeholders in the environmental resource planning and management process. Based on a detailed analysis of two specific developments:
   (1) the Urban Extension of Xlendi Village and
   (2) the Conversion of Fort Chambray,
   both of which are linked to observed trends in the Study Area. Using the SAGE Matrices Actors-Actors and Actors-Actions respectively, the effects of Uncontrolled Urbanization of the Seasonal Influx of Tourists are retrieved. The same approach can be used also for the study of the effects linked to possible future scenarios, such as the continued extension of the Xlendi Village, or the construction of an airstrip in Gozo.

b) The SAGE Matrices clearly identified a severe lack of consultation and communication between the different stakeholders and indicated that most actions were ‘investor driven’. More extensive communication and dialogue between all actors should directly result in improved planning for sustainable development.

c) Equally valuable, the SAGE matrices identified the shortcoming of having insufficient protective type of measures. In the example developments that have been studied, the developments resulted in significant alteration of the environmental resources, with hardly any counter effect from environmental protection and conservation measures that could have kept such alteration at bay. A more sustainable use of the environmental resources will require a much more balanced compromise between 'protective' and 'aggressive' type of actions.

d) The above conclusions demonstrate how the SAGE matrices can be used effectively to identify the priority areas that need to be tackled if an acceptable equilibrium is to be reached between the need for development and the need for protection and conservation of the environmental resources. These findings provide a firm basis needed to construct Optimum Response Strategies. (Refer to Annex – *Optimum Response Strategy Report*).

e) One potential difficulty, which became apparent from the work done on the database construction in the three Mediterranean partner countries, concerns the level of detail to be used when defining environmental stresses or impacts (scale effect). This became clear when the SAGE methodology was adapted to the local situation in the Gozo Study Area. It proved to be useful to retain a maximum degree of compatibility in determining the specific Karst resources and Karst heritage features, as well as the optimum strategies for their conservation and their protection.

The SAGE approach is based on a combined diagnosis - the so-called global diagnosis - in which the more conventional diagnosis of the state and use of the environmental resources using GIS is coupled with the diagnosis of the axis - stakeholders. The diagnosis of the state and use of the environmental resources in a GIS environment will be analysed in the next Chapter - Assessment of the Territorial Reference Units (RMM units). The validation exercise carried out here, i.e. using the SAGE Matrices, has served to demonstrate the innovative character of this methodology: it becomes possible - at least hypothetically - to construct an entirely different type of scenario. This concerns the construction of a scenario where one of the stakeholders - or a group of stakeholders - would be given more weight than the other stakeholders.

Assessment of the Territorial Reference Units (RMM units)
for the Gozo Study Area

1. Objectives of the Territorial Reference Units

Within the SAGE methodology, the term 'reference unit' is used in reference to the hydrological basin, which therefore serves as the basic territorial reference unit in the French law. However, the precise perimeter of the so-called CLE's (Local Water Commissions - charged with the elaboration and follow-up of SAGE) is then further refined through the identification for example of smaller catchment areas with specific, common characteristics, difficulties and needs. Using these criteria, it becomes possible to group two or more catchment areas to a same CLE.

The objectives of the latter are clearly identical to the objectives of the RMM Units (see *Sub Report on Test Methodology Formulation* submitted with the *Second Annual Report*), but require a major adaptation of the SAGE methodology. For the purpose of water resources management, the hydrological basin and the catchments within the basin are clearly the 'optimum' territorial reference units. This is not a priori transferable when it comes to the management of all the environmental resources, which is the scope of the present research.

Conceptually (see *Sub Report on Test Methodology Formulation*), the RMM Units have been defined as having the objective to provide a spatial representation of the karst structure and functioning. The Appendix 1 to the above Report - RMM Unit Creation, proposes two interrelated steps to arrive at the RMM Unit for each Study Area, which are repeated below:

Step 1 Select the covers which best represent the dynamics of the karst system
Step 2 Check that the size of the layers produced is optimal

2. Selection of Covers to create the RMM Units

As explained in the above referred reports, the RMM Units are derived from the crossing of two or more basic Cover Maps. Many such Covers can be retrieved from the GIS that could serve to create the RMM Units. However, if these are to represent the dynamics of the karst system, the possible choices become much more reduced.

While these RMM Units should serve the planning and management of all the environmental resources, it is most worthwhile to verify which covers should be given priority from a water resources point of view. Indeed, where SAGE points to the catchment as the 'optimum' reference unit, this would not suffice to represent the specificity of the karst. Another reason is that there is a general acceptance that the other environmental resources (soil, biodiversity, forest etc.) are all linked to the water resources.

The special vulnerability of karst aquifers in relation to water resources management has been the object of several important research studies - including the European Research - Cost Action 65 on the "Hydrogeological Aspects of Groundwater Protection in Karstic Areas". The Final Report of Cost Action 65 includes a National Report for Malta by D. De Ketelaere and A. Spiteri (1995). The Guidelines, published separately from the Final Report, advises that "a karst system may be defined by its framework (provided by the geology), by its structure of underground flow paths and by its hydraulic behaviour". It follows that the main characteristics of karst aquifers are in relation to the infiltration conditions and the recharge mode.

The **Surficial Cover Infiltration (SCI) Map**, which was developed as part of the ResManMed Research, combines four distinct parameters: (1) surface lithology, (2) fault density, (3) drainage density and (4) karst features (including sinkholes and dolines for the Gozo Study Area). The SCI Map was validated as a scientifically credible means to represent the structure of the Karst System in the Gozo Study Area.

The **Geology Map** for the Gozo Study Area provides a clear delineation of the various perched aquifer systems - besides the knowledge that the Island's largest aquifer is situated at sea level. The Map also provides important information concerning the potential locations for limestone quarries, especially the areas from which the much sought after Lower Globigerina Limestone could be mined. Locally known as 'Franka', this limestone layer provides the easily workable, pale cream to yellowish building stone. Apart from these so-called Softstone Quarries, the Geology Map is used to determine the areas which can be quarried in the Upper Coralline Limestone to provide gravel, which are known as Hardstone Quarries.

Hence, the Geology Map can be considered as a valuable means to represent the Karst System, in terms of the karst aquifers, but also to represent the value of the geological resources in the Study Area.

The third potential cover concerns the **Watershed Map**. For the Gozo Study Area, there is a widely accepted recognition among all stakeholders, that the valley systems should be treated as the Island's most valuable natural assets. As expanded in the Annex - *Surface Water Quality in the Gozo Study Area*, the monitoring of vegetation and hence biodiversity can be used to determine the level of degradation / pollution in the respective valley systems. A crossing with the Watershed Map therefore offers the possibility to maintain a link between the RMM Units and the biodiversity in the Gozo Study Area. Evidently, keeping the valleys clean would also help to prevent contamination of the underlying aquifers.

The **Landcover** Map could also be considered as the specific karst landscape may affect or even control the landcover/landuse. In the Annex *Database Report for the Maltese Study Area* submitted with the Second Annual Progress Report, it has been elaborated why it became necessary to adopt a rather specific landcover legend for the Gozo Study Area. The Classification Levels 1 (5 categories) and Level 2 (22 categories), were intended to provide a common reference legend for the Landcover Maps of the Study Areas in Lebanon, Turkey and Malta. When applied to the Gozo Study Area, it became clear that at these broad levels, an insufficient spatial variation was observed on the Landcover map. This challenge was addressed by increasing the landcover classes to 53 categories at Level 3.

However, at this very fine level of detail, a fairly large number of polygons become less than 100 square meters, which would clearly be too small a size for the purpose of the RMM Units.

A final map which has been considered for the creation of the RMM Units is the **Local Councils Map**. Although this map does not serve to represent the karst system, it has been considered because this map offers a direct link to the administrative structures and governance of the Gozo Study Area. For the purpose of creating an environmental planning and management tool, this was considered an important element.

3. RMM Unit Cover Creation: selected examples

For the reasons explained above, the following covers have been selected as potential covers for the creation of the RMM Units:

a) Surficial Cover Infiltration (SCI) Map
b) Geology Map
c) Watershed Map
d) Local Councils Map

Potential RMM Unit Covers are then obtained from the crossing of two or more of the above maps. Selected examples of RMM Unit Covers are presented in this section, together with an appraisal of the distribution of the Size of the RMM Units that were obtained from different crossings. Print-outs of the corresponding maps have been grouped in an Appendix '*Maps'* to this Report.

3.1 Crossing of Geology and Watershed Covers

Starting with the crossing of the Geology and Watershed Maps, a first RMM Unit Map is obtained (see Appendix -Map 1). The total number of units obtained from this crossing equals 630, with an average size of 10.4 hectares. The minimum and maximum correspond to sizes of as small as 0.04 hectares up to 326 hectares respectively.

The Distribution of the Size of the Units is very asymmetrical, being (highly) positively skewed as can be derived from the table below.

RMM Unit Size (ha)	RMM Unit Frequency
< 10	492
11- 25	71
26 - 50	30
51 - 100	27
101 - 150	6
151 - 200	3
201 - 250	0
251 - 300	0
301 - 350	1
Total	630

Table 5 Distribution of RMM Units by Size in hectares -
(resulting from crossing of Watershed and Geology covers)

Another presentation of the distribution of the Size of the RMM Units (Geology/Watershed) is given in Figure 3, where the RMM Units (X-axis) have been re-numbered according to increasing size of the Units (Y-axis).

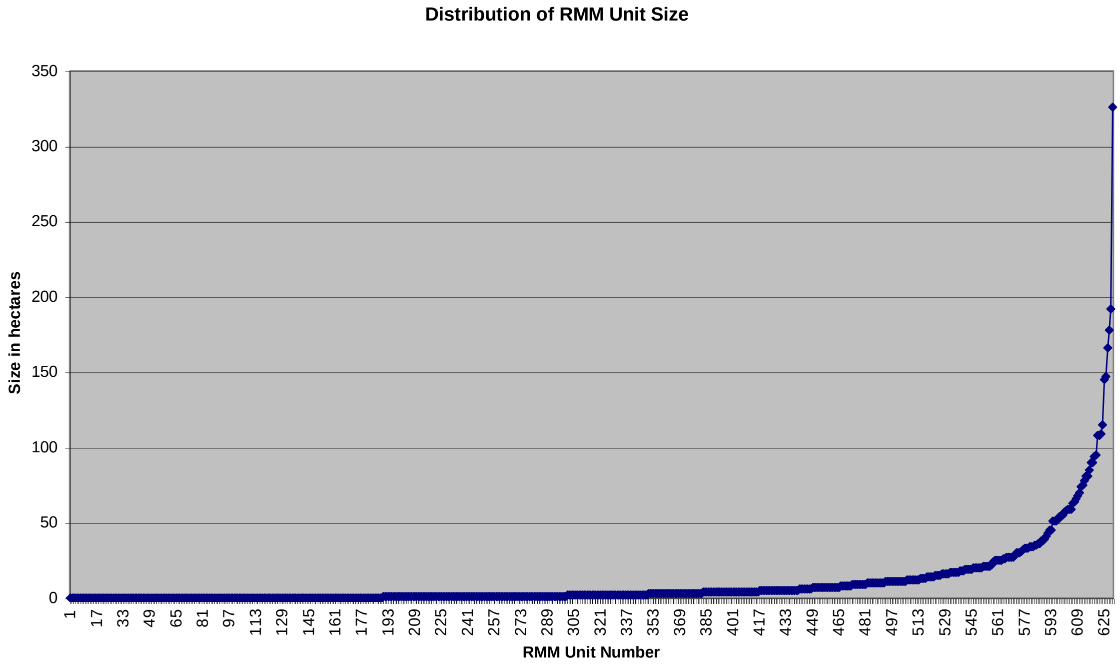

Figure 3 Distribution of RMM Unit Size (Crossing Geology / Watershed Covers)

Finally, Map 2 (see Appendix) provides an idea of the spatial distribution of the size of the Units obtained from this first crossing. The largest units are found in the central, upper part of the Study Area, corresponding to the drainage basin of Marsalforn and Ramla watercourse respectively.

3.2 Crossing of Watershed and SCI Covers

A second RMM Unit Map which was selected for further assessment concerns the crossing of the Watershed and the Surficial Cover Infiltration (SCI) Maps. Compared to the previous example crossing, the number of Units is now reduced to 344, ranging in size from a minimum of 0.04 hectares to a maximum of 280 hectares, with an average size of 18.8 hectares.

As can be derived from Table 6, the Distribution of the Size of the RMM Units is again highly asymmetrical and positively skewed, though to a lesser extent compared to the RMM Cover obtained from the Geology / Watershed Crossing.

RMM Unit Size (ha)	RMM Unit Frequency
< 10	225
11- 25	60
26 - 50	25
51 - 100	19
101 - 150	8
151 - 200	3
201 - 250	2
251 - 300	2
301 - 350	0
Total	344

Table 6 Distribution of RMM Units by Size in hectares (resulting from crossing of Watershed and SCI Covers)

Further comparison between the two RMM Unit Covers, in terms of the distribution of the Size of the Units, is provided in Figure 4, where the RMM Units (X-axis) have again been re-numbered according to increasing size of the Units (Y-axis). Their spatial distribution over the Gozo Study Area is provided by Map 3 (see Appendix).

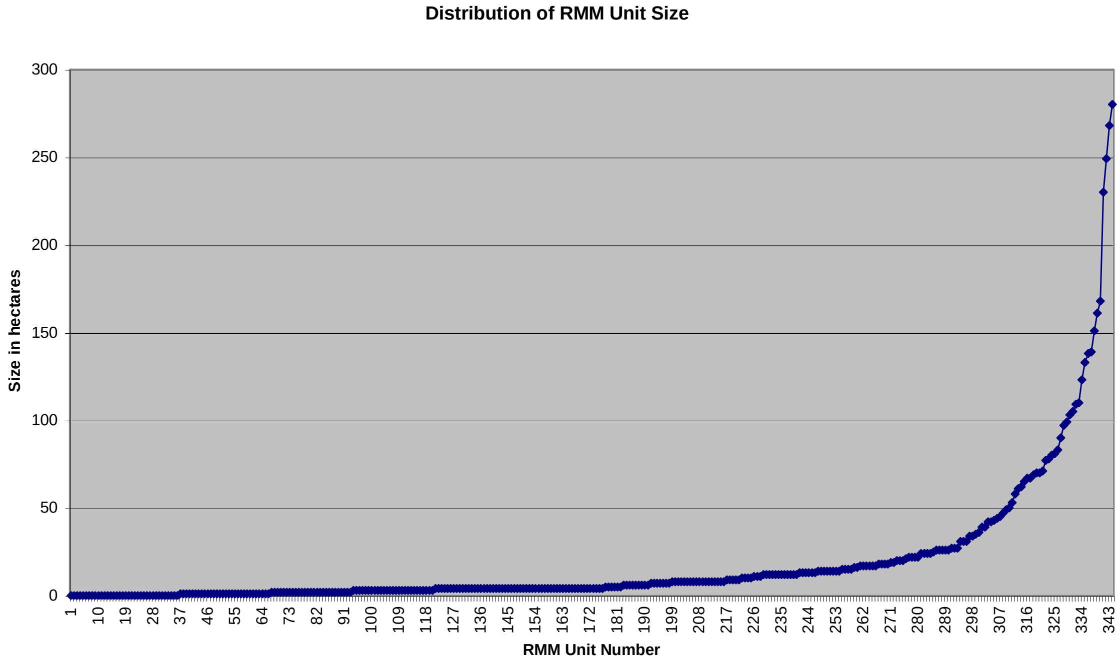

Figure 4 Distribution of RMM Unit Size (Crossing Watershed / SCI Covers)

3.3 Crossing of Watershed / SCI and Local Council Covers

A third RMM Unit Map is constructed from the added crossing of the previous "Watershed / SCI" Unit Map with the Local Council Map, the latter representing the existing administrative division of the Gozo Study Area. As a result, the number of Units is now increased to 514, and the largest size is down to 186 hectares from 280 hectares. An appraisal of the distribution of the size of the units is provided in Table 7 and Figure 5 respectively.

RMM Unit Size (ha)	RMM Unit Frequency
< 10	373
11- 25	74
26 - 50	32
51 - 100	24
101 - 150	10
151 - 200	1
Total	514

Table 7 Distribution of RMM Units by Size in hectares - (resulting from crossing of Watershed, SCI and Local Council covers)

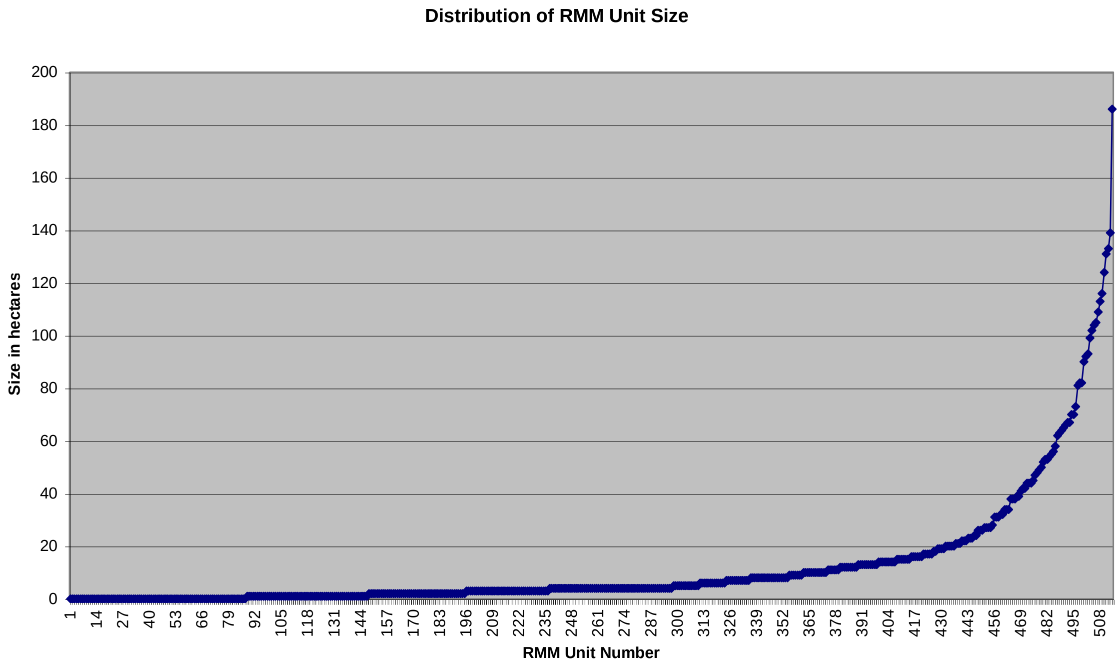

Figure 5 Distribution of RMM Unit Size
(Crossing Watershed / SCI and Local Council Covers)

Finally, a representation of the spatial distribution of the size of the units thus obtained is given in Map 4 (see Appendix).

4. Selection of Optimum RMM Unit Cover

4.1 Review of Lorenz Curve and Gini Coefficient applications

In a communication entitled "Creating RMM Units" circulated by Tarnium on March 11, 1999, the Mediterranean partners were advised to use the Lorenz Curve and Gini Index as a statistical tool to decide on the "optimum" size of the RMM Units.
This raised a number of questions, which were compiled by CREDCO in a communication on 3rd February 2000, entitled "Selection of RMM Units". This resulted in a further communication by Tarnium entitled "Methodological note on Lorenz Curve and Gini Index" circulated to all partners on February 7th, 2000, repeating the advice that the Gini index, which is associated to the Lorenz Curve should be used to arrive at the optimum RMM Units.

IRM Co. then proceeded with a bibliographical study on the use of the Lorenze Curve and the Gini Coefficient. A brief summary of this review is presented below:

1) The Lorenz Curve generally features in the list of "measures" that can be used for summarizing data. In this respect, the Lorenz curve is useful to provide a visual comparison of differences and a precise index of this difference. An Index of Concentration (I) is then defined as the ratio between the area enclosed by the curve with an even distribution and the area contained by the individual curve. A typical example involves the use of this index to measure the extent to which the distribution of employment in a given area has the same level of concentration as a whole country or region in respect of a particular category of employment.

2) The review on the Lorenz curve applications was then focused on its capability to compare between two distributions among spatial units. While the Lorenz curve itself is again constructed using cumulative percentages in both x and y directions, the computation of the Index of Concentration (I) becomes more cumbersome, which leads to the use of another measure: the Gini Coefficient or Index of Dissimilarity, which measures the difference between two sets of paired percentages. The coefficient ranges between 0 and 100, where 0 represents complete similarity, or a minimum concentration and 100 represents maximum dissimilarity, or a maximum concentration. The classic illustration concerns the use of the Gini Coefficient to compare between the spatial distribution of the population in a country when using progressively smaller spatial units (e.g. states, regions, departments, towns).

3) The latter exercise permits to define a first limitation of the Gini Coefficient as a measure of concentration: Any variability within the reference area (region, department or town) is ignored, therefore reducing the amount of spatial variation that can possibly be measured in this way. This limitation explains the "information loss" described in the Tarnium communications: "at each level (size of unit) corresponds to a specific level of information loss, and this loss is proportionally significant to the size of the units".

4) However, the second limitation presents a more significant obstacle: the greater the number of subdivisions, the greater the measure of variation (or concentration). This second limitation will now be illustrated in respect of the previously defined RMM Unit Covers.

4.2 Determination of the Optimum Size of the Units

In the previous chapter, three distinct RMM Unit covers have been created. A recapitulation of the distribution of the size of the units that were obtained is provided in Table 8 using the same categories (classes) which provided the legend for the RMM Unit Maps 2 to 4 in the Appendix - Maps.

In each case, the distribution of the Size of the Units is very asymmetrical, being (highly) positively skewed as can be derived from the table below.

Base Covers for Crossing :	Geology + Watershed	Watershed + SCI	Watershed + SCI + Local Council
RMM Unit Size (ha)	RMM Unit Frequency	RMM Unit Frequency	RMM Unit Frequency
< 10	492	225	373
11- 25	71	60	74
26 - 50	30	25	32
51 - 100	27	19	24
101 - 150	6	8	10
151 - 200	3	3	1
201 - 250	0	2	-
251 - 300	0	2	-
301 - 350	1	-	-
Total	630	344	514

Table 8 Recapitulation : Distribution of RMM Units by Size in hectares - (resulting from 3 selected, example crossings)

As can be expected, the additional crossing of the Watershed + SCI with the Local Councils map, results in an increase of the number of units (i.e. also a decrease in the size of the units). The Gini coefficient therefore suggests that by incorporating the Local Councils an improved measure of concentration is obtained, corresponding to a reduced loss in information. Consequently, further crossings with a fourth or even a fifth map would continue to provide an improved measure of concentration.

A further bibliographical review revealed that the Gini Coefficient is used to analyse a change in concentration of a parameter distribution over time, i.e. when a parameter is considered in a dynamic (i.e. historical) context. However, the Gini Coefficient cannot by itself lead to the determination of the optimum size of the spatial reference units in a static context.

As can be derived from Table 8, each of the selected crossings resulted in a very high number of smaller size units (less than 10 hectares). Evidently, this is a reflection also of the very high level of detail at which the covers (geology, watershed and SCI) were constructed.

4.3 Local Environment Commissions

It is most worthwhile to consider the selection of the optimum size of the units in the context of the SAGE methodology (see also Annex to Final Report: *Test Methodology Formulation: Adaptation of the SAGE methodology to the Gozo Study Area*). The setting up of so-called 'Local Water Commissions' is linked to the division of a hydrological basin in catchments. Catchments with similar characteristics and also needs, are then grouped under the responsibility of a single 'Local Water Commission'.

By extending this concept to the planning and management of all the environmental resources, these extended responsibilities can be assigned to a "Local Environment Commission". Clearly, the implementation of this approach would be greatly facilitated if the area of jurisdiction of each commission respects - or even borrows - the existing administrative division of the Study Area. For the Gozo Study Area, this would mean the setting up of an Environment Commission for each Local Council.

There are 14 Local Councils in Gozo, with an average surface area of 4.7 square kilometers. This simple and straightforward division of the Gozo Study also results in a practicable number of territorial reference units.

However, as will be detailed further in the next chapter, the interrogation of these territorial reference units needs to be adapted from the manner in which the RMM unit covers that were defined earlier can be queried. The reason lies with the fact that the Local Council divisions were obviously not drawn up with the environmental resources in mind. In fact, many of the Local Council boundaries coincide with streamcourses, so that from a water resources management point of view, these boundaries can definitely not be considered suitable.

5. Presentation of RMM Unit Statistical Databases

5.1 Creation of RMM Unit Statistical Databases

The various information layers that were stored in the GIS database for the Gozo Study Area are now linked to the RMM Units in the following manner:

- each information layer (e.g. soil, landuse, habitat etc.) is crossed with the RMM Unit Map, thereby providing - for each crossing:
- an attribute table (e.g. RMM Units crossed with Soils), in which the precise surface area covered by each soil type for each RMM Unit can be found.
- This information is then transcribed into the so-called RMM Unit Database as follows:
  1. For polygon information layers, the RMM Unit Database stores a percentage value, computed by: Area of Intersection divided by Area of RMM Unit:
     e.g. Area of Soil Type "A" is divided by Area of RMM Unit No. 1, and is expressed as a percentage value. This calculation is made for each RMM Unit and stored in a column "%_Area_Soil_type_A". The same process is then repeated for each soil type.

  2. For information taking the form of a segment map, the RMM Unit Database stores a density type of value, computed by : Length of Segment divided by Area of RMM Unit:
     e.g. Length of Road Type "Primary" is divided by Area of RMM Unit No. 1. Again, this calculation is made for each RMM Unit and the results are stored in a column "Density_Primary_Roads". The process is then repeated for each road type (primary, secondary, other surfaced roads, and dirt roads for the Gozo Study Area)

  3. For point data, the RMM Unit Database stores a "count" type of value, computed by : Number of points in each RMM Unit
     e.g. Number of springs in each RMM Unit

The above procedures were followed to create 3 distinct Statistical Databases, corresponding to the RMM Unit Maps that resulted from the crossing of:

A) Geology + Watershed (630 RMM units)
B) Watershed + SCI (344 RMM units)
C) Watershed + SCI + Local Councils (514 RMM Units)

5.2 Comparisons between RMM Unit Statistical Databases

In this section, an illustration is provided of a typical output that can be obtained from the RMM Unit Statistical Databases, together with the result of a typical Database Query using the landcover polygon map.

First it is reminded that the landcover legend that was adopted for the Gozo Study Area constitutes a significant extension of the CORINE landcover classification. Map 5 illustrates the man-made areas in the Gozo Study area, distinguishing between: residential areas, university, church (in open field), cemetary, harbour, heliport, hardstone and sofstone quarries, cultural heritage, boathouses, sportsgrounds and race tracks.

Maps 6, 7 and 8 illustrate how the occurrence of man-made areas has been transcribed statistically (as a percentage value) in the 3 RMM Unit Databases. Towns, representing the largest man-made area category, are therefore also shown on these maps by means of their perimeter.

A typical database query is then formulated: show the RMM Units with more than 50% man-made area. This could again be tested for each of the 3 RMM Unit Databases that were created and the corresponding outputs are provided in Maps 9, 10 and 11 respectively.

The maps demonstrate that a progressively better representation of the man-made areas is obtained as the number of RMM Units increases, a result already expected from the application of the Lorenz Curve and the Gini Coefficient. This first conclusion was confirmed from the comparison between the outputs of similar queries in respect of soils, habitats etc. This allows to describe the validity of the RMM Units as follows

- Best representation found with Geology + Watershed (630 RMM units)
- Followed closely by Watershed + SCI + Local Councils (514 RMM Units)
- Least valid representation with Watershed + SCI (344 RMM units)

However, this would be a rather optimistic evaluation, when repeating the same exercise at the Level 3 of the LandCover that was prepared for the Gozo Study Area, the occurrence of e.g. wooded areas is no longer retrievable in the RMM Output Maps. At least, not unless the threshold is lowered significantly from the 50% mark to as low a threshold as 5% in many cases.

The purpose of the RMM Unit Covers is not to compete with the original data information layers, but rather to enable additional types of queries concerning the state and use of the resources. Particularly the size of the Gozo Study Area may present an obstacle in this respect: since the exact location of very detailed information such as the location of eucalyptus groves which are used for bird hunting, the type and number of livestock in each farm etc., is now readily available from the GIS that was constructed with the ResManMed project, it is not a priori clear to the planner and/or decision-maker what extra information is obtained from the RMM Unit Covers.

This observation led IRM Co. to consider if the RMM Unit approach could be used to visually demonstrate the scarcity of the environmental resources in the Gozo Study Area.

5.3 Local Councils used as Territorial Reference Units

It proved most worthwhile to apply the RMM Unit approach to the creation of a statistical database which is tied to the Local Councils in the Gozo Study Area.

The use of a statistical representation such as:
- percentage area in the RMM Unit Maps corresponding to Man-Made Areas in the Landcover Map - see Maps 6 to 8 - or using
- a threshold percentage as was done in Maps 9 to 11 (RMM Units with more than 50% Made-made area),

fail to represent the 'uncontrolled urbanization' which was identified as one of the most significant impact scenarios for the entire Gozo Study Area.

Maps 9 and 11 demonstrate how the RMM Units provide a good representation for the towns in the central part of the Gozo Study Area: Victoria, Xewkija, most of Xaghra and part of Nadur. On the other hand, a strikingly poor representation is found for the villages of Gharb and Ghasri in the northwest, Qala in the east, Sannat in the South. The seaside resorts of Marsalforn and Xlendi are also not represented satisfactorily. Yet, each of the latter villages is definitely subject to a very high level of uncontrolled urbanization.

This apparent anomaly is very likely because of the fact that the actual growth of urbanized area, especially in the latter villages, corresponds to a linear extension of residential and tourist developments, along roads and natural escarpments. Such linear expansion is dramatically impacting on the value of the landscape (escarpments and valleys).

Using the Local Councils Map as a Territorial Reference Unit Map, and linking the environmental resources to these existing administrative divisions of the Gozo Study Area, permits a novel way to demonstrate the scarcity of the resources: e.g. percentage of remaining garigue and maquis areas in each Local Council. Most interestingly, the uncontrolled urbanization along Gozo's valley roads can also be shown statistically - percentage of valley course length already affected by urbanization.

Appendix 'Maps'

	Gozo Territorial Reference (RMM) Unit Map
Map 1	resulting from crossing of Geology and Watershed Maps
	Gozo Distribution of Territorial Reference (RMM) Unit Size using:
Map 2	Base Covers: Geology + Watershed
Map 3	Base Covers: Watershed + SCI
Map 4	Base Covers: Watershed + SCI + Local Councils
Map 5	Man-made Areas in Gozo
	RMM Unit - Statistical Database Construction using:
Map 6	Base Covers: Geology + Watershed
Map 7	Base Covers: Watershed + SCI
Map 8	Base Covers: Watershed + SCI + Local Councils
	Example RMM Unit Database Query
Map 9	Base Covers: Geology + Watershed
Map 10	Base Covers: Watershed + SCI
Map 11	Base Covers: Watershed + SCI + Local Councils