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Traditional Use of Shore Platforms: A Study of the Artisanal Management of Salinas on the Maltese Islands (Central Mediterranean)

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Abstract

Shore platforms and salinas in the Mediterranean region have a long-standing relationship, rooted in the traditional practice of salt making. On small islands with limited natural resources, the production of salt from seawater, through insolation and intense human endeavour, offered numerous economic benefits. Salt has been a foremost natural resource for millennia with a range of uses from preserving edible foods to cooking, cleaning, laundry, and hygiene, and for medicinal uses in dilute solutions. Within the Maltese Islands, this traditional activity was developed primarily on the soft limestone shore platforms situated along low-lying rocky coasts. Although coastal production has declined in number over the years, a few salinas have persisted in their artisanal practice and are becoming a cultural geo-heritage attraction. The aim of this article is to explore the multiple geographies of this industry on two shore platforms by examining the complicated relationships that have emerged and molded between the physical landscape and human culture. Mapping out these relations through the traditional but complex management systems at two salinas, that is, the salinas at Delimara Point (Malta) and those at Xwejni Bay (Gozo), highlights the delicate nature of these relations as well as the need to support them in order to continually reproduce the cultural micro-landscape. The resultant micro-landscape is becoming an increasingly important living expression of the cultural geo-heritage of the Maltese Islands, which requires careful understanding and management of these relations if it is to be maintained as a vibrant geo-tourist attraction.

Keywords

salinas, shore platforms, cultural geo-heritage, Xwejni, Gozo, Delimara, Malta, Maltese Islands

Introduction

Salinas are mainly found in climate regions with a dual seasonal pattern, consisting of a winter season receiving 65% to 80% of annual rainfall and a warm, dry summer with high evaporation rates (Davis, 2000; Davis & Giordano, 1996; Rodrigues, Bio, Amat, & Vieira, 2011). With its distinctive long-indented coastline, numerous islands, and a climate with a high degree of insolation, the Mediterranean region has been a favourable area for salt-making activities for centuries (Neves, Petanidou, Pinto, & Rufino, 2005). The importance of Mediterranean salinas has been more pronounced in the past, when salt was a vital commodity, at least for food preservation, and played a key role throughout history, providing political power to those who controlled its production and trade. For many centuries, states, churches, cities, and families acquired power and wealth from producing, trading, or simply taxing monopolized salt.

Over the centuries, salt production has been influential in shaping the Mediterranean coastal landscape, with salt-making practices functioning on a system of successive evaporation basins, even before the 10th century (Petanidou & Dalaka, 2009). Based on such basic evaporation techniques, many varieties of salt-making adapted to the particularities of geology, climate trends, and anthropological input and created a diversified Mediterranean salt production landscape (Hueso & Petanidou, 2011).

Over the past two decades, many studies have been dedicated to the physical, ecological, economic, and cultural aspects of Mediterranean salinas (Hueso & Petanidou, 2011; Neves et al., 2005; Papayannis & Pritchard, 2011; Sadoul, Walmsley, & Charpentier, 1998; Walmsley, 1999). Such studies recognize the large diversity of salt-mining practices, which is reflected also in the rich terminology used to

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describe such practices, for example, “salterns,” “saltpans,” “saltworks,” “salt-gardens,” “salinas,” or “salines.” The term “salinas” is the most widely and encompassing term used in literature to describe a site where salt crystals are produced from brine evaporation through natural or artificial systems (Davis & Giordano, 1996; Davis, 2000; Petanidou, 2000; Petanidou & Dalaka, 2009; Sadoul et al., 1998; Walmsley, 1997, 1999). The term “salinas” has also become distinct from the term “saltworks” with the latter attributed to large scale mechanized operations, while manual surface work is referred to as “salinas” (Petanidou & Dalaka, 2009).

The Mediterranean region is home to more than 170 salinas (Crisman, Takavakoglou, Alexandridis, Antonopoulos, & Zalidis, 2009; Sadoul et al., 1998). Walmsley (1999) investigates 165 salinas, with 90 salinas still producing salt, while 64 were inactive or abandoned. Salinas were also found to vary considerably in size, from rudimentary saltpans of less than 1 ha to the large modern industrial salinas of 11,000 to 12,000 ha in southern France (Walmsley, 1999).

Out of the 90 active salinas, 75% are located in northern and central Mediterranean, that is, Spain, Italy, Greece, and France (Crisman et al., 2009; Walmsley, 1999). France is the highest producer with nearly 2 million tons, followed by Turkey, Spain, and Italy. These four countries produce 84% of all Mediterranean salt. Despite the fact that salt can be produced throughout the year in southern Mediterranean countries, there are numerically more salinas producing a much higher annual salt production in the northern Mediterranean countries (Walmsley, 1999).

Salt production has undergone a major transformation during the past two centuries (Crisman, 1999, as cited by Crisman et al., 2009). Although mechanization, especially the development of high volume pumps, led to an expansion in the overall extent of salinas during the 19th century, this trend was reversed in the middle of the 20th century, due to increased efficiency in emerging large scale operations and an associated economic failure for small operations (Sadoul et al., 1998). Traditional salinas in the Mediterranean have been in continuous decline since the 1950s (Hueso & Petanidou, 2011; Petanidou & Dalaka, 2009). In the Mediterranean region, salinas continue to disappear as the demand for prime development land for industrial, urbanization, and tourism projects continues (Petanidou & Dalaka, 2009). Coelho, Hilário, and Duarte (2015) believe that the causes are more complex and include other causes such as lack of technological innovation, competition from aquaculture, changes in hydrological regimes, and lack of environmental integration. Faced with the need to be economically viable, Mediterranean salters are confronted with the choice of either closing down, industrializing the production, or finding a niche market for quality salt that gives higher market returns.

Study Scope

The geographical context and history of salt-producing activities outlined above illustrate the unique cultural micro-landscape produced by the interactions of Mediterranean people with their physical landscape. Salt production on the Maltese Islands is still carried out in a traditional manner, with artisan knowledge that has been passed down through generations and with families working the same salinas for over 200 years.

Research on such an artisanal enterprise needs to highlight more the level of personal connection which exists between the salters and the land they manage with such an intimate knowledge. This work is a first for the Maltese Islands on four accounts: (a) it collects and records traditional site-specific knowledge of local salt-making practices, (b) it identifies and examines how local salinas management is influenced by physical settings at micro- scale, (c) it creates a first mapping visualization of traditional salinas management, and (d) it provides a visual tool for the salt workers to communicate more effectively with their salinas visitors about how their artisanal knowledge is practiced on a spatial level.

To help in the conservation of these cultural geo-heritage sites, it is important to understand the physical landscape upon which they are based, the traditional management of the key physical processes of salt production, and how the relations between these maintain an important geo-heritage activity. Using this knowledge, it is then possible to identify how this geo-tourist resource might be managed to ensure its continuation into the future.

Physical Setting of Maltese Coastal Landscapes

Study Area

The Maltese Islands are located in the central Mediterranean region, at 96 km from Sicily and 290 km from North Africa (Figure 1). The archipelago consists of three main islands—Malta, Gozo, and Comino—and several small uninhabited islets. The Maltese Islands enjoy a Mediterranean climate with hot dry summers and cool rainy winters. The average annual temperature is 18.6°C and monthly means range from 12.4°C (January) to 26.3°C (August) for the same period. The mean annual rainfall is about 550 mm but with high seasonal and interannual variability (Galdies, 2011). The highest precipitation rates generally occur between October and February, and rainfall is characterized by storms of high intensity but of relatively short duration. The island’s wave climate is driven mostly by prevailing westerlies, with the north-westerlies which blow in on an average of 20.7% annually, followed by west south–westerlies (8.9%), the south south–westerlies (7.8%), and north north–westerlies (7.4%). The microtidal regime is predominantly semidiurnal, with a range of only 20.6 cm (Drago, 2009).

Geology and Geomorphology of Maltese Rocky Coasts

The Maltese coastline is 272 km long (Axiak et al., 1999, as cited in Gauci, Deidun, & Schembri, 2005), with 90.5% of its total length consisting of rocky coasts (Gauci et al.,

Figure 1. Location map of the Maltese Islands, with coastal salinas which were developed over the last two centuries.

2005). The physical landscape of the Maltese coast is mainly controlled by tectonic structure and exposed geological strata. Such controls give rise to both an uplifted faulted block and a tilt of about 4° in a northerly direction (Ellenberg, 1983). The resultant coastal landforms are plunging cliffs on the south and southwestern coasts of mainland Malta, while the northern coasts descend to low cliffs and low-sloping rocky shorelines. The island of Gozo has an easterly dip resulting in high cliffs on the west coast and sloping coastlines on the north-east and eastern coast (Pedley, House, & Waugh, 1978).

The Maltese archipelago is composed of Late Oligocene to Late Miocene succession of sedimentary rocks, mainly limestones (Paskoff & Sanlaville, 1978). The oldest unit is the Lower Coralline Limestone and is characterized by massive and resistant gray limestones. The soft and yellowish Globigerina Limestone is composed of fine-grained limestones. The sedimentary sequence continues with the Blue Clay (formed mainly by marls and clays), a thin and fossiliferous unit of Greensand and the last unit of Upper Coralline Limestone which outcrops mostly in northern Malta (Pedley, Clarke, & Galea, 2002; Said & Schembri, 2010).

The blend of tectonic structure and limestone geology developed the ideal coastal landscape for salt production. Geology and geomorphology combined to produce soft Globigerina Limestone at sea level, which resulted in the development of either low-sloping rocky coasts or horizontal/subhorizontal shore platforms along the Maltese coasts. Low-sloping rocky coast (including shore platforms) is the most widespread coastal landform consisting of 36.7% of the Maltese coasts (Schembri, 2003; Figure 2).

Shore platforms in Globigerina Limestone are a type of horizontal to subhorizontal rock surface (0°-5°) which were developed by horizontal or gently dipping geological outcrops at sea level and which are affected by marine action (i.e., wave erosion, biogeochemical dissolution, and other weathering processes; Trenhaile, 1987, 1997). They are usually backed by retreating soft cliffs and end with abrupt low cliff lines and deeply carved notches at mean sea level. Shore platforms on the Maltese Islands can be observed at 5 to 10 m above sea level (a.s.l.) and are rarely submerged due to the microtidal conditions on the Maltese Islands. They have developed when the sea reached its present level about 6,000 years ago (Biolchi et al., 2016). Salinas on shore platforms have developed strategically in a honey-combed rock platform structure (Figure 2). In many cases, the initial presence of naturally forming shallow solution pools with flat bottoms on limestone platforms, better known as *plates formes à vasques* (Trenhaile, 1997; Viles & Spencer, 2014), easily encouraged the further hewning of man-made salinas, through widening and enlarging of these natural pools.

Figure 2. Maltese salinas hewn on a Lower Globigerina Limestone shore platform at Baħar ic-Ċagħaq (Malta).

Thus, the rocky shore platforms of the Maltese Islands formed the basis for the evolution of Maltese rocky saltscapes, on which humanly produced systems built and extended on the natural processes that originally formed the pools. The embedded nature of salt-making activities within the cultural heritage of Malta and their co-evolution with the physical processes has ensured a system that has an effective traditional design and operation but one which needs the consistent application of the tacit knowledge of traditional artisans to continue to function effectively. The knowledge associated with operating the salinas can only be maintained through the long-term experience of interactions with the land and of informed adaptations of tradition methods to changing physical conditions. Experience through practice is the basis for this knowledge and one that requires individuals to learn and to undertake tried and tested traditional practices to preserve them.

Earliest Records of Maltese Salt Production

There is yet no local documented evidence to suggest the existence of salinas on the Maltese Islands prior to the medieval period. To date, no records about its earliest origin have yet been found (Agius Vadala, 1951; Dingli, 2000; Gauci & Schembri, 2014). Such an enterprise is rarely, if ever, mentioned in historical documents. It could be speculated that for a small population in antiquity, the naturally occurring salt from pools on the shore platforms would have been sufficient to fulfill the salt requirements of the population. Potentially, such natural pools could have been enlarged and managed as the population rose and the demand for salt increased. The northern town of Mellieħa, for example, took its name from the Maltese word *melħ* meaning salt, due to the early form of salt-gathering activities taking place at the shores of Għadira Bay (Figure 1).

Formally, the local manufacture of salt became a royal monopoly of the Sicilian kingdom during the Norman rule of the islands (1194-1530) suggesting that it had grown by this time to be large enough to be of economic interest to the ruling powers. That right was eventually inherited by the Order of St. John, when Malta was passed to the Order as a fief and became the home seat of the Order in 1530. During the time under the Knights of St. John (1530-1798), the need for salt increased not only due to a significant rise in the population but also as a result of fear of a siege by the Ottoman Turks which could severely restrict the possibility of food preservation reaching the strongholds. The geo-strategic significance of salt-making activities illustrates even further the increasing integration of this activity into the economy of Malta and its role in maintaining the strength of the occupiers. Realizing its potential, the Knights established a monopoly on fixing prices and imposing heavy penalties on unauthorized salt-making activities (Dingli, 2000).

Price-fixing monopolies are represented as the first documentary record of salt-making activities in 16th-century Maltese documents. Other documents describe the expenditure involved, especially with regard to costs and maintenance of salt-making activities. It was during the 17th century that a saltmarsh area in Salina Bay, situated downstream at the mouth of the Burmarrad valley, was artificially expanded and established as a first example of state-funded salinas (Figure 1). The earliest detailed plans of this project can be traced back to the *Il Cabreo Del Magistero* manuscript compiled under the instructions of Grand Master Jean Paul de Lascaris (1636-1657). A 1715 redoubt located close to Salina Bay, that is, the Salini Redoubt, was subsequently enlarged with a salt store to act as a guardroom for salt harvest security. Salt production reached the peak around 1867 with an annual production of 4,000 tons of coarse salt over two harvests and an export balance of 75% of total salt yield.

Given the massive increase in the demand for salt generated by the Knights of Malta, most typical Maltese salinas, dotting the islands' limestone coast, date from 16th to 17th century (Dingli, 2000). Notwithstanding the economic significance of salt production during the times under the Knight of St. John, detailed information about these type of salinas is very scant. Historical information about the development, location, and number of rocky salinas is very limited, with their earliest reference dating back to the writings of Lacomo

Bosio in 1533 (Dingli, 2000) and some early maps (such as that of Antonio Lafreri in 1551) indicating salinas in the town of Mellieħa (Figure 1). Yet, these Maltese rocky saltscapes remain historically elusive, and in representing one of the most unique Mediterranean landscapes, they surely deserve more research and policy attention.

Maltese Salinas: Location and Typology

In a study by Dingli (2000), it was estimated that there are about 40 salinas along the Maltese rocky littoral, varying in surface area from 1,000 to 17,000 m^2 and with their nearest point located between 1 and 10 m from the water's edge (Figure 1). Their total area is about 170,000 m^2. Mainland Malta has the largest percentage distribution of salinas (70%), while the remaining 30% is located in Gozo (29%) and Comino (1%; Dingli, 2000). Most of these salinas are no longer active and are in highly variable states of disrepair. With the exception of the reclaimed salinas of Salina Bay, the remaining salinas are located on low-sloping coast or on shore platforms (Figure 1).

According to Walmsley (1999) and Petanidou (2005a), the salinas on Maltese rocky substrate are defined as primitive pans. Primitive salinas, as defined by Petanidou (2005a), consist of two types: those on a silt or clay substrate (i.e., a lagoon) and those on a stony substrate (on pre-existing natural solution hollows or artificially carved out from calcareous rock or even marble). Petanidou (2005b) also describes the Maltese salinas as one of the best examples of "atypical" salinas and also as "artisanal," that is, small-scale salinas, operated manually by one salter at all stages of production. Another typology used by Petanidou and Dalaka (2009) would distinguish Maltese salinas in two types:

i. State saltworks: lagoon-type reclaimed salinas, which were subjected to state monopoly with taxes. Salina Bay salinas would belong to such a category as it was developed in the saltmarsh area by the Knights of St. John, and
ii. Non-state saltworks: subdivided into two types, that is, primitive salinas operating on earth lagoon substrates or artisanal salinas operating on rocky substrates. The Maltese small salinas would belong to the second category.

Method

This work is a first for the Maltese Islands in exploring the multiple geographies of Maltese salinas and combining site-specific field surveying techniques with detailed ethnographic work with two families to create a spatial demonstration of a long-established traditional practice. It has investigated two of the best examples of active salinas on the Maltese Islands and run by two families: the Ċini family in Xwejni Bay (Gozo) and the Mangion family at Delimara Point (Malta). Intensive field surveying and ethnographic work was carried out on each site, in collaboration with the site owners over a period of 1 year, that is, from September 2013 to September 2014. Information about the traditional practices undertaken at each respective site was recorded, including their locations, timings, and durations. Ethnographic research included semistructured interviews and discussions with the family members, to allow them to explain their understanding and experience of the site in their own words.

Research data from field surveying and ethnographic work were also used to create a spatial representation, through a mapping visualization of the traditional management of these two salinas. Maps are powerful means to show spatial information and communicate complex phenomena (McInerny et al., 2014). A mapping system of each site can combine spatial information on the extent and internal structures of the salinas with the knowledge derived from experience of the artisans in managing each site. All site features and salt-making techniques were identified, measured, classified, and digitally integrated by using Adobe Illustrator® (Creative Suite Package), Google Earth®, and 1:25,000 geology maps. This method allows data input and manipulation to create a thematic map which displays all the physical features and management operations of the salinas. Combining these layers gives a rich and complex visual representation of the interactions between the geology and knowledge in practice.

Description of Sites

Xwejni (Gozo)

The coastal village of Marsalforn in Gozo has a coastal stretch of salinas extending over 2 km, from the butte of Qolla l-Bajda to the limits of Wied il-Għasri (Figure 1). Xwejni Battery is the last of the fortifications built in the area around 1715, highlighting the strategic nature of both the coastal location and the associated salinas system in that period. The western side of Marsalforn Bay is dominated by the three member subdivisions present in the formation of Globigerina Limestone, that is, Upper, Middle, and Lower Globigerina members (Pedley, 1993; Biolchi et al., 2016). The geomorphological landscape of Xwejni Bay is dominated by Lower Globigerina Limestone (LGL) shore platforms, with the latter backed by Middle Globigerina Limestone (MGL) cliffs (Figure 3). The base of this MGL formation rests on a relatively more resistant LGL member, with a pronounced hard phosphatic bed (the C2 conglomerate) acting as a boundary between the two members. The differential marine erosion—due to the chance combination of these geological features—was the key determinant for the development of Xwejni shore platforms.

Within this setting, the first salinas started to be hewn out more than a century and a half ago (E. Ċini, personal communication, January 16). The salinas at Xwejni, known locally as

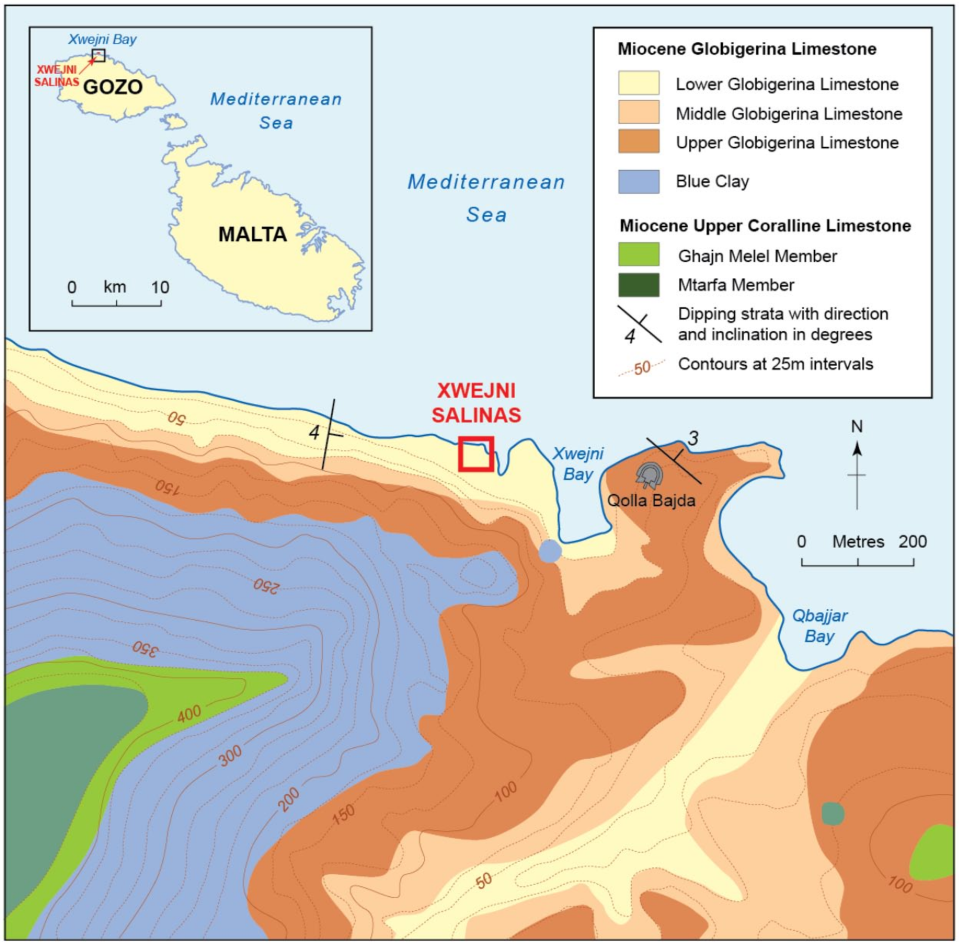

Figure 3. Location and geology of Xwejni Bay (Gozo), with location of salinas belonging to the Ċini family.

is-Salina tax-Xifer, have been tended to by Emanuel Ċini over the past 40 years (Figure 4). Some of the original Xwejni saltpans are 160 years old and were dug by his wife's, Roża, grandfather. At the venerable age of 82 years, Mr. Ċini still works on the pans with the help of his daughter, Josephine Xuereb.

Delimara Point (Malta)

The salinas at Delimara Point are managed by the Mangion family and, like the Ċini family, the work is mostly done by the elder member of the family with the help of his sons.The Delimara salinas are located on a subhorizontal platform at the tip of the Delimara peninsula, known as Delimara Point, on the south-eastern coast of mainland Malta, between the town of Marsascala and Marsaxlokk (Figure 1). Most of the interior section of the peninsula is mainly composed of Upper Globigerina Limestone (UGL) member, while most of the western coastal fringes exhibit MGL member cliff outcrops. The eastern side of the peninsula dips. Two faults—one in a North Northeast (NNE)–South Southwest (SSW) direction and another in a Northeast (NE)–Southwest (SW) direction—intersect at the upper and lower part of the peninsula, respectively. The NNE–SSW fault contributed to a dip of the eastern coastline in easterly and south-easterly direction with an inclination varying between 2° and 6°, with the result that only UGL member is exposed a.s.l. (Figure 5).

These site descriptions illustrate that the chance combinations of geology and lithology have produced a coastal landscape of shallow shore platforms that provide a physical context within which human activity and ingenuity can hew a livelihood. The intimate links of individual families to the landscape highlight the importance of a traditional and experience-based understanding of this physical landform to maintain the cultural micro-landscape that has emerged from it.

Results

Main Elements of the Salinas Functionality

The Maltese primitive salinas consist mostly of rectangular (ca. 0.5-1.5 m^2) and shallow pans (ca. 15 cm in depth; Figures

Figure 4. (a) Located strategically on the foreshore, the rectangular crystallizers occupy significant areas near the shoreline at Xwejni Bay (Gozo), and (b) the salt is collected manually by Emmanuel Ċini in single heaps and then transferred to larger collection pans to drain from excess seawater fluid for another week.

3 and 6). These salinas are in most cases divided by embankments, rarely thicker than 0.15 to 0.20 m and which require regular maintenance. From simple pools originally carved out by seawater action and filled with seawater during storms, in modern periods of more systematic exploitation, these pools were extended and filled systematically with brine either directly from the sea or from larger basins located closer to the shoreline.

As illustrated in Figures 7 and 8, both salinas structurally comprise a connected series of the following four functional elements:

i. evaporation basins: where seawater is collected and allowed to become hypersaline in successive stages;
ii. shallow crystallizers: where seawater is distributed from the evaporation basins and allowed to evaporate and crystallize;
iii. salt collection pans: gently inclined pans on which salt is finally collected and accumulated in heaps from the nearby crystallizers and allowed to drain and dry, before being transferred to the packaging stores; locally it is known in Maltese as *il-manxar*; and
iv. brine water channels: equipped with sluices and water gates, they control and lead brine water by gravity from the larger evaporation basins situated at the shoreline to other smaller evaporation basins located further inland.

Seawater is mainly brought up by mechanical pumps (originally done manually) and distributed along the different evaporation basins, with the brine water channels supplementing seawater by gravity throughout the platform area. Salters undertake a successive system of water evaporation

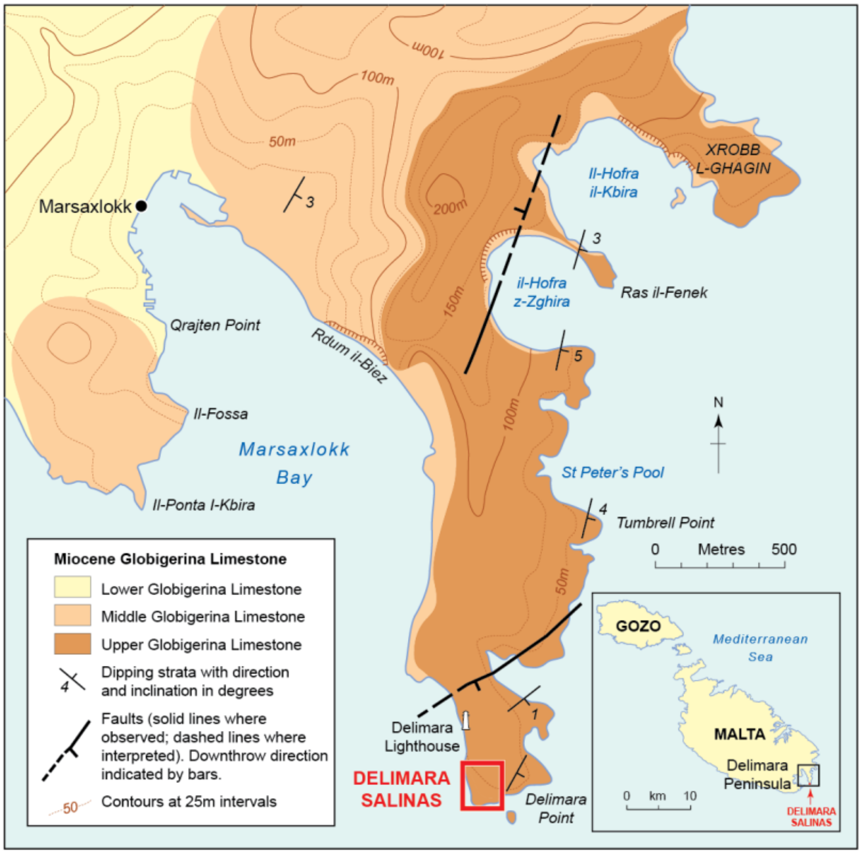

Figure 5. Location and geology of Delimara Peninsula (Malta), with the location of salinas belonging to the Mangion family at Delimara Point.

from one basin to another, which is known locally in Maltese as *il-qibla*. According to this controlled system, the seawater enters the first evaporation basin located close to the shoreline, and as it flows inland through successive evaporation basins, its density gradually increases by solar evaporation. Key objective of this method is to maintain steady state conditions in every evaporation, that is, constant brine density and depth, allowing only small daily variations as each basin feeds into a successive one. As the brine water goes from one basin to the next, fractional crystallization occurs through evaporation regulation and ensures the practical elimination of calcium salts (completed in the evaporation basins of high concentration) and prevents the precipitation of magnesium salts before the complete crystallization of NaCl (which takes place in the crystallizers). Thus, the gentle gradient of shore platforms, especially the subhorizontal type, is fundamental to the success of such fractional process. This system operates particularly effectively because the basins are fed from open seas with pure seawater, and constant care has been taken in for the proper design and operation of the salinas (Korovessis, 2009).

At both sites, the succession of evaporation basins extend from the shoreline to the backshore area, bounded landward either by the road (Xwejni) or the cliff-platform junction (Delimara; Figures 7 and 8). Supplemented by the natural gradient–aided transfer of brine water, most crystallizers are spatially networked around the area of the evaporation basins. Once an optimum brine concentrate is produced, it is then directed—by means of irrigation canals, sluice gates, and pumping systems—to the shallower crystallizers where it stands for another 7 days before harvesting.Where the platform gradient allows it, several access points (marked in black dots in Figures 7 and 8) supply brine concentrate by gravity to the nearby crystallizers. Where such gravity may not be possible, the transfer is aided by a pump system.

Xwejni Salinas: Site-Specific Features and Management

All the sites features and the salina management system undertaken at *is-Salina tax-Xifer* have been mapped out in Figure 7. The crystallizers are displayed in red squared polygons. A total of 273 crystallizers occupy an area of approximately 1,054 m^2 and they mostly range in size between 3 and 6 m^2. The pink polygons indicate the position of the premodern salinas, which today are no longer used in the main

Figure 6. Shore platform at Delimara Point, with salinas belonging to the Mangion family: (a) The upper section of the salinas with evaporation basins and smaller premodern salinas in the foreground; (b) evaporation basins and crystallizers in the lower section of the platform during harvesting time.

production. The gray polygons indicate the collection pans; there are four of these types and in total cover an area of 28.5m^2. The largest collection pan (16.7 m^2) has a (X) symbol to distinguish it as an original crystallizer which was converted into a collection pan. The four collection pans, with dimensions ranging from 3 to 16 m^2, have been set up at various points to facilitate networking of manual collection of salt deposits and transportation to the packaging stores.

The evaporation basins occupy an area of 536.5 m^2 and they range in size from 0.75 m^2 to 77.94 m^2. The total crystallizers' area, that is, 1,054 m^2, is approximately double the size of the combined evaporation basins. All the evaporation basins have hewn-in steps which act as access points to manage the transfer of water through the pump system. These access points are represented on Figure 7 as black dots on the edge of the evaporation basins.

In total, there are 20 evaporation basins at the Xwejni salinas, with the largest ones located in relatively closer proximity to the shoreline and which supply brine water to the smaller basins located landward. Due to the extensive number of salinas present, the management system of the Xwejni site is further subdivided into two sections: the upper section named as *il-Biċċa ta` Fuq* (meaning "the upper part") and the lower section of *il-Biċċa t'Isfel* (meaning "the lower part"). Some cystallizers without channels are filled up with buckets or through a system of overflow. When a crystallizer is positioned at a higher level than the channel, circular channels with stone shutters or small wells raise the water to the required level.

Figure 7 illustrates how most of these Xwejni evaporation basins are connected with brine channels to create a network along most of the basins and crystallizers to facilitate the distribution of seawater from shoreline to the middle shore and backshore area (where brine basins and crystallisers are found). These brine water channels are indicated in Figure 7 in thick blue lines with arrows showing the direction of the water movement along each channel. The channels which are no longer in use are denoted by thin blue lines in Figure 7. At particular end points, some channels have been blocked to manage the water flow. Figure 7 displays such end points in blue points. Apart from the brine channels permeating through the area, the salinas also had a rainwater channel around its perimeter and are marked in a thick dark blue line on Figure 7. It diverts all of the rain surface run-off away from the salinas to avoid water collection and is located on the periphery of the crystallizers.

The Xwejni salinas have also an additional functional feature: a supply basin located close to sea level. Rodrigues et al. (2011) describes the function of a supply basin as a colder and deeper seawater basin that is filled with water and acts as first step before seawater is distributed in the evaporation basins. Seawater is pumped up from this basin by means of a well, located above this supply basin named as *L-Imkisser tat-Tarf* (meaning "the broken one at the edge"), situated on the north-western part of the Xwejni shoreline (Figure 7). Most of the large evaporation basins are denoted by Maltese names to distinguish them from others. At Xwejni Bay, for example, they have named the evaporation basins mostly for their physical characteristics, for example, *Il-Baxx* (meaning "the shallow one"), *Tas-Salib* (meaning "the one with the cross"), *It-Twil* (meaning "the long one"), or *Tal-Kantun* (meaning "the one with a slab of rock").

Delimara Point Salinas: Site-Specific Features and Management

The shore platform site on which the salinas are located has a surface area of 5,633 m^2 and a total coastal length of 245 m. The salt pan area is located on UGL and is totally backed by UGL cliffs at heights between 15 and 8 m a.s.l. The platform stands at an elevation of between 2 and 9 m a.s.l., with the highest platform elevation measured in the northern part of the platform, and then it gradually drops to 2 m a.s.l. in a

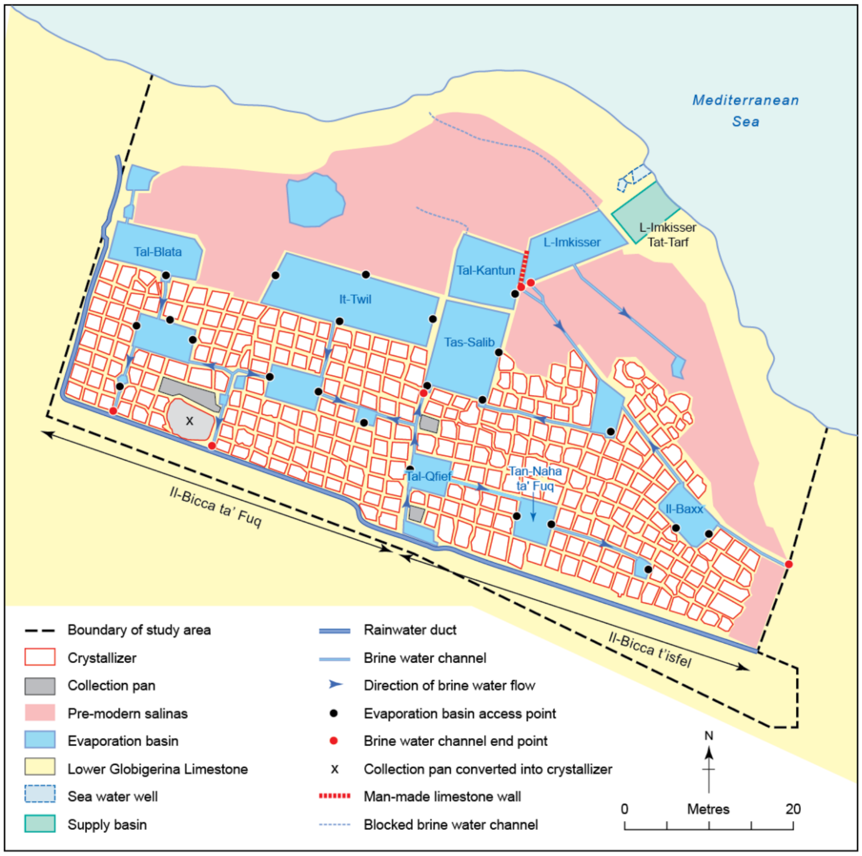

Figure 7. A mapping representation of the traditional salinas system maanaged by the Ċini family at Xwejni Bay (Gozo).

southerly direction. Topographically, the salinas site is highly unaccessible given that the platform is situated at the bottom of steep MGL cliffs (Figure 6a). In fact, the salt workers access the site from the street level by ladder and need to uplift the collected harvest through a chain block system to transport it to the stores.

As displayed in Figure 8, the salinas at Delimara Point comprise a total of 60 units: 28 evaporation basins (marked in blue) which supply hypersaline water (marked in blue line) to 29 crystallizers (marked in white with a red border). Three unused areas of premodern salinas (marked in pink) are still visible as a testament of the original roots of this industry (Figure 8). The 28 evaporation basins range in size from 9.3 to 177.8 m^2 and together occupy an area of 3,760 m^2, that is, 57.5% of the shore platform area. The 29 crystallizers are substantially larger than the ones of Xwejni Bay. They range in size between 8.5 m^2 and 150 m^2 and occupy an area of 1,430 m^2 (25.5% of the platform area). The salt is then collected in three collection pan areas (marked in gray), centrally located in the backshore part of the platform (Figure 8).

The interconnecting feeding system between the evaporation basins and the crystallizers exists also at the salinas of Delimara Point. The process of salt production at Delimara Point starts in March, with the salinas checked and repaired from winter damages until May. During May, cleaning from algal growth takes place and then are manually swept with seawater for a final clean. Once the brine water is pumped into the various crystallizers, surface salt crystals start to form and then deposit themselves at the bottom of the unit. Aluminum spades are regularly used to break down the bottom salt crust to not allow the crust to harden further and facilitate the collection of the salt crystals. A crystallizer is usually filled with approximately 2 inches of brine water, and the latter takes approximately 1 week to evaporate into salt crystals.

Similarly to Xwejni, most of the evaporation basins at the Delimara salinas have been given Maltese names, to aid in their recognition during work. At Delimara, evaporation basins come in relatively more different shapes and sizes and are spatially more unevely distributed. Thus, as seen in Figure 8, numerous basins bear specific names, making their utilization more intensive and their mapping more complex. Most of the names of the evaporation basins are related to their shape or location, for example, *It-Twins* (meaning “The Twins”) is the name of two brine basins that are identical in shape and are located next to each other. The terminology here indicates the way the Maltese have taken on English terms to substantiate explanation of features. The brine

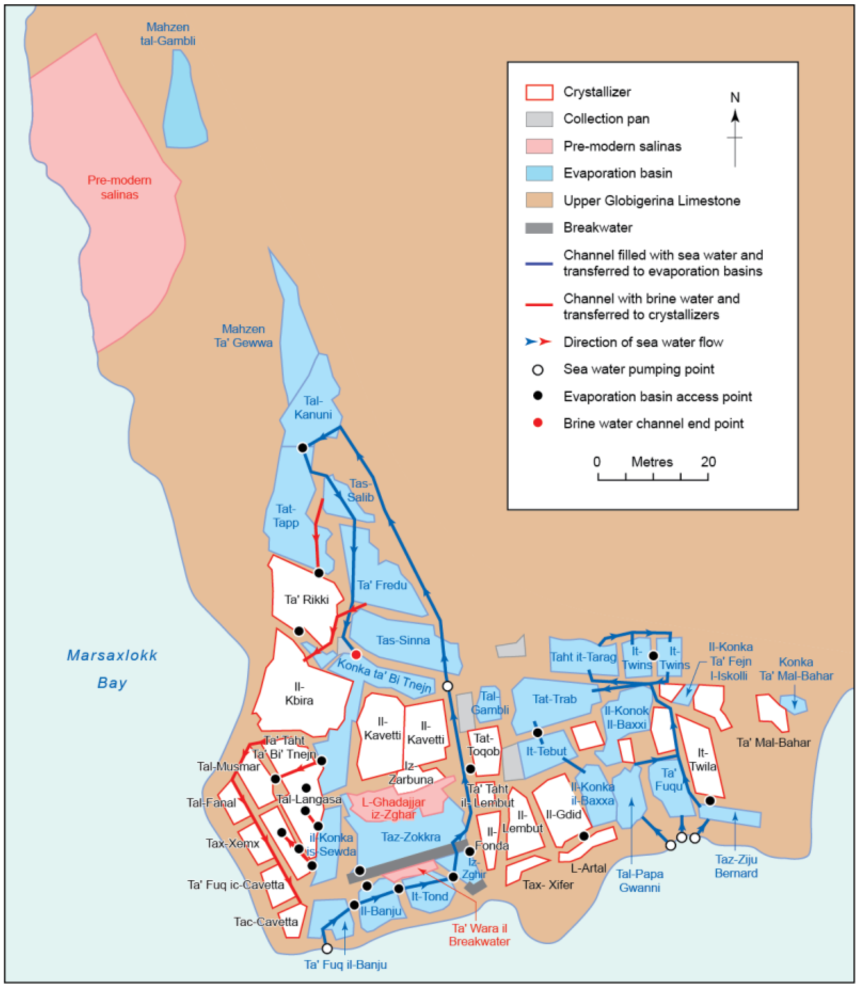

Figure 8. A mapping representation of the traditional salinas system managed by the Mangion family at Delimara Point (Malta).

reservoir of *Taħt it-Taraġ* (meaning "under the stairs") owes its name to its location under the stairs leading from the top road to the platform site (Figure 8). There are other names of some evaporation basins which owe their names to their shape or position within the plaform. The name *Il-Kavetti* refers to two salinas that have a creel-shaped form. *Kavetta* is also the word used to a container where caught fish are placed to be sold at the market and which has the same form. *Tal-Lanġasa* salina owes its name to its pear-shaped form while *Iz-Żarbuna* salina has been named due to its form being similar to a shoe. *Il-Lembut* refers to its shape as a funnel, whereas *Tax-Xifer* [the one at the edge] refers to its position at the edge of the platform ("xifer" meaning "edge"; Figure 8).

It was rather interesting to record some familial stories that led to the christening name of some other salinas. The salina of *Taċ-Ċavetta* (meaning "of the key") owes its names to an incident when one of the owners lost his home key in it. *Tas-Sinna* (meaning "of the tooth") refers to another incident when one of the sons of the owners lost a tooth while helping his father during his younger years. Both items were thankfully found and retrieved.

Harvesting

It is estimated that a favourable season may produce between 2 and 3 tonnes of salt (Ċini and Mangion salters, Personal Communication, January 16, 2014). Depending on the size of the crystallizers, it may be collected in single heaps at the center of each unit, such as at Xwejni Bay (Figure 3a). In the case of Delimara Point salinas, which are relatively larger, the salt from the crystallizers is harvested into smaller equally spaced sectors, with several salt piles prepared in each crystallizer. The salt is swept up with traditional tools (such as soft brooms, hand spades, and even by hand) and gathered in buckets locally referred to as *sossli*. Salt is collected into one main pile and left outside to dry in the sun on a slightly inclined large collection pan for the prepared pile to drain from any excess liquid. Once dry, it is transported back to garage stores in wheel barrows where it is packaged under particular brand names: in this case, as "Xwejni Salt™" and "Lighthouse Salt™" (for the Delimara Lighthouse located closed to the Delimara Point salinas site). In the case of the Delimara Point, given that the platform is located at the foot of a high rectilinear cliff, the salt is initially packed up in sacks of 50 kg each and then lifted up with a crane onto a waiting truck, where it is loaded and taken to stores. The evaporation basins are then re-filled with fresh seawater for successive harvesting weeks. Salt, in 400 g packaging, is then mainly distributed to wholesalers, supermarkets, green grocers, and vegetable vendors. However, other customers may come directly to the salinas during harvest time, to purchase salt as a food condiment and for the preservation of capers and local olives, and for making cottage cheese.

Discussion

Salinas: An Entity With an Identity

This research demonstrates how the two investigated salinas share aspects of functionality, which are similair to other artisanal salinas found in the Mediterranean region and described in the literature (Hueso, 2015; Neves et al., 2005; Petanidou & Dalaka, 2009). Yet, although Maltese salinas may share common artisanal functions on how to produce salt, the ethnographic and mapping work on the two salinas also illustrate how much the work remains highly dependent on the physical elements operating on the platform: the exposure of the salinas to the prevailing winds, the humidity conditions brought by that same winds, the elevation of the platform, the platform surface area that can accommodate a ratio of between evaporation ponds and crystallizers, and the gradient that influences the gravity flow of the brine water throughout the platform. Site-specific knowledge associated with operating the salinas can only be maintained through the long-term experience of interactions with the land and of informed adaptations of tradition methods to changing physical conditions. Experience through practice is the basis for this knowledge and one that requires individuals to learn and to undertake tried and tested traditional practices to preserve them.

Salt-making process has revealed itself to be more than just an industrial system of inputs and outputs. For both families of salters, the salinas represent a lifetime connection with their forefathers and an inheritance of land hardship and tight family values passed on to them. Both sites have been managed by up to five generations who have in turn developed each a site-specific artisanal practice, with the latter being both attuned to and constrained by the geo-topographic characteristics of the site. This work presents very scantily documented knowledge of the land and demonstrates how artisanal salinas management is the result of experience from practice and intergenerational familial ties. The interviewed salters exhibit a strong sense of landscape attachment and share a firm belief in the authenticity of their work based on the specific features of their salinas and the salt produced.

Another important finding presented in this work is that the investigated salinas represent more than just nameless rocky saltscapes. Salinas possess an unique identity, deeply connected with the site-specific features and the family members who look after them. Their site features are endowned with names which hold personal memories and familial histories. Such names are nowhere documented, and this work provides a first evidence of their location and meaning within the salinas (as displayed in Figures 7 and 8). Hueso (2015) reiterates how much all this effort for landscape authenticity—rooted in familial identity and a sense of belonging—highlights the uniqueness of this practice as a living heritage and its importance at strategic policy levels.

In investigating the two salinas, it became increasingly difficult to consider them as purely cultural landscapes, without any connection with the physical setting in which they operate. Küster (2004) explains such an ambivalent perspective by suggesting that, though natural landscapes are mainly shaped by natural processes and cultural landscapes are more or less intensively influenced by humans, the distinguishing line between the two landscapes may be difficult to locate precisely. If cultural activities are still dependent on and sensitive to the physical processes operating on such landscapes, Küster (2004) argues that it becomes increasingly difficult to differentiate between natural and cultural landscapes. Within this context, salinas do acquire such type of dual identity, in which human traditional systems and physical processes remain mutually dependent for success in their operations.

Challenges: From Global to Local

Like in other Mediterranean countries, the traditional salt industry on the Maltese Islands is giving way and being replaced by more efficient and highly industrial way of salt production. In the last three decades, the world salt market has experienced profound changes with salt production becoming increasingly industrialized and managed internationally and transnational by multinational companies (Neves et al., 2005; Petanidou & Dalaka, 2009). The importance of less salt for a healthier living, together with the use of refrigeration (and other methods) in food preservation have undermined its role as a prime commodity, its consumption and marketability. The abandonment pattern experienced on the Maltese Islands has not been very different from the ones experienced in other Mediterranean countries (Neves et al., 2005; Petanidou & Dalaka, 2009). The future occupation of the salters is of special concern, as the decline in artisanal salt production has led to increased salinas abandonment, with a consequent loss of cultural landscapes and related site-specific traditional knowledge.

Apart from the changes driven by the global world markets, societal changes and personal economic aspirations have also to be taken into account. Although salt making may constitute a second or third source of income for many families (Petanidou & Dalaka, 2009), the intensive working nature of salt making does little to appeal to future generations outside the familial ties of salters. Salt production is very labour-intensive all year round, with the highest peak of work needed to be carried under the scorching summer heat. Hueso and Petanidou (2011) discuss how saltscapes are fragile systems built from material found on site, and the construction is subtly complex requiring technical knowledge of the land. When left abandoned, these structures decay very quickly. Thus, the survival of such artisanal work relies on the provision of well-trained and strongly motivated individuals (Hueso & Petanidou, 2011) and which this industry is in dire shortage of.

As Allen and McIntosh (1997) point out, there also a number of immediate local challenges which lie outside the control of the salters, and these are mostly tied down to the physical conditions in which they operate. These challenges were also encountered at the investigated Maltese salinas. The amount and quality of annual salt production is variable and largely dependent on atmospheric evaporation such as air temperature, wind intensity, atmospheric humidity, and water exposure surface. In the case of the Maltese Islands, strong winds, southerly dust-borne winds, and high humidity do not augur well for a good harvest. Although evaporation is faster when temperature and wind intensity are higher, strong winds exacerbate the drying effect of salt water, leading to the rapid development of evaporite crusts on the surface and interrupting the evaporation process. The salters would need to manually break the surface crust and replenish the water with same salinity and temperature conditions to resume the evaporation process. Alternatively, high atmospheric humidity slows down evaporation and, as a result, the drying process too. With winds having a huge influence on the speed of evaporation, the orientation of the salinas is of critical importance. For a more effective action of the winds, crystallizers' orientation should allow predominant winds to blow diagonally over the compartments, from the deepest to the shallowest basins. In the case of Delimara, given the UGL cliffs border the entire shore platform, strong north-westerlies may release cliff material and dust which ends up being deposited in the brine basins located close to the cliffs. In fact, the brine reservoir most exposed to cliff debris contamination is aptly named *Tat-Trab*, meaning "the one with dust." Exposure to storm waves is also challenging. The Xwejni Bay salinas are highly exposed to north-westerly and north-easterly storms, which cause severe damages to the embankments by wave action in winter (Figure 9d). The Delimara Point salinas receive high storm waves conditions from south and south-easterly direction. Apart from impact damages, storm waves during spring may also disrupt the preparation phase of the site, with rough sea conditions sweeping away the prepared brine water in the evaporation basins.

Land use development within the vicinity of the site is also another external and immediate threat. The Xwejni Bay salinas border a highly accessible road and lie in the vicinity of diving practices. Although the roads have favoured salinas visitors with more accessibility, it has also meant that salinas became accessible for other recreations which peak during the same summer months and coincide with the intensive harvesting activity (Figure 9). However, the Delimara salinas, located at the base of a rectilinear cliff escarpment, have limited accessibility and thus are cut off from possible threats of nearby land use development. Protection from further land encroachment is expressed by the salters as a primary protection requirement and mingled with some hope for an appreciation of the intrinsic values of this rugged landscape.

Many of the active Maltese salinas still remain left to their own devices, with the families responsible for their regular restoration, conservation, and market management. Most of these sites are not listed as scheduled property under the Malta Scheduled Property Register, which is a national register for all legally protected heritage property of the Maltese Islands. To date, only one salinas site has been included in the scheduled list of properties by the Environment and Resource Authority (ERA), that is, the salinas at Salina Bay, listed as "historic architecture" under the 1992 Act of Property Scheduling. Presently, government funds are only available for maintenance works on the large capacity salinas of Salina Bay.

Diversification and Outreach for a Living Heritage

The salt harvesting part has retained much of the original traditional elements, similar to other salinas of the Mediterranean region (Neves et al., 2005; Rodrigues et al., 2011). The salt is normally harvested with very primitive tools, such as spoons and hand spades, or, more frequently, is collected and scooped with palms and fingers to ensure protection of the salinas' structures. It is mostly this part of the salt-making practice that holds cultural charm as a living heritage and attracts large number of tourists in summer, with the salt harvesting time coinciding with peak tourist season, that is, between June and September. Studies in fact confirm how much saltscapes hold potential as alternative resources for sustainable local development and revitalization of marginal areas (Petanidou, 2001; Petanidou, Dahm, & Vayanni, 2002; Petanidou & Dalaka, 2009; Zeno, 2015).

The cultural attraction within the traditional and artisan practice of salt making is slowly but similarly transforming the Maltese salinas into a prime site for geo-tourism. Such attractions to local salinas has been happening over a number years in a very spontaneous and organic manner, without any policy pushes or protective legislations at national level. The two investigated salinas (as like other local salinas) have featured regularly in both local and international media and independently keep an active outreach of their work through the use of social media and hands-on workshops for the

Figure 9. At Xwejni Bay (Gozo): (a) an educational sign board issued by the Ministry of Gozo; (b) a vandalized information sign about the salinas; (c) other warning signs set up by the salters; (d) winter storm waves from north-west heavily impacting on the salinas.

public. Such initiatives are proving to be very cost-effective ways to market their artisan practices and are generating a growing interest and appreciation.

Conclusion

Mediterranean societies have undergone profound social changes at all levels, particularly in relation to systems and means of production. These changes have had inevitable effects on the traditional multifunctional Mediterranean landscapes, especially with regard to the small-scale rural components (Pinto-Correia & Vos, 2004). As part of this transformation, saltscapes today constitute a threatened landscape in the Mediterranean and elsewhere. Yet, saltscapes still hold values associated with architectural aspects of the salinas, traditional ways of production and equipment used, working and social conditions of the people employed in salt making, and even the product itself as a cultural element (Neves et al., 2005; Petanidou, 2001; Petanidou et al., 2002). Under these circumstances, the only solution is to preserve their existence and values by applying an alternative type of rehabilitation and management focused on promoting them as sites of special cultural value for environmental and geoheritage education and for alternative forms of tourism (Neves, 2002; Rodrigues et al., 2011).

In terms of traditional wisdom as part of cultural heritage, a paradigm shift is required to look at traditional uses of Maltese shore platforms as an evidence and a representation of traditional practices and also as an important living, cultural geo-heritage in practice. Salters practice artisan knowledge that needs to be exhibited and conserved, especially in the light of the declining numbers of salt workers, each with their family history and traditions in salt-making.

This work has demonstrated important linkages between the traditional work of the salters and other uses, communities and interests, and across the land-sea interface of shore platforms. There needs to be more recognition of the ever dynamic and multidimensional use of shore platform space, which, in this work, has been best captured through the visual efficiency of mapping systems and the stories of inherited knowledge, both uncovered through geographic and ethnographic research. It is hoped that this research may rekindle a debate about the geo-heritage value of coastal micro-landscapes and inject further discussion on how both these landscapes and existing artisanal practices operating on them can be better supported, as part of a wider national debate on geo-heritage recognition and resultant conservation.

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