

RESEARCH ARTICLE

Thalassocracy in the Bronze Age and Its Relationship to Sustainability

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Abstract

The Greek world has a long tradition in shipping and maritime trade, dating back to the first appearances of the Minoan civilization in Bronze Age. This tradition secured for the ancient Greek world dominance over a large area around the Mediterranean Sea throughout the Bronze Age. The evidence of this supremacy, based on the findings of archaeologists and historians, supports the statement that the term “thalassocracy,” a Greek term meaning sea power, was coined by the Greeks to describe this regime. In time, other powers also demonstrated their ability to control the sea lanes, until today. The focus of this paper is a brief review of the evolution of Bronze Age thalassocracy and the important relationship between thalassocracy and sustainability during that period for the Mediterranean world.

Keywords: Bronze Age, Prehistoric Times, History, Sustainability, Water Purification, Desalination, Navigation, Sea Power.

1. Introduction

The sea is the heart of the planet. Water covers more than two-thirds of the Earth’s surface. Sea plants, such as Posidonia, produce 70% of the oxygen we breathe, and the deep waters are home to wildlife and some of the biggest creatures on earth. It provides us with food, jobs, life, entertainment, healthy, and sailing (UN, 2017) Without it, civilization cannot survive. In the past, dominance of the sea was related to power. The term “Thalassocracy,” derived from the Greek language which translates to “rule of the sea,” was first used by the Ancient Greek historians to describe the type of government that was set up by the Minoan civilization, which depended on its navy for its power (Constantakopoulou, 2013; Abulafia, 2014). Thalassocracy was also critical to the development

and sustainability of the Minoan culture. Other important later ancient thalassocracies included the Greek, Syrian, and Egyptian civilizations (Knapp, 1993).

The purpose of this paper is to present a brief review of the relationship of thalassocracy to the development and sustainability of the Mediterranean region during the Bronze Age. The paper is organized as follows: following this introductory section, the Bronze Age civilizations and the evolution of thalassocracy is considered in Section 2. The relationship of thalassocracy to sustainability in Bronze Age is discussed in Section 3. The relationship of thalassocracy to sustainability in contemporary times is considered briefly in Section 4. Some closing thoughts and observations are presented in Section 5.

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2. The Evolution of Thalassocracy in Bronze Age (Ca 3,200- 900 Bc)

Four major occurrences can be used to characterize Bronze Age in the Mediterranean region: the development of the Minoan and Mycenaean Civilizations, the ascendancy of thalassocracy in the Bronze Age, the development of the Minoan and Mycenaean ships, which made their thalassocracy possible, and the parallel contributions of thalassocracy to the sustainability of the region and vice versa. The evolution of thalassocracy in Bronze Age is examined in the section, along with new findings and how underwater archaeology helps to shed light on the past. The role of thalassocracy in furthering all aspects of sustainability during this period is considered in the following section.

2.1 The Minoan Civilization (ca 3200-1100 BC)

The first Minoans are believed to be mainly descended from Neolithic people, who probably migrated thousands of years earlier, between ca 10000-8000 BC from the Levant region, located in the eastern Mediterranean which today includes Israel and the West Bank, Jordan, Syria and part of southern Turkey (Hughey *et al.*, 2013).

The Minoan civilization is remarkable for its many scientific, engineering, technological, and cultural advancements. Its large and ornate ‘palaces,’ up to four floors high, with intricate hydraulic networks and murals are living implementations of these advancements. Most modern historians agree, the Minoans were also people of the sea. They were also mercantile people who were engaged significantly in overseas trade, and at the peak of their civilization may well have had a dominant position in international trade in the Mediterranean region. The Minoan civilization has also been described as the first of its kind in Europe, while historian Will Duran described the Minoan civilization as “*the first link in the European chain*”.

The Minoan period is also characterized by extensive trade between the settlements in Crete, the Aegean, and the Mediterranean, especially in the East. Through merchants and their artists, the cultural influence of the Minoans reached beyond Crete to the Cyclades, Egypt, Cyprus, the Levant, and Anatolia. Some of the most remarkable Minoan works of art are preserved in the town of Akrotiri on the island of Santorini, which was destroyed by the eruption of its volcano. In addition, based on the findings from

important colonies at Thira, Kytheia, Melos, Keos, Aegina, Rhodes, Miletus, and others mostly in the area of the Aegean Sea nearest to Crete it is evident that Minoans built up a sea empire or “thalassocracy” (Hood, 2015).

2.2 The Minoan Thalassocracy

Knowledge of the Minoan and later Mycenaean thalassocracy is based on historical texts by various authors and on the archeological findings from stratigraphic excavations and underwater discoveries, as discussed in Sections 2.5 and 2.6, respectively. The following discussion deals with various aspects of thalassocracy that relate to sustainability in the Bronze Age. The ships that made the Minoan and later Mycenaean thalassocracies possible are discussed in the following section.

2.2.1 The Minoan Merchant Fleet and Trade

Regarding their merchant fleet, E. Hirschfeld (2021) reported that: “The Minoans came to dominate the seas, sailing for hundreds of miles in search of trade from Spain in the west to Syria in the east. It is possibly a measure of both the Minoans’ geographical isolation and the strength of their fleet that their coastal towns seem to have had few fortifications (Muge and Loukovikas, 2013). Also, it has been reported that Minoans dominated the Eastern Mediterranean and Aegean for almost two millennia, and apparently took an active part in eliminating some of the conflicts that occurred in the region by forming a Thalassocratia – or “sea power” (Starr, 1955; Laviosa, 1984; Krasilnikoff and Angelakis, 2019).

The above statement is also supported by the historian Thucydides, who lived a millennium later and mentions characteristics of the Minoan navy. Translated from the Greek text, Thucydides writes that “*Minos (a king of Crete), according to tradition, was the first to acquire a navy, and dominate most of the Mediterranean Sea*”. Thucydides also writes that Minos with his navy conquered the islands of the Cyclades, established a colony in most of them and in due course expelled the Carians and the Phoenicians, known as the first pirates, and installed his sons as rulers (Kastrenopoulos, 2010). He also notes that Minos eliminated piracy, which was endemic, from the Mediterranean sea area so that the goods could move more safely (Histories, 2021).

2.2.2 The Minoan Merchant Fleet and Peace

Arthur Evans who excavated Knossos makes reference to this period as “*the Pax Minoica*” or “*Minoan peace*”

– a time when cities needed no walls. Like “*Pax Romana*”, of course, such a peace, if it existed, would have been the product of military strength rather than pacifism (Muge and Loukovikas, 2013; Angelakis, 2017). As further evidence of the importance of the Minoan fleet in keeping peace and ensuring protection of their settlements, later civilizations after the Minoans had to apply specific measures to assure protection. For instance, “cyclopean walls” were discovered in Mycenaean settlements and fortresses and other military constructions have been found in later land based Roman settlements.

Baurain (1991) reported a crisis of thought about how the Minoans brought about such lasting peace. Archaeologist John Devitt Stringfellow Pendlebury suggested that the Minoan civilization was a Maritime Empire, a widely accepted view, but more recently it was challenged by the lack of specialized warships.

What can be said in summary about the nature of the relationship of Minoan Crete to Aegean islands and especially to the Cyclades and about the thalassocracy? Various views and models have been advanced. Wiener (Wiener, 1984) has suggested that the lack of evidence of a total destruction indicating conquest of the Melos, Kea, and Thira which were governed directly or indirectly from Crete. Others believe that Thira was controlled from the palatial centers of Crete, as part of the Minoan ‘thalassocracy’ as described in Thucydides (Book 1 and Chapter 4). However, Cretan dominion could have come about gradually and relatively peacefully without the prior stationing of a garrison, as in the case of the Athenian subjugation of Melos when it refused to join the Delian League. The gradual growth of a Minoan trading colony and intermarriage (perhaps including intermarriage of leading or ruling families) could have led to Minoan political control.

2.2.3 Mention of the Minoan Fleet by Homer

The Minoan fleet is also mentioned by Homer. According to Greek mythology, Idomeneus was king of Crete, son of Deucalion and grandson of Minos. Homer, who often praises him, calls him “dourikliton” (famous on the spear). Idomeneas together with Meriones, participated with 80 ships in the campaign of the Greeks against Troy. After the end of the war, according to another tradition, Idomeneas, facing a terrible storm, swore to the Gods that he would sacrifice the first man he would meet, if he arrived in Crete with good fortune (see Fig. 1). Unfortunately, the first one he met was his son and, faithful to his oath, he sacrificed him. Later because a plague fell on Crete, the Cretans considered their king as the cause of evil and expelled him from their island. Idomeneas first took refuge in Calabria and then in Colophon, where he died. He was buried on Mount Kerkafos. However, the Cretans displayed his tomb in Knossos and awarded him heroic honors (Kargakos, 2017).

2.3 The Minoan Ships

During the excavations in Aegean “Akrotiri” (Thira) in 1974 by Prof. Spyros Marinatos, a Greek archaeologist, a color tichography was discovered in a house, which presents a whole fleet of ships consisting of seven large and three crescent moon-shaped boats (Marinatos, 1974) (see Fig. 2). “The ptychography treasure is considered to be of seminal importance, not only for its artistic, value but also for its historical significance”, as noted by Marinatos (Saroglou-Tsakou, 2014). Marinatos (1976) was also the first to collect 30 seal stones illustrating ships of Minoan Crete. Seal stones, initially made of rocks of various types, and were decorated with various patterns, illustrations, and inscriptions. The types of Minoan ships and the extent of their travel is considered below, especially with respect to sustainability.



Figure 1. A virtual sea photo on the way of Idomeneus back to Crete (Kargakos, 2017).

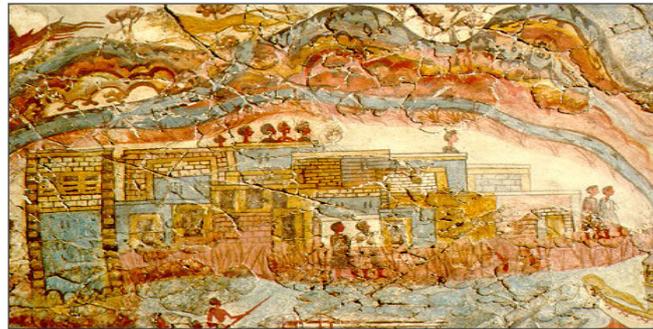


Figure 2. Left-hand portion of a large Minoan fresco from Akrotiri, illustrating various types of ships in procession (ca 1500 BC) (Abulafia, 2014).

2.3.1 Types of Minoan Ships

From the depictions in the Fresco at Akrotiri and the seal stones, it is clear that Minoans developed and used various types of ships probably since ca 1500 BC, evolving from small boats propelled with paddles, to larger ships propelled with oars or sails, and to even larger ships propelled with oars and sails. Along with different modes of propulsion, the Minoans also developed numerous specialized techniques including the development and implementation of composite boat hulls (Aed, 2018).

In the composite method of construction, linen cloth is placed over the wooden hull. Molten pine resin, a natural polymer, is then applied to the cloth forming a water-proof liner, equivalent to modern day fiberglass. Typically, several layers of impregnated linen cloth were used to form the composite layer. Use of the composite hull allowed Minoan ships to be lighter, to be more maneuverable, to carry larger loads, and to be easier to repair, if damaged. It is also interesting to note that pine resin was also applied to ship sails to make them stronger. As far as is known, it does not appear that knowledge of the double composite hull method of construction was shared with or adopted by other thalassocracies.

From the sustainability standpoint, the larger ships are of greater significance, as they were designed for the transport of goods to be traded (both exports and imports) and persons to be relocated at more distant

ports of call. Also, the larger ships formed the basis of the Minoan Thalassocracy. The importance of the larger ships is also depicted in the procession of ships shown on the Fresco at Akrotiri (Marinatos, 1976). Starting from left the ships shown are as follows: a small 10 oared vessel, followed by two 42 oared ships followed by another 42 and 36 oared ships, and finally a 36 and 42 oared vessel. With the exception of the 10 oared ship, all of the other ships depicted were design for traveling great distances (Basch, 1987). Two 42 oared ships from the Fresco in “Akrotiri” are shown on Figure 3.

2.3.2 Extent of Minoan Ship Travel

E. Hirschfeld (2021) noted that the sea travel abilities of Minoans were remarkable based on the assortment of international goods transported from northern Europe, to Africa and to Mesopotamia (Muge and Loukovikas, 2013)). It should be noted that the extensive travels of the Minoan thalassocracy was made possible by their innovative ship design, their ability to obtain drinkable water from sea water and their ability to navigate through treacherous waters (See section 3). The documentation of these travels is based on the presence of Minoan seal stones and other cultural artifacts found throughout the Mediterranean region.

Finally, a modern reconstruction of a 20 oared Minoan ship is shown on Figure 4.



(a)



(b)

Figure 3. Examples of Minoan ships: (a) paintings of 42 oared Minoan ships, from the Fresco in “Akrotiri”, Thira and (b) a model of a ship adapted from the Thiran Fresco that further provided insights of the reconstruction (from (Angelakis et al., 2021)).



Figure 4. Modern reconstruction of a 20 Oared Minoan ship (Photo from the Archeological Museum of Gortys, taken by A. N. Angelakis).

The discovery of wrecked ships is adding to the knowledge base concerning the extent of Minoan ship travel. For example, the shipwreck discovered, by a local sponge diver, in the summer of 1982 close to the east shore of Uluburun (Grand Cape), Turkey, in the Mediterranean Sea (Pulak, 1998), which carried the most spectacular late Bronze Age assortment of international goods from northern Europe, Africa, and Mesopotamia that have been found in sunken ships in the Mediterranean Sea. The importance of this ship wreck is that its contents have shed light on the importance and extent of the sea trade in the ancient world.

2.4 Thalassocracy and the Mycenaean Civilization (ca 1750-1050 BC)

During the latter part of the Brown Age (ca 1450 BC) when the Minoan civilization and thalassocracy began to decline, the Mycenaean civilization through its thalassocracy became the dominant power in the Mediterranean region, including the islands of the Aegean Sea and Eastern Europe. This domination is known from the characteristic products of the late Bronze Age (e.g., Mycenaean pottery) discovered

within the region of Mycenaean rule or influence. For example, pottery and other artifacts including seal stones (discussed below) can be used as a guide in tracking the Mycenaean presence in the eastern regions of the Mediterranean (Gorogianni *et al.*, 2016). In the early 15th century BC, commerce intensified with Mycenaean pottery reaching the western coast of Asia Minor, including Miletus and Troy, Cyprus, Lebanon, Palestine, and Egypt (Schofield, 2006).

The thalassocracy routes used by both the Minoan and Mycenaean civilizations, primarily for trade, are shown on Figure 5. However, an important difference between Minoan and Mycenaean civilizations is illustrated in the hunt and war scenes that are depicted in Mycenaean art. Unlike Minoans, known for their peaceful thalassocracy, the Mycenaean society was oriented towards war and expansion, and as shown in their art (Fumic, 2020). With respect to the implementation of actions and concepts leading to what today is known as sustainability, the Mycenaean's essentially furthered the actions and concepts initiated and developed by the Minoans, as discussed previously, in section 2.1.



Figure 5. The principal routes of thalassocracy in the late Bronze Age.

2.5 New Findings in the 21st Century

According to Sakellarakis (2012) in the 20th century important Minoan findings related to the Minoan naval domination, demonstrated the diffusion of Minoanism (μινωικότητας) and he hopes that the 21st century

will highlight more findings of the Minoan naval domination. Demetris Matsas, his student, discovered Minoan merchants, not only stone seals but even samples of Minoan writing (Bietak *et al.*, 2007). The passage to the Black Sea is obvious from there.

W. Niemeier, Director of the German Archaeological Institute in Athens, in that time clearly demonstrated the Minoan penetration of the Aegean in the Eastern Mediterranean and Central Asia (Niemeier, 2009). During his excavations in Miletus, many Minoan elements, ceramics, stone, frescoes, and even elements of the Minoan Linear A ‘Bible came to light.

Minoan elements came to light recently in Erythres, opposite Chios (Tsikritsis, 2008). Again W. Niemeier in an excavation at Tell Gabri in Israel, discovered frescoed floors that may have been made by Minoans (Niemeier, 2009). It was recently announced that Linear A points were marked on two Trojan shells, and quite recently in a jar that came to light in Tel-Harbor, Palestine, points of Linear A were found again. Minoan elements also came to light in Qantas, Syria. Ironically, a very important finding for the Minoan naval rule in the Aegean came to light in Thira. It refers to the seals, i.e. the clay imprints of seals on clay, sealed by metal Minoan rings and with representations known from various similar seals found in different parts of Crete, which certainly sealed some goods or instructions given to the vast territory of Minoan thalassocracy (Tsikritsis, 2008). Clearly, all these findings serve to further demonstrate the importance of early thalassocracy in spreading the cultural advances of the Minoan civilization and thus enhancing sustainable development throughout the Mediterranean region and beyond.

2.6 How Underwater Archeology Helps Understanding the Past

Studying the past and especially the history of ships’ evolution and sea trade is to a large extent based on our ability to find evidence that lie underwater. In particular, shipwrecks are important sources of information not only on the construction of the ships, but also on the goods they transferred, and the sea routes in relation to the human civilizations (settlements) that the ships belonged to. Underwater and / or marine archeology is a branch of archeology that deals with the search, study and research of archaeological sites, deposits and shipwrecks located under the surface of the water of the seas, oceans, lakes, and rivers. With new equipment and techniques, it is now possible to develop a clearer picture of the past than ever before.

The relationship of Ancient Greece and sea, in the sea area of Aegean Fourni (a remote cluster of uninhabited small islands), extended underwater research over the last years resulted to the identification and documentation of 53 shipwrecks together. In addition

to the shipwrecks, individual findings were recorded, mainly ceramic discs and anchors, definite witnesses of the intensity and extent of navigation and freight traffic at this key naval crossroads of the eastern Aegean (NEWSROOM IEFIMERIDA, 2017).

Recently, according to the Greek Ministry of Culture, underwater archaeologists found in Hagioi Theodoroi, in the northwestern coast of Crete a construction which is considered to be a Minoan dry dock. The Ministry of Culture reported that: “The research completed the corresponding operation carried out during 2014 with seismic methods and tests in conjunction with topographical and photographic surveys of the sunken Minoan architectural remains belonging to a building complex with a very strong foundation” (Zikakou, 2015). In addition, other buildings which were probably dry docks, as well as other architectural remains have been discovered. Using modern magnetic and electrical tomography methods archeologists have located numerous parts of buildings, both south and north of the land passage that joins Crete with the Kolokytha peninsula (Zikakou, 2015).

Thus, evidence of the extended extensive Minoan interest and preoccupation with shipbuilding that led to the Minoan thalassocracy is well supported.

3. The Relationship of Thalassocracy to Sustainability in The Bronze Age

Although “sustainability,” as the term is used today, is a modern concept, it is interesting to examine the relationship of thalassocracy to sustainability in Bronze Age. Currently, four distinct areas of sustainability are identified: human, social, economic, and environmental (Goodland, 2002). The elements of each of these areas is well documented in the literature and is not repeated here. Rather, the purpose here is to examine how thalassocracy during the Minoan and Mycenaean periods contributed to sustainability, and to discuss some of the significant contributions to sustainability made by the Minoans to the Mediterranean region. The contributions to sustainability occurred as a result of the confluence of two parallel developments: (a) the evolution the Minoan ships which made the Minoan thalassocracy possible and (b) the simultaneous progression of the Minoan scientific, engineering, technological, and cultural advancements. Thus, as Minoan ships became larger and could travel further, as discussed above, it was possible to transfer both goods and services, as well as artisans who could transfer the knowledge of the Minoan civilization over a wide region.

Of the many Minoans scientific, engineering, technological, and cultural advancements, five areas are considered briefly in the following discussion: water purification, celestial navigation, movement of goods and services, transfer of technology, and the transfer of language and culture. The advancements that are discussed were selected to illustrate the breadth of the Minoan accomplishments and because of their significant impact on the long-term sustainability of the region. Later in the Bronze Age, as noted in the previous section, the Mycenaean's essentially furthered the actions and concepts initiated and developed by the Minoans, with respect to sustainability.

3.1 Early Water Purification Techniques: A Parallel Development

The development of the Minoan thalassocracy was to a great extent assisted by the development of water purification techniques to obtain drinking water from sea water. The ability to obtain drinking water from sea water allowed the Minoan fleet to travel great distances without the need for stopping at intermediate ports. Two types of techniques were utilized to obtain drinking water from sea water: evaporation and filtration.

3.1.1 Drinking Water through Evaporation

Following archaeological evidences, it appears that Minoans had probably implemented water distillation for thousands of years by boiling the seawater the freshwater is evaporate and separate from the salt (Angelakis *et al.*, 2021). The first written indication about the desalination of seawater via the boiling process is reported by Alexander of Aphrodisias in *ca* 200 AD illustrated of boiling saltwater in a brass vessel and suspended large sponge to absorb the evaporated water (Kalogirou, 2005). During historical times, the Greek philosopher Aristotle (384–322 BC) recognized that the water phase might be changed, and the exchange of energy in his relative work that has been published and pointed out that saltwater could become sweet by turning vapor, but it does not turn back to saltwater again when it condenses (Angelakis *et al.*, 2021).

3.1.2 Drinking Water through Filtration

Aristotle also reported that a suitable wax vessel, when submerged in seawater for a long time, holds potable water and filters the salt as: "... saltwater is being mixed with something else is an evident not only from what was said but by whether someone after building a wax-vessel, put in the sea while having tie around

the orifice in such a manner as not to be poured into the seawater. This (water), thus coming in through the wax-vessel walls, is drinkable (water), such that the separated soil substances (from the water) with filtration, so what makes the water salty is mixing (with something else)..." (Meteorologia, Book B'). Today, water purification technologies developed in prehistoric times are used worldwide to produce drinking water from sea and brackish water (Birkett, 1984; EPA, 2000; Ahmed *et al.*, 2020). For example, desalination technologies, including distillation (i.e. evaporation) and reverse osmosis (i.e., filtration), have become the critical component in ensuring long-term water resources sustainability (Angelakis *et al.*, 2021).

3.2 Celestial Navigation Methods for Travel

The Minoan civilization has been described as the first of its kind in Europe, while historian Will Duran described the Minoan civilization as "the first link in the European chain". The Minoan civilization may have relied heavily on the paths of the celestial stars above to help them navigate the Mediterranean. The study examined the orientations of the palaces along the navigational directions, where large rectangular central courtyards, generally oriented north-south on the long axis, are considered the defining architectural feature of Minoan palatial construction.

"It has been hypothesized that the orientation of palatial architecture to star paths and specific sea lanes may have symbolized the special relationships between palaces and distinct foreign trade frontiers, while also being a source of legitimizing power for the local elite who controlled the ideological and technological framework of maritime knowledge," Berio wrote (Berio, 2022). The study found that Knossos, the largest Minoan palace, was perfectly aligned in a "star", the constellation Virgo, and the commercial center of Sidon.

This alignment may have played a critical role in guiding Minoan sailors to critical trade destinations in Egypt and the Levant. Indeed, the orientation of various palaces to specific star paths and sea routes may have symbolized the unique relationship between these palaces and distinct foreign trade hubs (see Fig. 6). In addition, they may have legitimized the power of the ruling elite, who controlled maritime knowledge and technology, as well as specific sea routes. The ability to travel to distant locations safely and return also contributed to the sustainability through the interchange of goods and services and ideas.

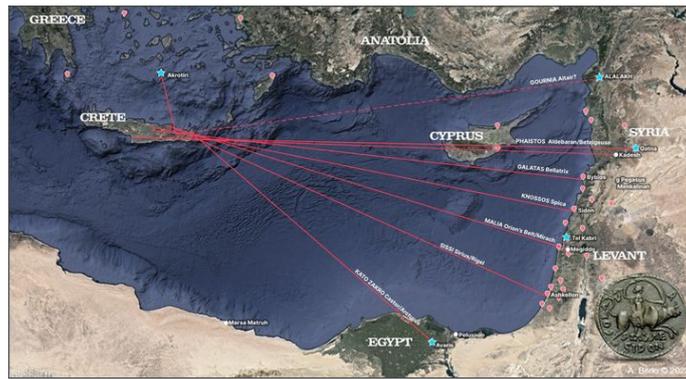


Figure 6. Minoan navigation was largely based on the paths of the celestial stars (Bruno, 2022).

3.3 Sustainability through the Transport of Goods and Services

The Minoan thalassocracy also made it possible to trade goods and services, which contributed to economic sustainability. The trade in goods is well known, based on the Minoan and other cultural artifacts found in all parts of the then-known Mediterranean world. Services were also exchanged which led to improved standards of living, thus improving the human condition (BrandPost, 2022). Another example is the transfer of desalination techniques to other cultures, which also contributed to human sustainability.

3.4 Sustainability through the Transfer of Technology

The transfer of technology through thalassocracy is perhaps the most important contribution to the economic and environmental sustainability of the Mediterranean region. As Minoan ships travelled throughout the Mediterranean region, they brought with them technology which was shared with others. Several technologies are highlighted in the following discussion.

3.4.1 Ship Design and Building

The later development of the Minoan thalassocracy was, based to a large part, on the innovations in ship building technology. The use of a composite boat hulls, described previously, is one of the many design innovations developed by the Minoans. The shipyard discovered at Hagioi Theodoroi, discussed previously, made possible the design of larger ships. It is believed that knowledge and understanding of the Minoan shipbuilding technology was instrumental in the later development of the Mycenaean thalassocracy, as many of the ships, which were of similar design as the latter Minoan ships, had to be built in shipyards located on the mainland of Greece.

3.4.2 Water Treatment

The Minoans are considered to be the first to have

developed and implemented water supply treatment technologies around 2000 BC (Angelakis *et al.*, 2023). Minoans relied on rainwater collecting and harvesting, since their early time. Moreover, to remove suspended solids from the water as sediment, small sedimentation tanks were used before the water was stored in a cistern.

3.4.3 Sanitary and Storm Water Conveyance Systems

Minoans made significant contributions to the development of sanitary and storm water conveyance systems through their understanding of the principles of fluid hydraulics. One of the most advanced Minoan sanitary and storm sewer systems was discovered in Hagia Triada (close to the south coast of Crete, a few kilometers west of Phaistos in the southern central Crete). The Italian writer Angelo Mosso (Mosso, 1907), who visited Phaistos and the villa of Hagia Triada at the beginning of the 20th century and inspected the storm sewer system, noticed that all the sewers of the villa functioned perfectly and stated:

“...all the sewers were still working! It was very interesting for me to see the water in the drainages and sewers so big that a man could enter. I doubt if there are other examples of ancient sewerages working after 4 thousand years...”

Clearly, the transfer to the hydraulic principles and knowledge developed by the Minoans for the design and implementation of sanitary and storm water conveyance systems benefitted the entire Mediterranean region by contributing to human economic and environmental sustainability through improved water supply practices and drainage of storm water and other liquids.

3.4.4 The Flushable Toilet

Another notable Minoan development that was transferred to other parts of the Mediterranean region

was the flushable toilet. The Minoan design of both flushable toilets and toilets with running water for flushing wastes contributed significantly to public health and human sustainability. In most cases, evidence for the identification of a toilet is from the existence of a terracotta sewer at the floor level

passing through the exterior wall and connecting with the outside central sewerage and drainage system (Yannopoulos *et al.*, 2017). The toilet in the residential quarter of the Palace of Minos in Knossos is probably the earliest flush lavatory in the Mediterranean region is shown on Figure 7.

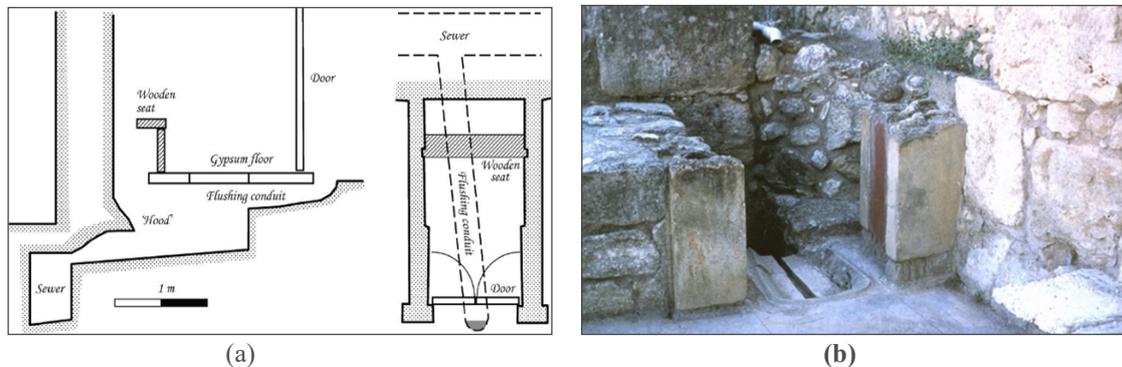


Figure 7. Flushable toilet in Palace of Knossos: (a) Section and plan views of ground-floor toilet in the residential quarter of palace and (b) photograph of the ground-floor toilet (Antoniou *et al.*, 2016).

3.4.5 Desalination Techniques and Agricultural Practices

The transfer of desalination techniques to areas with shortage of fresh water supplies, is another example of how Minoan technology contributed to human sustainability by allowing settlement of populations with good living conditions in coastal areas with limited freshwater resources.

Finally, the advanced agricultural practices, for both animals and products grown in soil, developed by the Minoans that were transferred to other areas in Mediterranean contributed to human social and economic sustainability by improving methods of producing agricultural products efficiently, which are important for human nutrition.

3.5 Sustainability through the Transfer of Language and Culture

Early Minoan language and culture was also spread by thalassocracy throughout the Mediterranean region. Through language it was possible to exchange ideas including agricultural practices with contributed to human social and economic sustainability. The transfer of knowledge of hydraulic principles which were developed by the Minoans, as discussed above, also contributed to human and environmental sustainability. Once basic human needs were met, it was possible to spread Minoan human and artistic culture as documented by art found throughout the Mediterranean region.

4. The Relationship of Thalassocracy to Sustainability in Contemporary Times

With the development of many new ways to transfer

human, social, cultural and technical information, the relationship of thalassocracy and the sea routes to sustainability in contemporary times, is primarily related to the transfer of goods services, the mining of the ocean resources, and the development of naval fleets to maintain world order. Supply chain disruptions which affect all types of goods, commodities, and products impacts economic sustainability. Such a disruption was evident in the closure of the Suez Canal in 1967 for 8 years, which resulted in a huge economic disruption of the Mediterranean countries based on the goods that were transported through the Suez Canal. Goods that were to be transported by means of larger sea routes became more expensive (Lee and Wong, 2021). A similar situation occurred on the West Coast of the United State during the Covid lockdown (2020-2022), when supply chains for various components needed for a variety of manufactured products were disrupted.

Ocean resources are a vital part of contemporary sustainability. Big companies able to perform surveys to identify exploit sea-bottom resources and countries involved in the exploitation of their shelf will become prominent players in the world sustainability game and will be members of a thalassocracy of new type.

Energy sustainability, an aspect of environmental and economic sustainability, is also based to a large extent on the cost of fuel transportation and its type. The design of new types of ships able to transport efficiently and with relatively low-cost oil, gas or other types of fuel is now an absolute need. Ship owners able to invest in the construction of these types of ships are

expected to become prominent players in the world sea-trade and members of a thalassocracy of new type which has no borders.

5. Conclusion

During the Bronze Age, by chance or fate, the Minoan's developed a unique civilization on the island of Crete, which was destined to bring change to the Mediterranean region during this unique period of history. In addition to significant contributions in, celestial navigation, ship building, innovative building design, desalination technologies, water treatment, sanitary and storm water conveyance, the flushable toilet, agricultural practices, language and culture, the Minoans developed the first thalassocracy in the Mediterranean. The word thalassocracy is used to describe the government of the Minoan civilization, whose power depended on its naval fleet (Abulafia, 2014). The wise explorer of Knossos, Arthur Evans, having diagnosed the radiation of Minoan Crete, foresaw the way of Minoan penetration in the Aegean and the Eastern Mediterranean, which of course was based on the Minoan thalassocracy and the trading posts that were established (Sakellarakis, 2012). In effect, the presence in the Mediterranean region of the Minoan thalassocracy made it possible to spread of Minoan concepts and practices of human, social, economic and environmental sustainability throughout the region. The principles and practices developed by the Minoans for sustainability served as a model for subsequent civilizations and continue today.

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