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# Seascapes and Fresh Water Management in Rural Greece: The Case of the Mani Peninsula, 1261–1821 CE

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## Abstract

The Mani peninsula is a semi-arid landscape with few natural sources of fresh water, yet it supported a dense population during the Late Byzantine and Ottoman periods. This paper reviews the archaeological and historical evidence for water-management practices in Mani, concentrating on its domestic-scale hydraulic infrastructure (cisterns and saltpans) and the ports and harbours along its coasts. The data point to a critical shift in household-level social organization at the turn of the 18th century, underscoring the fact that people living in supposedly 'peripheral' regions like Mani nevertheless engaged in far-reaching networks of contact and exchange.

## Keywords

rural landscapes; cisterns; salt production; Ottoman period; Greece



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## **Introduction**

When the travel writer Patrick Leigh Fermor first visited the Mani peninsula in the 1950s, he imagined he was stepping into a version of Greece's past where modernity had not yet eased the difficult way of life in the remote countryside. Throughout his account of Mani, he alluded to the hardship imposed by a scarcity of fresh drinking water:

[W]e watched the daughter of the house drawing water from a deep well leading to a cistern in the white rock. What a time it took till the half brackish, half sweet and slightly cloudy liquid appeared; it was as if the delay were caused by slow and tender decanting in some subterranean cave! [...] Poor Maniots! The policeman sighed and said that he sometimes woke up in the night, thinking of a glass of crystal spring water. (Fermor 2004: 73)

The image of a man dreaming of fresh water is an appropriate symbol for the critical role played by water resources in the everyday lives of people living in rural and semi-arid landscapes like the Mani peninsula. Throughout the post-Medieval period (i.e. the Late Byzantine [1261–1460], first Ottoman [1460–1685], Venetian [1685–1715], and second Ottoman [1715–1821] periods)<sup>1</sup>, Mani was home to a growing population despite the scarcity of fresh water resources: the few natural springs were concentrated in the very northern and southern parts of the region, and there were no perennial streams or irrigation systems to water the fields. Survival depended on the ability to capture and store rainwater during the wetter winter months for use during the dry summer. Hundreds of cisterns, preserved today amidst the ruins of post-Medieval settlements, attest to the efforts of previous generations to harvest rainwater for their day-to-day survival. At the same time, the sea that surrounds Mani's shores connected the peninsula to other coastal

<sup>1</sup> The term 'post-Medieval' is widely used in archaeological research in Greece to refer to the centuries following the climax of Byzantine rule in the Middle Byzantine period (AD 843–1261), up until the Greek Revolution began in 1821 (e.g. Bintliff and Caroscio 2013; Caraher et al. 2008; Vionis 2012). Admittedly, the popularity and tenacity of the term reflect a bias toward sites and materials which predate Ottoman rule. Ottoman archaeology in Greece is still nascent, and the paucity of archaeological information about these later centuries makes it difficult to establish regional chronologies and tease apart the specific phases that correspond to historical events and administrative changes. Until further archaeological work is done, this term will continue to serve the functional role of describing settlements in Greece dated to the 13<sup>th</sup> century and later.

regions and passing ships, providing it with the resources necessary to sustain a relatively large population — or providing them a means for emigration when it could not.

The data presented here were collected in 2014 and 2016 for a study on the post-Medieval settlements of Mani (Seifried 2016). The study area encompassed the southern half of the peninsula (ca. 350 sq km), ending at the town of Oitylo in the northwest and the fortress of Passava in the northeast (Fig. 1). A total of 215 post-Medieval settlements were recorded, including permanent villages and towns, but excluding seasonally occupied sites and monasteries (see Fig. 2). Field visits were made to 159 (74%) of the settlements in order to map houses, cisterns and other features, while the remaining 56 settlements were identified in remotely-sensed satellite imagery and historical aerial photographs. In tandem, archival records were assessed in order to collect demographic information and trace local toponyms, most of which have remained relatively unchanged since the earliest available records. It was possible to assign general dates to the settlements based on their architecture and representation in historical records, but more precise dating is not currently possible due to the lack of regional ceramic chronologies for the post-Medieval period (see note 1).

This study examines the relationship between water resource management and household-scale social organization in the Mani peninsula, where a shift in water-related social practice can be discerned around the turn of the 18<sup>th</sup> century. Throughout this paper, the term 'household' is used to refer to individuals living in a single residential structure or a residential compound with attached or associated houses. In the early phase, roughly corresponding to the Late Byzantine and first Ottoman periods, access to fresh water was equally distributed throughout the settlements. Cisterns were unprotected and generally adequate for supplying water to a group of 4–6 people and a small number of animals or a garden. In the later phase, corresponding to the Venetian and second Ottoman periods, fresh water resources were increasingly protected within the walls of residential compounds, and their increased size could supply water to a greater number of people. Unusually large cisterns existed in both phases, but their location within the settlements suggests that the earlier could have been used as communal resources,

whereas the later were located within the compounds of the most powerful local families.

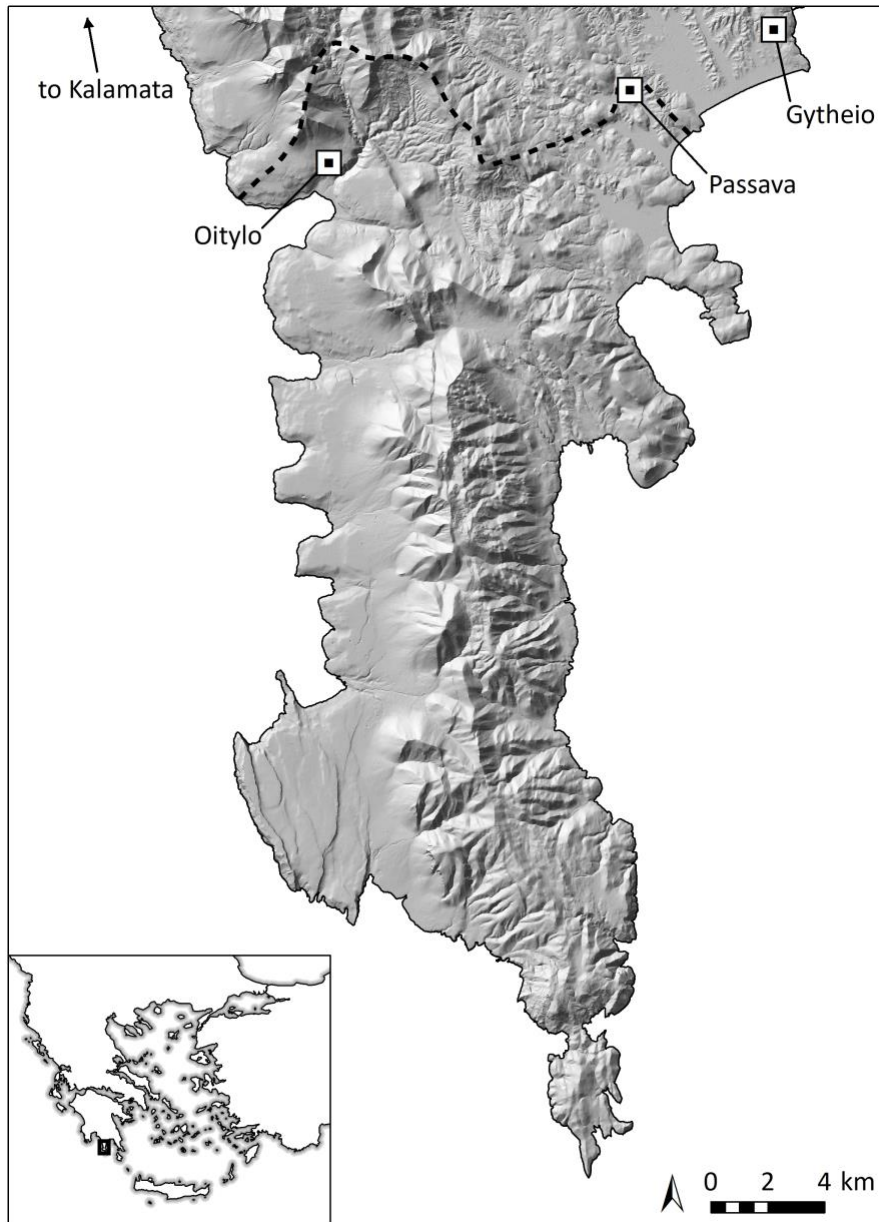


Figure 1. Overview and topography of the Mani peninsula, showing the northern boundary of the study area with a dashed line. Elevation data from the National Cadastre and Mapping Agency, S.A. (Ktimatologio).

Mani was a heavily populated but peripheral region at this time, and while officially subsidiary to the Ottoman Empire and the Republic of Venice, the reach of these powers was limited to the levying of taxes and a few ultimately unsuccessful

attempts to control its major harbours. Indeed, the fortresses built to protect these harbours appear to have been the only real markers of foreign rule in the region: no Turkish or Venetian settlements were established there; nor were any mosques or Catholic churches built (for a similar region in Crete, see Price *et al.* 2008: 98). Unlike regions with large-scale, state-sponsored hydraulic infrastructure, Mani's water resources were managed by local households, which built domestic-scale water infrastructure in order to sustain year-round agro-pastoral lifeways.

Despite the region's semi-arid climate, low agricultural potential, and geographical isolation from overland routes, the population of Mani in the post-Medieval period was sustained via two lifelines. The first of these lifelines was the sea, which made possible the inter-regional connections that brought necessities to Mani's shores, both in exchange for exported goods and by way of illicit activity. The second was the domestic-scale hydraulic infrastructure: the cisterns built to capture rainwater and provide potable water for the people and animals living in Mani, and the saltpans carved laboriously out of rock to collect salt.

## **Regional setting**

Mani is the central and most southern of three Peloponnesian peninsulas, situated north of where the Kythera channel connects the Aegean Sea to the wider Mediterranean (see Fig. 1). Its climate may be characterized as semi-arid, with a typical Mediterranean pattern of hot, dry summers and cold, wet winters (Baltas 2007: 71), and its predominant vegetation includes grasses, shrubs, low trees, and some succulents. It lacks perennial streams, and springs are almost absent from the main areas of post-Medieval occupation (Fig. 2). Data from the nearest weather station in Kythera (1971–2000)<sup>2</sup> indicate that the average annual rainfall in this area is about 520 mm, with a total of 79 days of rainfall per year (Hellenic National Meteorological Service 2017).

<sup>2</sup> Despite the rich potential of recent paleoclimatic studies of the Peloponnese, particularly for understanding the effects of climate change on agricultural production and demography, the data do not currently extend past AD 1000 (Boyd 2015: 36–44; Finné *et al.* 2017; Weiberg *et al.* 2016: 51).

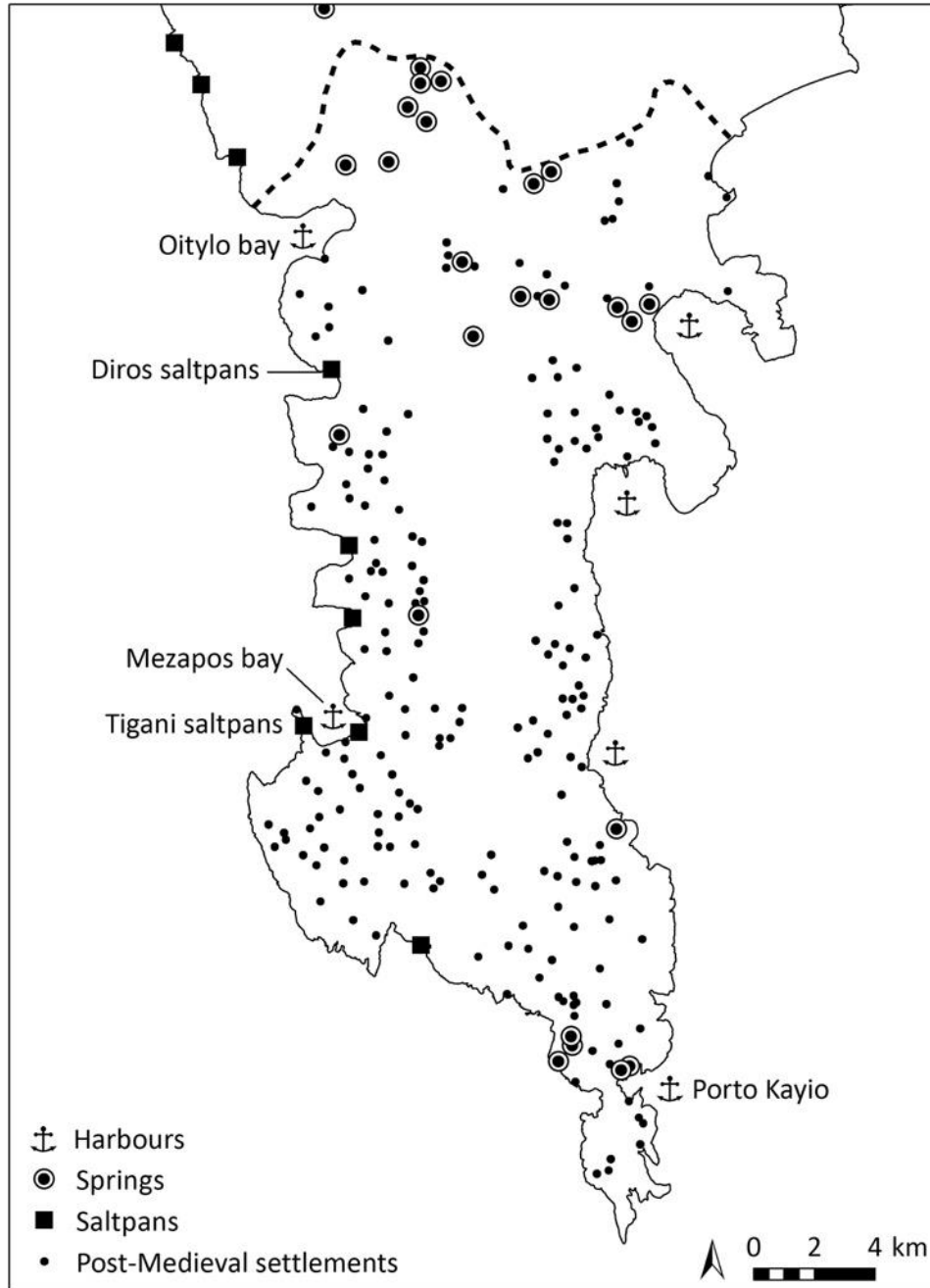


Figure 2. Map of the water resources and post-Medieval settlements (AD 1261–1821) in the Mani peninsula. Location of springs from Matsouka 2009 and saltpans from Saitas and Zarkia 2001: Fig. 1.

Archaeological evidence speaks to a continuous but sparse occupation of Mani from the Classical through Early Byzantine periods (Gardner 2018; Pullen *et al.* 2018), with settlement primarily concentrated in small coastal towns. The palynological record marks a decline in the Greek agrarian economy between the

7<sup>th</sup> and 9<sup>th</sup> centuries AD, followed by a revival of cereal cultivation in AD 900 (Izdebski *et al.* 2015: 82, 85). This revival corresponds roughly to a period of settlement intensification in Mani in the 11<sup>th</sup> century, when population shifted to a dense network of small settlements of between 10 to 50 houses. These settlements were concentrated in the plains and low foothills of the mountains and were characterized by a unique style of massive dry-stone architecture; houses were simple, rectangular, two-story structures averaging just over 20 sq m in internal area (Fig. 3; Moschos and Moschou 1981; Moutsopoulos and Dimitrokallis 1976–78, 1980). This settlement pattern and associated architectural style continued relatively unchanged into the early centuries of Ottoman occupation (Seifried 2016: 40–52, *in press*). Some of the settlements, today called *palaiochores* ('ancient villages') or *palaiomaniatika* ('ancient Maniate villages'), are still occupied today, while others were abandoned and are now preserved in a semi-ruined state (Moschos and Moschou 1981: 3–4, 1982: 263; Moschou 2004: 34–36).



Figure 3. Typical residential structure in the *palaiomaniatiko* settlement of Males near Pyrgos Dirou, from the southwest.



Despite a permanent contraction of the agrarian economy beginning in the mid-14<sup>th</sup> century (Izdebski *et al.* 2015: 89–91), archival sources indicate that Mani's population was relatively high during the post-Medieval period (Table 1; Seifried 2015). These sources include: (1) a letter written in 1618 by Pierre de Medici to Charles II, Duke of Nevers, which estimates the number of men capable of participating in a revolt against the Ottomans (Komis 2005: Appendix 3.1; Wagstaff 1977); (2) a list compiled in 1695 by the Venetian colonel Francisco Muazzo, which estimates the number of fighting-age men in Mani (Komis 2005: Appendix 3.5; Moatsos 1976–78), (3) a Venetian census of the Peloponnese from 1700, conducted under the Provveditor General of the Morea Francesco Grimani (Komis 2005: Appendix 3.7; Panagiotopoulos 1985; Topping 1976–78)<sup>3</sup>; (4) an Ottoman tax register (*defter*) of the Peloponnese from 1715, *Tapu Tahrir* 878 (or TT878; see Başbakanlık General Directorate of State Archives 2007: 15)<sup>4</sup>; and (5) an 1829 catalogue recorded by the French military and scientific mission to the Peloponnese, the Expédition Scientifique de Morée (Bory de Saint-Vincent 1834: 89–92).

It is important to discuss briefly the potential limitations of these documents for the purposes of demographic analysis. Caution must be taken when using multipliers to transform the different kinds of raw data they contain into a single, comparable population estimate (for commentary on Ottoman sources, see Barkan 1957: 18–21; Erder 1975; McGowan 1981: 82). Further, with the exception of the Venetian census from 1700, the sources summarized in Table 1 were not intended to record the exact population of the region. Muazzo's list and the Ottoman tax register recorded only the males who were old enough to bear arms and pay taxes (Erder 1975: 291), while the 1618 and 1829 sources recorded the number of households in each settlement. Thus, two different population multipliers are used, both of which were derived from the detailed Venetian census of 1700: 3.75 for the

<sup>3</sup> Cadastral surveys of the Peloponnese were conducted during the period of Venetian rule (1685–1715), but Mani was not included in these expeditions. For a recent publication of a selection of these maps, see Katsiardi-Hering 2018.

<sup>4</sup> The section of TT878 dealing with Mani will be published separately. Two earlier Ottoman tax registers from the years 1514 (TT80) and 1583 (TT603) are currently under study by Dr. Elias Kolovos (IMS-FORTH) and are expected to provide additional insight into the population of the region in the first Ottoman period.

registers of male population (total population per fighting-age male), and 4.07 for the household registers (total population per household). Finally, there is the issue of coverage: while most of the major settlements do appear in these lists, it is likely that smaller settlements are under-represented or even absent. Likewise, the possibility must be considered that residents deliberately evaded being registered by census-takers and tax officials (Given 2007: 138–39). In both cases, the sources would provide an underestimate of the total population of the region at that time.

Table 1. Demographic data for the southern Mani peninsula, 1618–1829.

Year	Document	Settlements within study area	Raw data	Multiplier	Estimated population
1618	Medici's letter to Charles II, Duke of Nevers	72	3,054 <i>fuochi</i> (hearths)	4.07	12,430
1695	Muazzo's list	48	3,918 <i>uomini</i> (combatants)	3.75	14,693
1700	Venetian census	48	9,089 people	--	9,089
1715	Ottoman <i>defter</i> TT878	37	1,239 <i>hâne</i> (heads of household) and 296 <i>mücerred</i> (bachelors)	3.75	5,756
1829	Catalogue of the Expédition Scientifique de Morée	87	2,874 <i>familles</i> (families)	4.07	11,697

Nevertheless, these sources are the best available information about the demographic situation in Mani from the 17<sup>th</sup> century on. They point to an initial population increase into the 17<sup>th</sup> century, but the temporary Venetian accession to power in 1685 brought on a drastic reduction in population and widespread settlement abandonment (e.g. Panagiotopoulos 1976–78), a population loss that is confirmed by TT878 (for a similar pattern elsewhere in the Peloponnese, see Davis *et al.* 2005). The Peloponnese was reconquered by the Ottoman Empire in 1715, and population levels quickly recovered from their temporary decline during Venetian rule. According to the estimates from TT878 and the Expédition catalogue, Mani's population nearly doubled between 1715 and 1829. These later figures are

probably fairly accurate, as both documents seem to be products of first-hand visits to the region. TT878 is a reconquest *defter*, and while such records were often based on earlier registers, there is evidence that the tax officials did not merely copy an older *defter* verbatim: many new names appear in this register that are not listed in the 1583 *defter*, one settlement is listed as 'empty of peasants' (*hâli ane'l-reaya*), and another settlement is listed with both its current name and its former name according to the 1583 *defter*. These changes indicate that the tax officials were physically present in the region and went to great effort to record even those settlements which were not listed previously. Further, the dramatic increase in the number of settlements documented in 1829 is not merely an artefact of more thorough coverage: 25 of the 87 settlements recorded in this year appear to have been newly founded after 1715, as they do not appear in any of the earlier lists, nor do they contain archaeological evidence of earlier occupation.

The large number of people living in Mani throughout the post-Medieval period would have quickly over-taxed the few natural fresh water resources and led to an increasing reliance on the sea as a means of obtaining needed supplies. Although it shares a similar climate with the rest of the Peloponnese, Mani's agricultural productivity is limited by a scarcity of springs, a lack of perennial streams or rivers, and a rocky and mountainous terrain which restricts the amount of arable land to about one-quarter of its area (Kayser and Thompson 1964: Maps 301, 319; Komis 2004: 18; see also Yassoglou 2004). Like other mountainous regions in Greece, it is likely that the residents of Mani engaged in a mixed agro-pastoralist economy at least since the Classical period, and its impressive step terraces were likely dedicated to the cultivation of grains such as maslin, a mixture of grains including wheat and rye that is ideally suited for dry, rocky areas (see Halstead and Jones 1989: 50–52). An account from the 18<sup>th</sup> century suggests that the primary crops grown in Mani at that time were subsistence foods including corn, wheat, barley, and sorghum (Wagstaff 1965: 298).

## The seascape of Mani

Mani's geography as a coastal peninsula played a critical role in its historical trajectory. Though physically connected to the mainland, a prominent mountain chain runs along its spine and limits the possibility of overland travel to only two routes: one along the west coast leading toward Kalamata, and the other along the east coast leading toward Gytheio. These same mountains that dissect the peninsula from the mainland form steep and rugged cliffs that descend abruptly to the sea, creating a few harbours large enough to moor small ships and dozens of shallow bays that can accommodate smaller vessels.

Archaeological research underscores the extent to which people living in Mani were connected to long-distance networks of trade and exchange in the past. In the Neolithic period, obsidian from the island of Melos made up over 90% of the toolkit of people living near Alepotrypa cave (Riebe 2018; see also Psoma 2015). Beginning in the Bronze Age and continuing through Roman times, Mani was a source of a unique and highly prized marble called *rosso antico*, which was quarried and shipped across the Aegean (Kokkorou-Alevras *et al.* 2009: 171; Warren 2012). A recent archaeological survey of the Diros valley identified a Classical–Hellenistic site that may have served as a waypoint for transporting goods from maritime trade to the settlement of Pyrrichos in the mountainous interior (Pullen *et al.* 2018). Later on in the Byzantine period, the vast number of churches built at this time attest to its strong connection with the Byzantine centres of Mystras and Constantinople (e.g. Drandakis 1986; Gerstel 2015; Kalopissi-Verti 2003).

The sea's role in everyday life in the early part of the post-Medieval period is less well understood, due in part to a lack of historical accounts about Maniate seafaring prior to the late 17<sup>th</sup> century. A historical account from 1689 attests to an export trade in quails, as well as an abundance of olive trees and vineyards — the products of which were also presumably destined for trade (see Randolph 1689: 10). Accounts from the 18<sup>th</sup> and 19<sup>th</sup> centuries list exports derived from bee-keeping (honey and wax), sericulture (silk), cattle farming (meat), olive cultivation (oil), and acorn harvesting (valonea tannin; Wagstaff 1965: 300–1). Sea travel also allowed for emigration, as when members of the Stephanopouloi and Iatroinoi

families were forced to flee Oitylo in the late 17<sup>th</sup> century. These and other Maniate families founded settlements in Corsica, Tuscany, and Genoa (Fermor 2004: 99–108; Greenhalgh and Eliopoulos 1985: 27; Papadopoulos 1982; Vagiakakos 1977, 1988).

In terms of everyday access to the sea, settlements of this time tended to be situated either on the high plateau along the west coast (approximately 200 masl) or on the lower slopes of the mountains above them; very few were located on the coast itself. Still, because of the topography of the peninsula and the distribution of smaller bays, the average distance between settlements and the nearest access to the sea was only about 3 km (Seifried 2016: 188–91).

Meanwhile, the larger harbours which were most suitable for seaborne trade and travel attracted the attention of imperial powers, which undertook major construction works to protect them. Between the 13<sup>th</sup> and 17<sup>th</sup> centuries, fortresses were built in three of Mani's major harbours: Mezapos bay, Porto Kayio, and Oitylo bay (Fig. 4). One of these three fortresses may very well be the elusive Frankish fortification of the Grand Magne, built in AD 1284 but not yet definitely identified (see Kriesis 1963; Traquair 1905–6: 275; Wagstaff 1991, 2009). These harbour fortifications continued to play a key role in imperial strategies of control, and all of them were repeatedly attacked and rebuilt through the 17<sup>th</sup> century.

Seemingly by the 17<sup>th</sup> century, Mani's harbours had become central foci in the daily lives of its residents as hubs of trade and bases for pirate activity. Piracy and corsairing activity (i.e. state-sanctioned maritime violence) had become major threats to sea commerce by this time, wreaking havoc on ports throughout the region and destroying commercial infrastructure. The activities of pirates and corsairs from Malta and the North African coast have been well documented (e.g. Abela 2016; Greene 2010; White 2014, 2016), and recently more attention has been focused on pirates and corsairs from the Greek islands and mainland coasts (e.g. Dimitropoulos 2016; Laiou 2016). Generally, piracy was a double-edged sword for coastal communities, bringing in prize goods and fuelling a black market trade that produced capital, while simultaneously inviting violence and posing 'a constant threat to the socio-economic fabric of indigenous societies' (Laiou 2016: 101).

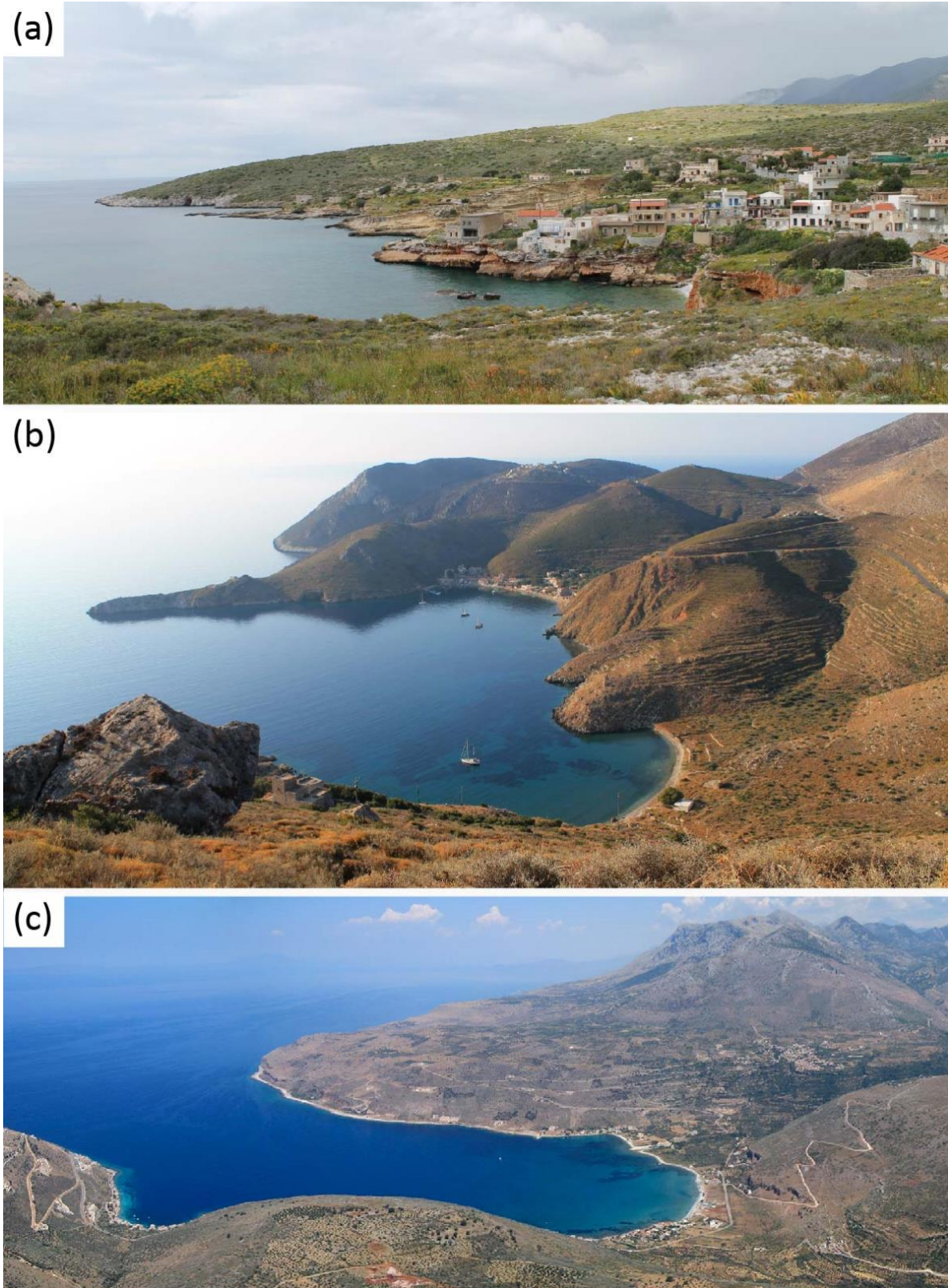


Figure 4. Three of the largest harbours in Mani, all protected by fortresses: (a) Mezapos bay, from the south; (b) Porto Kayio, from the north; (c) Oitylo bay, from the southeast.

While archaeological work has not yet determined the extent to which piracy affected the daily lives of the Maniates in the post-Medieval period, there is no doubt that the Maniates themselves were engaging in these activities. First-hand accounts from the 17<sup>th</sup> and 18<sup>th</sup> centuries allege that the Maniates engaged in slave trading and accused the priesthood of participating in raids (de Mirone 1740: 52; Randolph 1689: 9–10; van Egmont and Heyman 1759: 64). The English traveller John Morritt (1914: 190), who visited the region in 1795, wrote that ‘They are all robbers, or rather, pirates, and infest these seas with small armed boats, which pillage all the small craft from port to port’. F. C. H. L. Pouqueville (1821: 172) referred to Porto Kayio as a ‘nest of pirates’. Documents from shipping companies and navies testify that Maniates engaged in pirate activity up until the early 19<sup>th</sup> century (Nikolaos 2004; Dimitropoulos: 35). On several occasions, the seafaring powers which suffered at the hands of Maniate pirates (including the French, Venetians, and Ottomans) took retaliatory action against coastal towns in an attempt to subdue the region and its key harbours. Towns which sheltered pirates were attacked, as in the case of Kardamyli (Nikolaos 2004), and the major port of Gytheio was attacked in retribution for attempting to forge alliances with enemies of the Ottoman Empire (Greenhalgh and Eliopoulos 1985: 31; Wagstaff 1996: 279).

With the potential for trade and piracy combined, Mani’s harbours also offered an opportunity to accumulate power and wealth. They soon became the headquarters of the region’s most powerful clans, which rose to power in the second Ottoman period (Karakatsianis 2010: 122–24). The Mavromichalis clan established control over Limeni bay (adjacent to Oitylo bay), while the Grigorakis clan controlled Skoutari bay and the harbour of Gytheio; representatives of both families were appointed beyships by the Ottoman Empire in the 19<sup>th</sup> century (see Karakatsianis 2010: 124–25; Kostantaras 2013: 633). This ascension would ultimately lead to their critical role in fomenting unrest and coordinating the Maniates’ participation in the Greek Revolution beginning in 1821.

## **Hydraulic infrastructure in the post-Medieval period**

The sea undoubtedly served as a critical lifeline which connected Mani to other parts of the Mediterranean, but it was the domestic-scale hydraulic infrastructure which its inhabitants built — cisterns and saltpans — which sustained the permanent and year-round settlements in a period of relatively high population.

### ***Cisterns***

Although there are over a dozen springs in the northern mountains of Mani and a few at the very southern tip of the peninsula, the majority of post-Medieval settlements were situated too far away to make use of them (see Fig. 2). As a result, cisterns built to capture winter rainfall were critical sources of drinking water throughout the year. With the dramatic settlement intensification which began in the 11<sup>th</sup> century (see Moschos and Moschou 1981, 1982), cisterns became essential hydraulic infrastructure which enabled and sustained permanent settlement of the region.

There has been ample research on cisterns from throughout the Mediterranean, but very few of these publications deal with domestic-scale constructions associated with rural settlements. Instead, scholarship has tended to focus on large cisterns built in public spaces, and particularly those dating to the Classical through Byzantine periods (e.g. Mays *et al.* 2013). Recent studies include the ancient rock-cut cisterns of Geronisos island near Cyprus (Connelly and Wilson 2002), the large vaulted cisterns associated with Islamic fortifications in the Iberian Peninsula (Bazzana 1999), the monumental Byzantine cistern at Constantia in Cyprus (Stewart 2016), and large vaulted cisterns found within fortified sites and castles throughout post-Medieval Greece (e.g. Germanidou 2017). By comparison, little archaeological research has been published on smaller cisterns situated in rural contexts. A notable exception is Forbes' (2007: 239–48, in press) description of the cisterns of the Methana peninsula, Greece, which provides valuable insights into rural water management practices before the construction of modern infrastructure. A survey of cisterns in Jordan by the Karak Resources Project is also



worth mentioning (Pace 1996), although no attempt is made to date the structures or relate them to the social dynamics of neighbouring communities. Given the limited number of publications on domestic-scale cisterns from post-Medieval times, this section of the paper is dedicated to discussing the cisterns of Mani, the features of their construction, and the potential roles they fulfilled in settlement dynamics in the past.

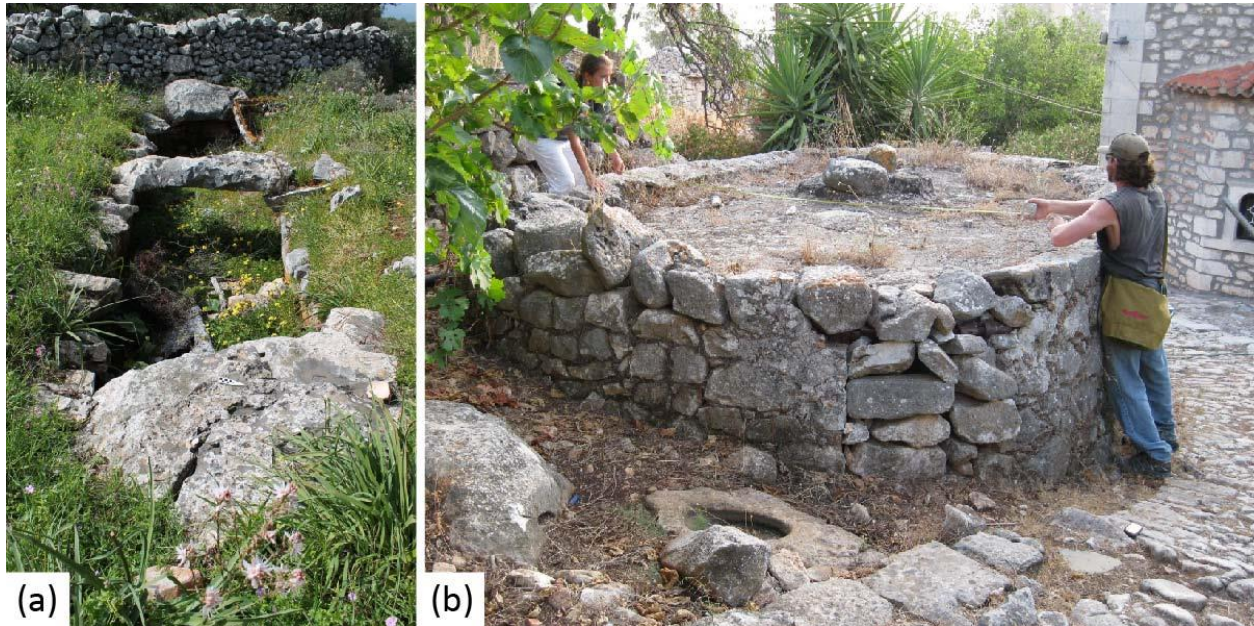


Figure 5. Examples of two cistern forms, exterior: (a) slab-topped cistern in Charia, and (b) barrel-vaulted cistern in Pyrgos Dirou (note a small rock-cut *gourna* in the foreground).

Until cement was introduced in the modern era, cisterns in Mani were built by digging a long stadium-shaped pit, lining the interior walls with stones, and coating them with an impermeable lining of hydraulic slaked lime mortar. Some rock-cut cisterns, similarly carved in a stadium shape, can be found in certain terrain and were also lined with hydraulic mortar. Hydraulic plaster was created by crushing limestone and burning it to form calcium oxide, then mixing it with sand and water to create hydrated lime. Finally, a pozzolan was added (such as brick dust, crushed sherds, or volcanic ash), allowing it to set underwater (Nawrocka *et al.* 2005: 110). An analysis of plasters from cisterns and baths elsewhere in Greece from the Roman, Byzantine, and Ottoman periods determined that a consistent recipe was

used throughout these periods, underscoring the durability of hydraulic plaster technology (Stefanidou *et al.* 2014).

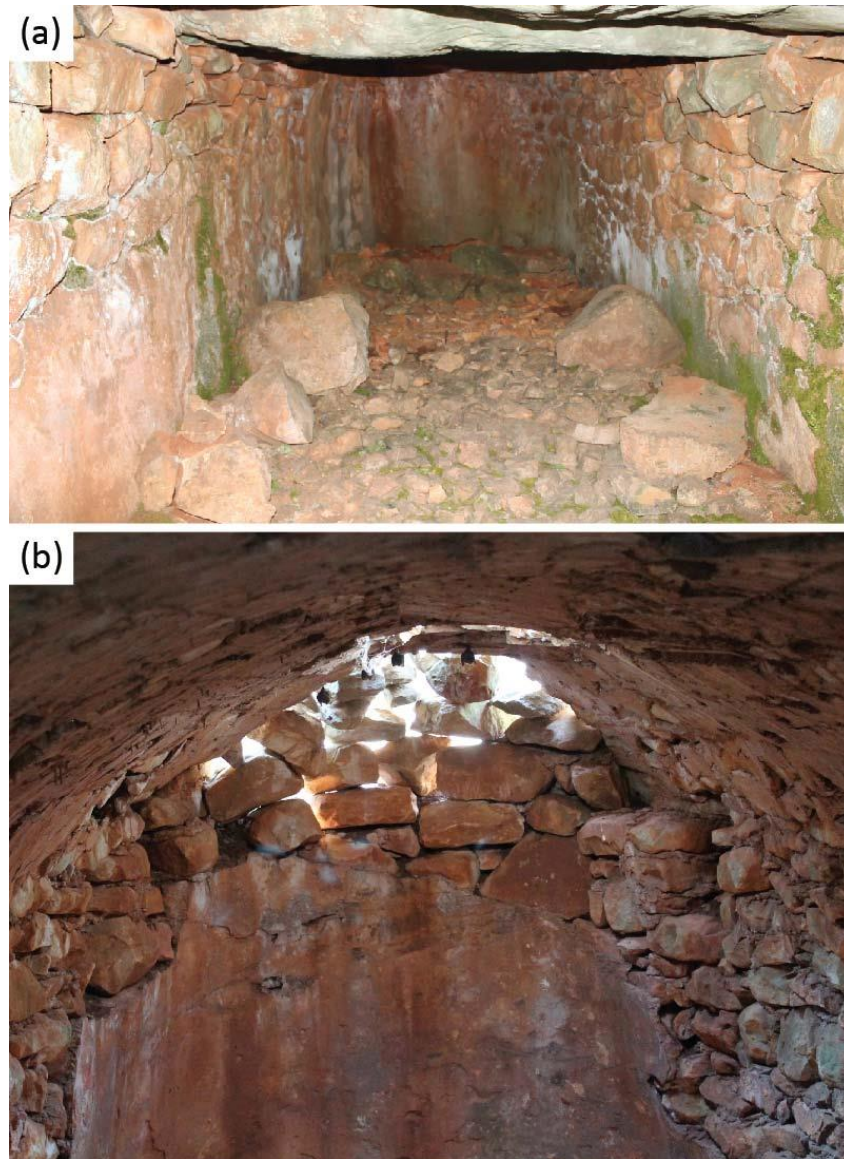


Figure 6. Examples of two cistern forms, interior: (a) slab-topped cistern in the *palaioமானiatiko* settlement of Kouvouklia, near Pyrgos Dirou, and (b) barrel-vaulted cistern in Erimos.

The cisterns fall into two general types: an early 'slab-topped' form, which appears to have been used from the Middle Byzantine through early Ottoman periods, and the later 'barrel-vaulted' form dating from the 18<sup>th</sup> century onwards

(Figs. 5 and 6)<sup>5</sup>. Slab-topped cisterns were covered with massive limestone beams (*makronia*), and in turn these beams were covered by smaller stones which helped filter the water into the cisterns (Saïtas 1990: 19; see Moutsopoulos and Dimitrokallis 1976–78 for plans and photographs). Barrel-vaulted cisterns were covered with a curved roof made of smaller stones. Frequently, carved stone basins of varying size (*gournes*) were placed adjacent to the cisterns and used to water animals.

Typically, cisterns in the early period were evenly distributed throughout the *paliomaniatika* settlements, with approximately one cistern for every house. The ruined settlement of Kouvouklia is an example of the most common, 'open' layout: the houses were spread across a gently sloping plain, forming a discrete but otherwise evenly dispersed settlement (Fig. 7a). The houses were relatively uniform in structure and oriented in the same direction, and there were few property walls to delineate private space. In rare cases, the cisterns were all built within a single area of the settlement. In a ruined settlement near Kouloumi, for example, six cisterns were built together at the southeast edge of the village (Fig. 7b). The cluster is situated near a church at the highest point of the site (around 144 masl). One possible explanation for the phenomenon is that it reflects a peculiarity of the local geography, wherein the cisterns were built in the best catchment area for collecting rainwater. On the other hand, the proximity to a church calls to mind the widespread practice of building cisterns near public spaces like churches, mosques, and fortifications. In many such cases, the monumental size of such cisterns indicates that they were being used to supply a large population, such as a monastic community or a garrison. This is probably the case, for example, in the

<sup>5</sup> The slab-topped cisterns are generally associated with *palaioaniatika* settlements, which are dated based on their association with Middle Byzantine churches (see Moschos and Moschou 1981). To help refine this chronology, samples of hydraulic mortar were taken from two abandoned slab-topped cisterns near Pyrgos Dirou with the aim of conducting radiocarbon dating on organic material contained therein. One of these samples, taken from the outer layer of hydraulic mortar, contained a fragment of charcoal (DEM-3259/MAMS-38304) that was dated to  $416 \pm 16$  BP, or cal AD 1439–1481 ( $2\sigma$ ) using the OxCal v.4.2.4 program (Bronk-Ramsey and Lee 2013) and the IntCal13 calibration curve (Reimer et al. 2013). The date was obtained through Accelerator Mass Spectrometry (AMS) at the Klaus-Tschira-Labor für Physikalische Altersbestimmung, under the supervision of Dr. Yannis Maniatis, Demokritos National Centre for Scientific Research. The cistern was probably abandoned sometime after its hydraulic mortar was last refreshed in the mid-15th century. The radiocarbon date thus confirms that slab-topped cisterns were in use in the Middle Byzantine to early Ottoman periods, but unfortunately it does not shed light on when the transition to the barrel-vaulted form took place.

neighbouring region of Messenia, where large, vaulted underground cisterns have been documented in the vicinity of monasteries and castles (Germanidou 2017: 223–4). In Mani, however, nearly all of the cisterns are small, isolated constructions that were most likely the property of individuals or households.

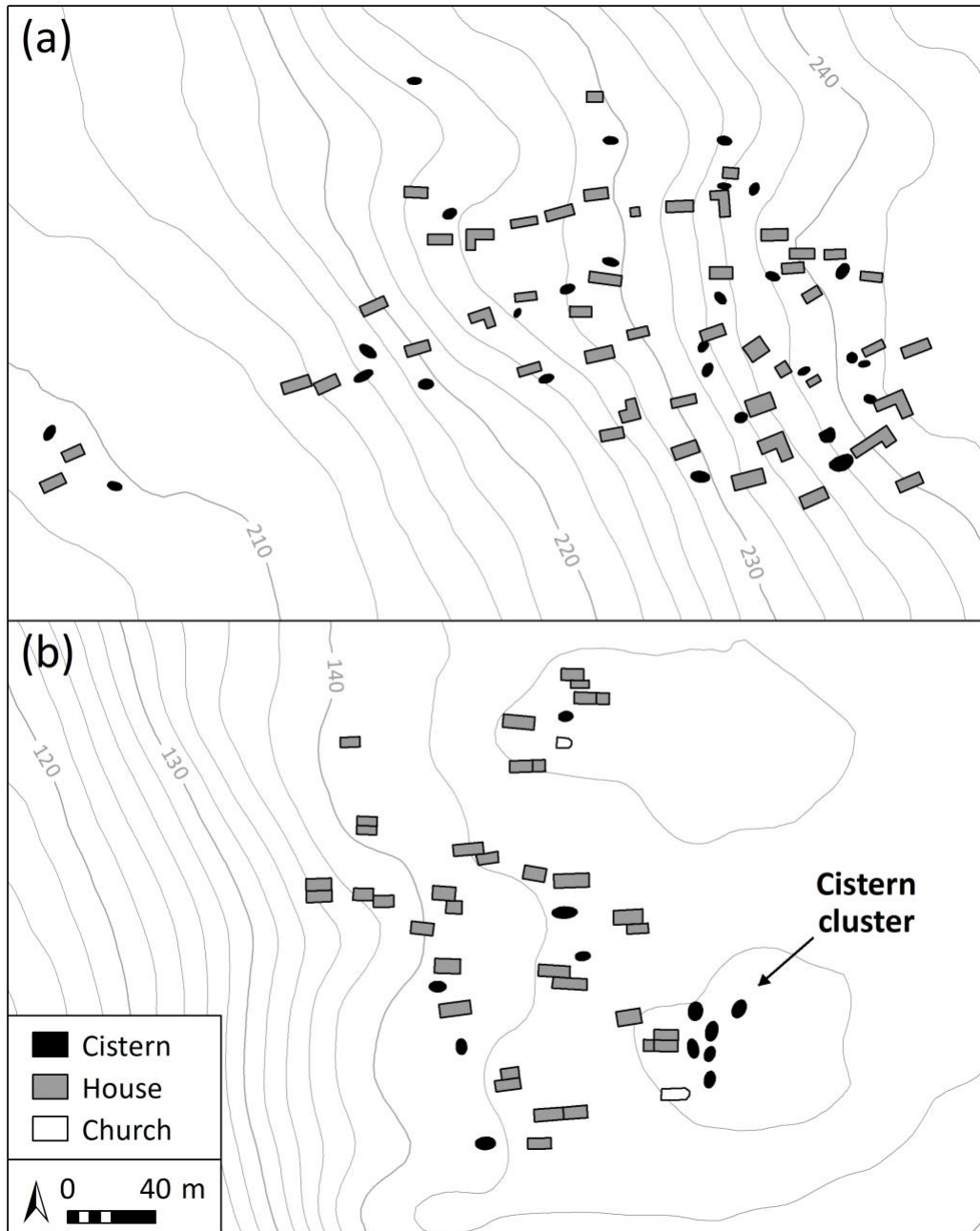


Figure 7. Typical distributions of the early slab-topped cisterns: (a) 'open' layout of Kouvouklia; (b) clustered layout of an unnamed village near Kouloumi (based on Saitas 1990: Fig. 16). Elevation data from the National Cadastre and Mapping Agency, S.A. (Ktimatologio).

By the 18<sup>th</sup> century, walled compounds enclosing multiple houses and a cistern were more common; these walls limited visibility and access to the main residence and prevented outsiders from gaining access to the precious water supply. Compounds belonging to the most powerful local families could also contain impressively large cisterns, such as several huge rock-hewn cisterns within the Sklavounakos family compound in Pyrgos Dirou (see Saïtas 1990: 110), which likely date to ancient times. In this case, the cisterns were not constructed in the 18<sup>th</sup> century, but rather the residential compound was built so as to enclose the earlier cisterns within its walls. While less frequent, isolated cisterns of both types were also built outside the settlements; these individual structures were likely used as a water supply for shepherds and their flocks.

#### *Water storage capacity*

A total of 244 slab-topped cisterns were recorded while systematically mapping selected *palaiomaniatika* settlements (for data, see Seifried 2018). Most of the cisterns were ruined and partially filled with rubble that had fallen from the collapsed roofs, limiting the number of candidates for measuring the structures' internal dimensions. Floors were exposed in 70 of the cisterns, permitting a measurement of the depth of the structure from the floor to the underside of the beams. The depths ranged from 1.5 to 3.8 m, with a mean depth of 2.5 m. Only 34 were sufficiently accessible to take measurements of the internal width and length. The internal area of these cisterns ranged from 1.9 sq m to 21.6 sq m, with a mean area of 10.1 sq m.

Six cisterns were sufficiently preserved to allow measurement of all three dimensions in order to calculate volume (Table 2). These six examples show a range of volumes that fits well within what would be expected for domestic purposes, with an average volume of just over 21 cubic m. If the average depth (2.5 m) is used to estimate storage capacity of the other measured cisterns, the resulting range mirrors this pattern (Fig. 8). The four largest cisterns, with estimated volumes ranging from ca. 35 to 55 cubic m, are interesting exceptions: three are located in the middle of ruined settlements, suggesting that may have

been used by multiple households (Fig. 9), while the fourth is one of two slab-topped cisterns built adjacent to a now-ruined Byzantine church, similar to the example in Figure 7b.

Table 2. Internal dimensions and total storage capacity of 6 slab-topped cisterns in Mani.

Cistern	Settlement	Depth (m)	Internal length (m)	Internal width (m)	Volume (cubic m)
1	Ippola	2.80	2.44	1.83	12.5
2	Kotraphi	2.24	4.50	1.90	19.2
3	Akia	2.16	4.99	1.87	20.2
4	Korines, near Dryalos	2.15	7.10	1.40	21.4
5	Pyrgos Dirou	2.00	6.30	1.82	22.9
6	Avles, near Ochia	2.18	7.20	2.00	31.4

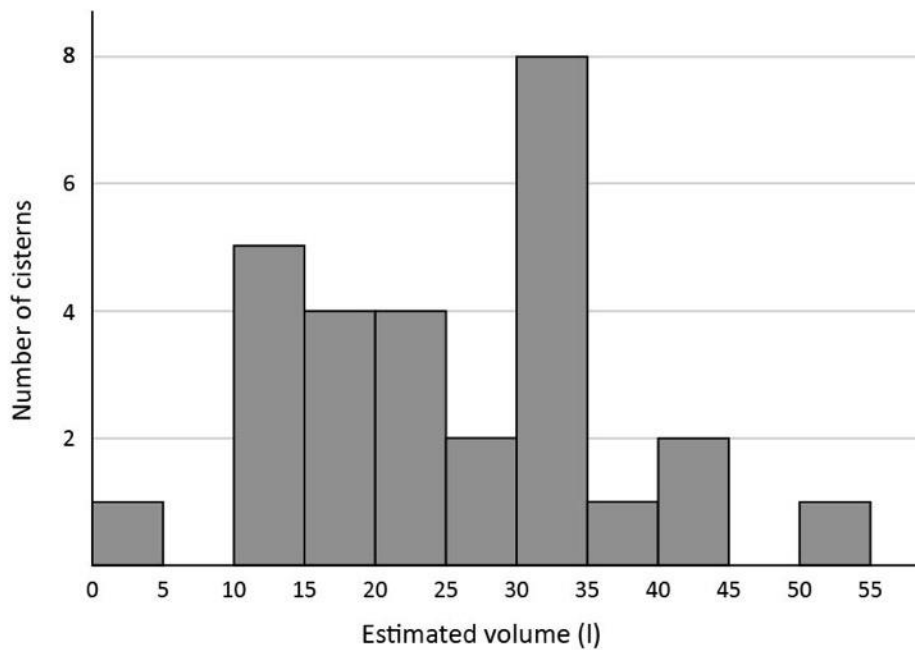


Figure 8. Range of estimated storage capacities of 28 partially-accessible slab-topped cisterns in Mani based on measurements of internal area and an estimated depth of 2.5 m.



Figure 9. Large cistern (with an estimated volume of 53.9 cubic m) in the *palaioaniatiko* settlement of Korines, near Dryalos.

Only 31 barrel-vaulted cisterns were recorded in the field. The smaller sample size is due to the fact that the mapping component of the research project targeted older settlements, where the cistern type was predominantly slab-topped. Of the barrel-vaulted cisterns, 9 were sufficiently accessible to allow for a measurement of the depth to an exposed floor, and 4 of internal area only. The depths ranged from 2.7 to 4.3 m, with a mean depth of 3.2 m. The internal area ranged from 13.0 sq m to 24.9 sq m, with a mean area of 16.1 sq m. Overall, the

barrel-vaulted cisterns that were measured appear to have been larger than the slab-topped form in both depth and area, and therefore it is likely that the total storage capacity of a typical barrel-vaulted cistern was larger than that of the earlier type. Based on the measurements taken in the field, the typical volume of the barrel-vaulted cisterns may be estimated at 40–50 cubic m.

*Estimated water supply during the wet and dry seasons*

It is possible to estimate how much water a cistern could provide over the course of a typical year if a few variables are known: the catchment area (i.e. an impluvium or other surfaces such as nearby roofs that channel water into the cistern), the monthly average rainfall, and the rate of draw from evaporation and consumption or use. In the case of the island of Geronisos near Cyprus, two cisterns were studied in detail (Connelly and Wilson 2002: Table 3): the first had a capacity of 10 cubic m and an impluvium area of 70 sq m, the second a capacity of 36 cubic m and an impluvium area of 120 sq m. The rate of evaporation was estimated at 30% (an arbitrary value), and the draw at 58 l per day and 120 l per day, respectively. A similar model was developed for the island of Pantelleria near Sicily, assuming an impluvium area of 40 sq m, an evaporation rate of 20% (based on data from Ibiza), and a daily draw of 36 l per day (Mantellini 2015: Tables 7 and 8). Both studies showed that average-sized cisterns would not have filled completely if water was drawn from them during the year, and that they would have been nearly empty by the end of the dry season: October in the case of Geronisos (Connelly and Wilson 2002: 288), and August in Pantelleria (Mantellini 2015: 420).

A similar model can be constructed for Mani. The catchment area for a typical cistern was likely the roof surface of a nearby house, though channels (several of which were recorded during fieldwork) could have diverted additional water to the cistern from outbuildings. The average roof area of the *palaioaniatika* houses can be estimated at 50 sq m (based on measurements taken of over 100 houses; for data, see Seifried 2018). Factoring in the average area of the cistern roof directly above the basin (10 sq m), the total catchment was likely about 60 sq m. Average monthly rainfall data is available from the weather station in Kythera for the years



1971–2000. Assuming a minimum evaporation rate of 20%, the resulting model shows that the average cistern in Mani could have stored about 25 cubic m (25,000 l) of water in a typical year, allowing for a daily consumption rate of 69 l (Table 3). As with the case studies above, a typical cistern in Mani would have run nearly dry in September, just before the rainy season began. This schedule would have sustained residents through the entire summer dry season and provided an opportunity for cleaning or re-plastering before the winter rains began in earnest.

Table 3. Estimated water supply to a cistern in Mani considering monthly precipitation, evaporation and draw.

Month	Average rainfall (mm)	Water supply from 60 sq m catchment (cubic m)	Water supply after 20% evaporation (cubic m)	Remaining after draw of 69 l/day (2.07 cubic m/month) (cubic m)
October	54.2	3.252	2.602	0.532
November	89.9	5.394	4.315	2.777
December	99.9	5.994	4.795	5.502
January	97.0	5.820	4.656	8.088
February	64.4	3.864	3.091	9.109
March	55.7	3.342	2.674	9.713
April	28.0	1.680	1.344	8.987
May	10.5	0.630	0.504	7.421
June	1.4	0.084	0.067	5.418
July	1.5	0.090	0.072	3.420
August	2.7	0.162	0.130	1.480
September	15.4	0.924	0.739	0.149
Total storage per year			24.989	

Source: Rainfall data from Hellenic National Meteorological Service 2017.

The World Health Organization (WHO) recommends a minimum water supply of 7.5 l per person per day in emergency situations for drinking and food, basic

hygiene practices and cooking (WHO 2013: Table 9.1). A higher estimate of 15 l per person per day is suggested for long-term situations, although even greater daily requirements around 50 l have been suggested (see Gleick 1996: Table 9). According to the WHO's minimum estimates, a daily draw of 69 l could support a household of 4–6 people (using 30–45 l per day), leaving a leftover supply of 24–39 l. This additional water could have been used to water nearby gardens and animals, practices which are still common today and are attested to in the past by the frequent presence of stone-carved basins (*gournes*) next to cisterns. Cattle and mules require a minimum of 20 l per day each (Aganga *et al.* 2000), while goats, sheep, and pigs require at least 10 l (Almond 1995). In short, a typical slab-topped cistern could have easily sustained a single household<sup>6</sup>, as well as one or two animals or a small vegetable plot. The few larger cisterns with estimated capacities above 35 cubic m would have had larger catchments and thus an even greater supply. Their large capacity and location either in the middle of the settlement or in association with public monuments like churches suggest that they may have been used as communal water-storage structures.

By contrast, the later barrel-vaulted cisterns were designed to capture substantially more water than their slab-topped predecessors. Enclosure within a compound would have provided the added benefit of harnessing additional roof surfaces for the channelling and collection of water. This factor may help explain why the barrel-vaulted cisterns had a greater capacity: a larger catchment meant that additional water could be captured and stored. If Table 3 is modified with double the catchment area (120 sq m), a household could draw 139 l per day and the cistern would still not run dry until September. Importantly, this additional catchment meant that at the end of the rainy season (March), the amount of stored water would reach its greatest volume of 19.2 cubic m. If a third roof is factored in (180 sq m), a household could draw 200 l per day, and the greatest volume of stored water would be 30.4 cubic m. Given the location of the barrel-vaulted cisterns and their larger size, it seems likely that they were built to capture water from a much larger catchment than their slab-topped predecessors, and likewise, to

<sup>6</sup> The average size of a household in the study region, as attested in the Venetian census of 1700, was 4.07 people.

provide a much greater amount of water for the daily needs of a household. While a cistern with a single-roof catchment could sustain a small household of 4–6 people and one or two animals (or a garden), a cistern with a catchment of three roofs could meet the needs of a large extended family (e.g. 15 people at 7.5 l per day = 112.5 l) with 87.5 l left over each day.

### ***Saltpans***

While the supply of fresh water was a critical prerequisite for sustaining year-round settlement on Mani, salt production was a less obvious — but no less important — facet of daily life. Salt was a critical ingredient for preserving food for local consumption and export, and it also served as a dietary supplement for animals and as an item of exchange for acquiring other foodstuffs. Several of the bays along Mani's western shore, including Diros bay and the Tigani peninsula, contain saltpans which were likely used in the post-Medieval period to supplement the inhabitants' dietary and economic needs (Fig. 10).

Some of the pans in these areas are groups of naturally eroded depressions, while others, like those in Diros bay, were carved laboriously into the exposed bedrock. A much larger area of salt collection is located on the Tigani peninsula, where over 100 carved and constructed saltpans are preserved, as well as two small dry-stone huts built to shelter salt collectors while they waited for the water to evaporate. Whereas the Diros saltpans are located immediately adjacent to the sea, the Tigani pans are located up to 150 m away from the jagged coastline, making for a treacherous walk as a person carries water to the pans. It should be noted that the area's long-term role in salt production is indicated by its name, as 'Tigani' is a common Greek toponym that refers to areas with saltpans (Pikoulas 2001: 299–300).

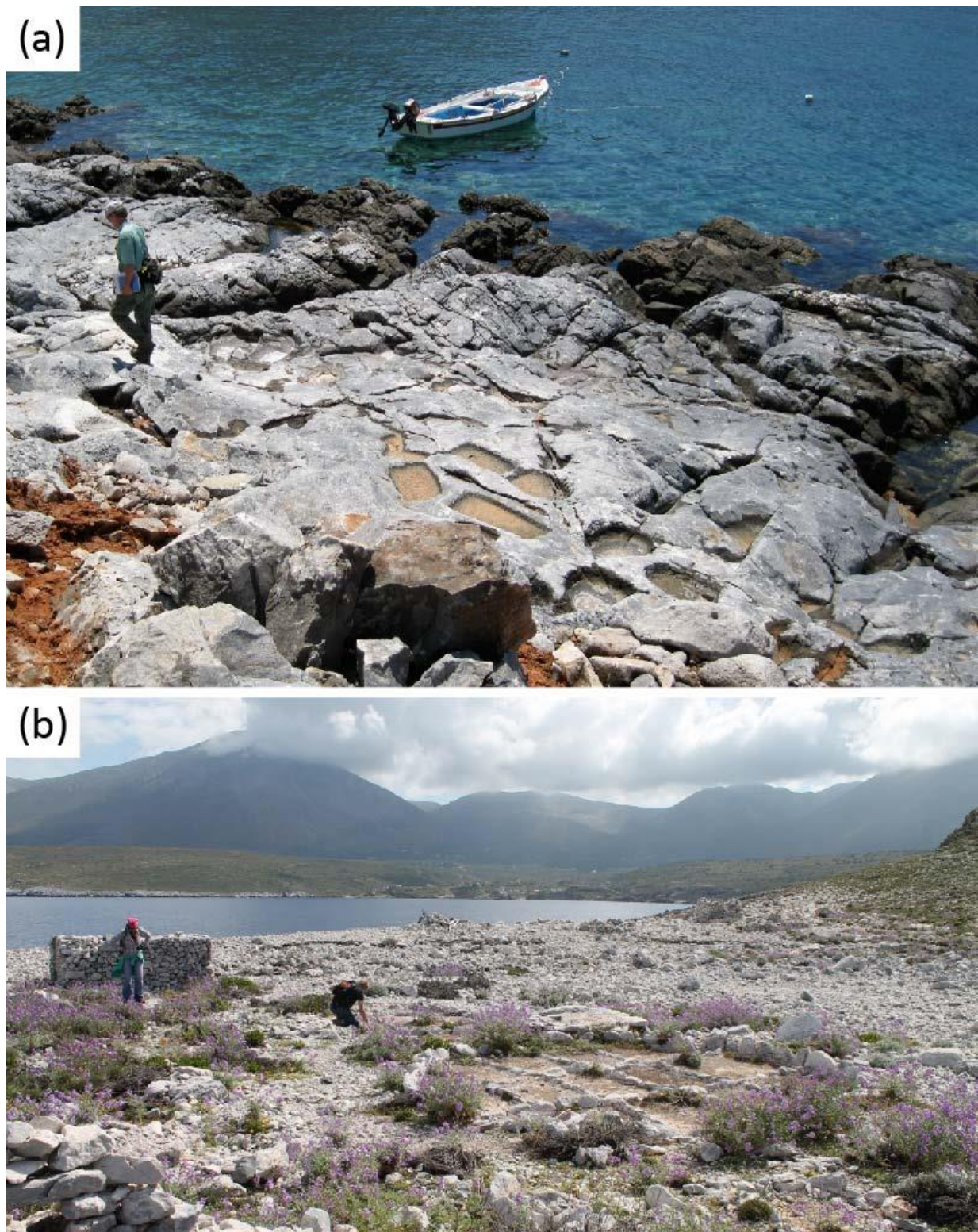


Figure 10. Saltpans: (a) Diros bay; (b) Tigani peninsula.

During Fermor's trip to the Tigani peninsula, which he described as a 'shadowless, desolate wilderness', he encountered:

[...] two tatterdemalion and barefoot women, a mother and daughter in antique straw hats as wide as umbrellas, their faces burnt black by the sun and eyebrows and tangled hair caked white with dried brine, [who] were gathering rock-salt in broad wicker baskets. They worked here all summer, they said, and sometimes in the winter too, sleeping in the huge cave by the chapel of the Hodygytria [...] (Fermor 2004: 78–79)

Fermor noted that the women could sell the salt for 'sixpence an oka', collecting 'a bit more than an oka' on a good day (one oka is equivalent to 1.3 kg; Fermor 2004: 79). Ethnographic research in the area indicates that the saltpans along the western coast continued to be used intensively until about 1970 (Saitas and Zarkia 2001, 2002). Older residents who had worked as salt collectors before then reported that one oka of salt was worth about one-tenth an oka of oil, and that in periods of hardship its value could increase to the equivalent of one oka of sugar or one-half oka of cheese. One resident estimated that the income from salt collection could have comprised roughly 15–20 per cent of a family's income, after oil and animal products (Saitas and Zarkia 2001: 256).

Based on the scale of saltpan infrastructure in Mani, salt production in the post-Medieval period was likely intended for domestic consumption, preservation of food for export, and exchange for other necessary food items. Larger salt production facilities existed in other coastal areas of the Peloponnese, such as the salt-lake at Thermisi (Topping 2000; see also Forbes 2000). In many places it was a lucrative business that earned the ruling power a substantial tax revenue (see Liakopoulos in press). In some parts of the eastern Mediterranean, ruling administrations needed to deal with the problem of salt smugglers trying to evade these hefty levies (for salt smuggling on the island of Pag, see Mayhew 2008: 63; in Albania, see Blumi 2003: 20). Fermor's story, however, illustrates how meagre a living could be made from this activity in a remote place like Mani.

While salt in itself has some trade value, in the post-Medieval period it was also a critical ingredient in one of the region's exports: dried quails. As Randolph (1689: 10) recounted, 'There are great quantities of Quails, so as they Salt them

up, and send them to several other parts. Powder and Shot is here scarce, but they do so well manage the Sling, as is to admiration, with which they kill Birds on the Wing.’ The name of the harbour of Porto Kayio derived from the Italian for ‘Port of Quails’, apparently due to the abundance of quails which stopped in the region during their annual migration (Coronelli 1687: 102–3). An analysis of 18<sup>th</sup> century records shows that quails from Mani were being exported to the Aegean islands and as far away as Constantinople (Wagstaff 1965: 301–2, 1996: 284).

## **Discussion**

Archaeological data and historical accounts both point to an intricate relationship between water and the social organization of Maniate settlements in the post-Medieval period. Two major conclusions can be drawn from the data presented here. First, the sea was a critical thoroughfare that connected Mani to other parts of the Mediterranean, enabling a dense human population to be sustained in a geographically isolated region. This interconnection is attested in the archaeological record as early as the Neolithic period, and grew more important as Mani’s population increased and maritime trade flourished. Second, Mani’s population was organized in discrete and relatively small settlements that were sustained, in part, through the construction of cisterns which captured the winter rains. Importantly, the data point to a shift in cistern construction around the beginning of the second Ottoman period which may reflect a changing social organization at the household scale.

The ways in which Mani was described by outsiders helps to contextualize its apparent strangeness vis-à-vis the rest of the Peloponnese. One of the earliest accounts comes from the Middle Byzantine period, when Constantine Porphyrogenitus described Mani as ‘waterless and inaccessible’, and the locals as ‘idolaters’ who were supposedly converted to Christianity during the reign of his grandfather Basil I in the 9<sup>th</sup> century (Porphyrogenitus 1985: 237). Dozens of travellers’ accounts from the 15<sup>th</sup> century onwards described in vivid detail the suffering that came from living in such an arid wasteland, framing Mani as an inaccessible backwater filled with pirates and thieves (see Institute for Neohellenic

Research 1993). Randolph (1689: 8–9) described the region in the late 17<sup>th</sup> century as ‘Mountainous and full of Woods, and very difficult to come at, either by Sea, or Land’. Pouqueville’s (1821: 166–167) account from the early 19<sup>th</sup> century described the locals as ‘inhospitable’ pirates who lived ‘on the spoils of shipwrecks and the debris of vessels so that they may have something to trade with their neighbours’. Indeed, this is a common theme in the later accounts. Four early 19<sup>th</sup>-century English travellers — John Philip Morier, Colonel William Leake, John Morritt, and William Gell — all described the Maniates as impoverished pirates who relied on the importation of grains and other staples from elsewhere in the Peloponnese (Wagstaff 1996: 281). According to Gell (1823: 268), the Maniates lived in a state of ‘squalid misery’. Even in the most recent and perhaps most famous travelogue of Mani, that of Patrick Leigh Fermor from the mid-20<sup>th</sup> century, these themes were woven throughout the narrative.

All these accounts underscore the ‘island-like’ quality stemming from Mani’s mountainous terrain and prominent coastline (Panagiotopoulos 1996), which isolated the region from the Peloponnese and oriented it outward toward the sea. The metaphor of ‘Mani as an island’ requires a reframing of the region from an insular backwater to a central node in larger networks of exchange. Islands are not the isolated wildernesses they once were imagined to be, but rather interconnected nodes that participate in trade and communication networks just as fully, if not more so, than mainland areas (e.g. Horden and Purcell 2000: 133–135; Çaykent and Zavagno 2014). As with true islands, the sea was a critical conduit for travel, communication, and trade between Mani and other coastal populations throughout the Mediterranean.

In addition to legitimate trade<sup>7</sup>, there is no doubt that many individuals made a living as pirates and corsairs in the post-Medieval period, and that piracy soon became a part of the economic productivity of the region as a whole. Piracy was a critical source of goods and capital; it was ‘a fundamental economic and cultural feature of the Mani peninsula, providing an alternative solution, not only for

<sup>7</sup> Data from a recent archaeological survey in Diros bay attest to maritime trade in the Classical-Hellenistic through Late Roman periods (see Pullen *et al.* 2018). Further research, ideally targeting post-Medieval settlements located away from the coast, is needed to discern the extent of maritime trade networks in the later periods.

survival, but also for cash accumulation either through piracy itself or through the functioning of a market based on stolen goods' (Laiou 2016: 102). But it should be emphasized that piracy was not just the 'capitalism of the poor and the dispossessed' — i.e. a system that became a fundamental part of the economy because of the region's poverty and rising population. It was also a flexible system that allowed Maniates to shift alliances, at times undermining Ottoman control of shipping lanes, while at others, working with the Ottomans to defeat competing pirate forces (Laiou 2014). From an archaeological perspective, it is currently impossible to assess the actual extent of these sea-borne activities and their impact on daily life. What is clear, however, is that piracy and seafaring more generally gave Maniates access to worlds beyond their shores, which they harnessed not only to their economic benefit, but to their political advantage as well.

As for fresh water, there is no doubt that cisterns were a necessary resource throughout all of Mani's history, but their social value appears to have increased by the second Ottoman period. Two seemingly contradictory stories from the late 18<sup>th</sup> century illustrate the extreme value placed on fresh water at this time:

When a Kakouvoulian [Maniate] marries, the most important task is to probe the tank, the main part of the dowry given to his wife. The more water consumed at the wedding banquet, the richer a person is considered to be. This extravagance makes a lot of noise, and it does not fail to instruct the entire township about how much water was drunk. [...]

One of these mountaineers confessed to a priest, with tears in his eyes, that he'd had the misfortune, after giving a drink to a beast of burden, to throw away the little water that remained. The priest judged the sin enormous, and granted absolution only with the payment of sixteen measures of oil. (author's translation, Grasset de Saint-Sauveur 1800: 369–70)

These stories must be read with some caution; as with other travellers' tales, Grasset de Saint-Sauveur's motives in recounting these anecdotes were coloured by the times. However, they illustrate viscerally the scarcity of water in Mani and the great value placed upon it. To waste it could provoke divine retribution, yet its very consumption was a matter of privilege and access. Water was deemed so valuable that cisterns comprised the 'main part' of marriage dowries, and a person who had



enough water to hand to share it lavishly with their guests was afforded great prestige.

An analysis of the cisterns found in Maniate settlements dating to the post-Medieval period indicates that a dramatic social transformation had taken place by the 18<sup>th</sup> century. In the early phase, settlements were arranged in an 'open' layout with cisterns usually dispersed between houses, while in a few cases a cluster of cisterns were built in shared catchment zones. This settlement layout raises questions about ownership and protection: were cisterns used by single households, or were they shared by multiple households? Did individual households have some kind of claim over their cisterns, and if so how were these claims established given the lack of boundary walls? Unfortunately, there is little documentary evidence presently available to shed light on the legal aspects of cistern ownership. According to Forbes' (2007: 164) ethnographic research, cisterns and wells in the Methana peninsula could be jointly owned (e.g. by brothers), but whether this system also applied in Mani – and how far back the practice may have extended – is currently unknown. Further archaeological research may help to illuminate these issues of social organization in the Late Byzantine and early Ottoman settlements of Mani.

In the later phase, cisterns were built with larger storage capacities and utilized multiple roofs to harvest rainwater, signalling a change in how domestic architecture was built and organized within settlements. These alterations in turn may reflect social changes, such as increased household size or a shift from small nuclear households (indicated by single isolated houses) to larger extended households (indicated by multi-house residential complexes). Further, the placement of cisterns within the walled residential compounds indicates they were being actively protected and shielded from public view. This change in how water was managed suggests that there was a decline in resource sharing as a social practice by the 18<sup>th</sup> century.

## **Conclusion**

An analysis of the domestic-scale hydraulic infrastructure of Mani — its cisterns and salt pans — underscores the lengths to which Maniates went to manage the water resources at their disposal. The cisterns required an extraordinary investment of time and resources to build, but they were critical tools that enabled the residents to survive the dry summers. Anyone whose cistern was compromised would be in a very difficult position until the winter rains returned. Early in the post-Medieval period, inter-household sharing may have been an important failsafe that allowed the unluckiest to survive. However, the on-going processes of conquest and administrative change left an indelible impact on daily life in the region. The everyday problem of securing sufficient fresh water did not change, but how local residents solved that problem did. Cisterns were enclosed behind property walls and guarded as precious resources, reflecting a change in water management and resource access at the household scale.

Meanwhile, as the seas around Mani surged with the ships of imperial powers and pirates from all parts of the Mediterranean, the residents of Mani redoubled their seaward focus. More so than ever before, the sea was a critical source of sustenance for the ever-increasing population of Mani: its harbours provided shelter to pirates and traders, and its salt pans allowed others who were less fortunate to eke out a different kind of living from the sea. The sea acted as a conduit which connected Mani to other Mediterranean lands, and for some, it was the only means by which they could survive — by leaving Mani altogether.

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