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Edited by
Daniele Malfitana, Jeroen Poblome, John Lund

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HEROM

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THEMATIC SECTION

FROM OPPORTUNISM TO THE MARKET? THE DEVELOPMENT OF HARBOR INFRASTRUCTURES IN THE AEGEAN FROM THE HELLENISTIC TO THE ROMAN PERIOD

Ioannis Nakas

INTRODUCTION[1]

It is not easy to study the Hellenistic and Roman ages as two independent periods. Despite the political and economic difference between the worlds of the Hellenistic dynasties and the Roman Late Republic and Empire, both periods form part of a coherent and gradual evolution of the Greco-Roman world that culminated with the final unification of the Mediterranean[2]. One of the most important elements of this evolution was the development of commercial networks. Thanks to the cultural, political, and economic unification of the region and the *pax romana*, production, manufacture and exchange networks developed to such a degree that some have suggested a new "proto-capitalistic" market economy. This contrasts with the limited and "opportunistic" commerce of the Classical and Hellenistic world, based on small exchanges and short-haul, mostly regional networks[3]. Although the nature of this transformation is still debated, the volume and intensity of seaborne exchange and travel reached unprecedented levels, which peaked in the early Roman Imperial Period[4]. Harbors played a major role as commercial hubs, markets, and shipping centers, many developing into maritime cities with their own dynamics and potentials[5], "models of really clever and efficient planning and artistic creations of a high order, beautifully laid out and adorned with imposing buildings and decorative sculptures"[6].

Essential for harbor development are specific infrastructures, ranging from structures in the sea or on the shoreline (breakwaters, moles, quays), to land structures (storage facilities, agoras, roads), some of purely practical use (shipyards, lighthouses) and other of mostly monumental and symbolic nature (temples, votives, gateways). Harbor infrastructures of the Hellenistic and Roman Aegean reflect the development of the commercial networks and a transformation from "opportunism" to a "market economy". Nevertheless, the relationship between infrastructures

1. Thanks to the editors, my proofreader (Jen Glaubius), Monica Livadiotti (Politecnico di Bari), Sabine Ladstätter, and Bettina Schwarz (OeAW-OeAI).

2. Horden-Purcell 2000, p. 27; Chaniotis 2018, pp. 10-30.

3. Paterson 1998, p. 150; Temin 2013, p. 2.

4. Wilson 2011, pp. 33-39.

5. Arnaud 2016, pp. 117-118; Feuser 2020.

6. Rostovzeff 1941, p. 1042.

and the success of a harbor was not straightforward. Many important commercial hubs remained simple establishments and natural harbors.

This paper examines the relationship between the existence, form, and extent of Aegean harbor infrastructures and the commercial traffic and ships they served, and their position within commercial networks. While this paper focuses on Aegean sites of the Hellenistic period through c. 300 AD, it also considers case studies from Lycia due to their proximity and association with the area in question (**Fig. 1**).

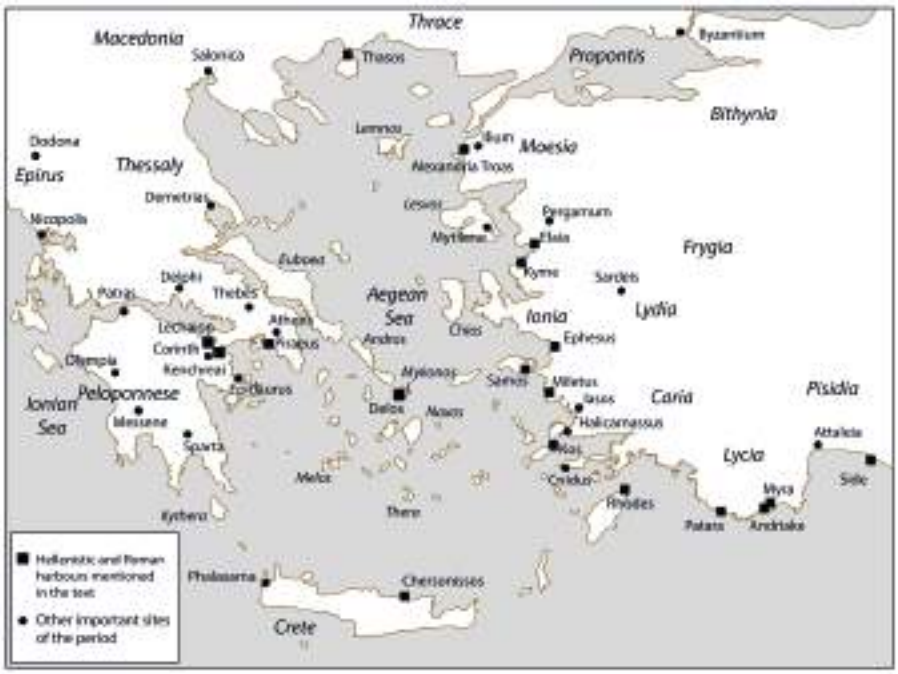

Fig. 1. Map of the Aegean Sea with Sites Mentioned in the Text (Drawing by the author).

THE BACKGROUND: FROM THE CLASSICAL WORLD TO THE EMPIRE

From Alexander the Great through the establishment of the *pax romana*, the Aegean Archipelago was gradually transformed into a unified world[7]. After an initial stagnation of population and economic growth in the 3rd century BC, the Aegean recovered after 200 BC[8], when some of the most important coastal urban and commercial centers developed (**Fig. 1**). Despite political fragmentation and endemic warfare,

7. Archibald 2005, p. 1; Chaniotis 2018, pp. 10-30; Van Oyen 2020, p. 25.
8. Reger 2007, pp. 463-483.

commercial centers like Delos and Rhodes thrived and played an important role in long-haul networks, especially concerning grain trade[9]. The Roman conquest established a long-lasting peace, and the Aegean economy recovered, boosted by the generous patronage of the Roman elites. This was reflected in the rise of population, the increase in the volume of commerce[10], and the creation of important public works[11]. The fundamentally conservative and limited commercial life of the Classical world was transformed into a more complicated and extensive production and exchange economy, in which seaborne networks played a vital role[12]. Free movement allowed growing numbers of people to carry knowledge, craftsmanship, and wealth around the region and to act as agents of economic development, consumers, producers, and clients. They also formed the audience for harbor architecture. Increasing trade required more space and better protection for ships[13], adequate storage facilities, and organized markets[14]. Mariners and travelers required provisioning, recreation, lodging, and worship. Large states, as well as political and financial elites, were able to invest in the creation of monumental harbors. Such harbors not only guaranteed the exchange of goods but also acted as symbols of authority and power, especially for imperial benefaction[15].

Nevertheless, this larger trade was only part of Aegean commercial life. Many local communities, especially in the islands, remained largely self-sufficient, basing their subsidence on local production and small-scale regional networks in operation since prehistory[16]. Smaller ships carrying mixed cargos continued tramping between different harbors and anchorages, covering local needs for both merchants/ship owners and coastal communities[17]. These secondary networks had a limited impact on larger trade routes and markets, but were vital for the well-being of many coastal settlements and operated alongside long-haul networks[18]. Corresponding to this dual network structure, the new highly advanced and monumental harbor entities were not universal nor evenly distributed, especially between mainland Greece, the islands, and Ionia[19]. The development of harbor infrastructures was often guided by politics, resulting in the parallel operation of networks of monumental and of less elaborate harbors.

9. Chaniotis 2018, p. 180.
10. Alcock 2007, pp. 676-677, 696.
11. Feuser 2020, pp. 2-6.
12. Polanyi 1957; Archibald 2005, pp. 3-10; Gibbins 2011, p. 90; Arnaud 2014, pp. 117-118.
13. Casson 1974, pp. 121-122; Archibald 2005, p. 10; Alcock 2007, p. 687.
14. Nakas 2022, p. 2.
15. Shipley 2000, p. 130; Arnaud 2015; Nakas 2022, pp. 118-119.
16. Broodbank 2000; Malkin 2011.
17. Hopkins 1983, pp. 94-96; Leidwanger 2020, pp. 71-76.
18. Wilson 2011, p. 39; Nakas 2022, p. 25.
19. Yegül-Favro 2019, p. 557.

THE AEGEAN AS A UNIT OF ANALYSIS AND THE NATURE OF THE EVIDENCE

The topography of the Aegean makes it a distinct and coherent Mediterranean sub-region for analysis, with fixed borders and a common geomorphology[20]. This maritime region has distinctive geographic features and has always been a sea of small distances, with islands playing a prominent role in crossings.

This study relies on archaeological finds and written sources that detail the use of harbors, their history, and their specific infrastructures. There are certain limits, however, concerning what these datasets can provide. Despite great progress in the last decades, there are areas where archaeological research on Aegean harbors has either been minimal, or important sites are beyond the reach of researchers, having been overbuilt or destroyed by modern development[21]. Furthermore, for even better-protected and excavated sites, it is often impossible, due to their size, to have an overall view of the entire harbor, and many vital elements and data for chronologies are missing. Written evidence gives relatively little information on harbor infrastructures, and should always be considered with caution. Finally, epigraphy provides evidence for only a few harbors such as Delos or Ephesus. The data and discussion presented here include only the sites that are well studied through field research to provide useful datasets.

THE INFRASTRUCTURES

Harbor works and harbor technologies

Harbor works that include protective structures in the sea—lighthouses, quays, and dredging operations—are the most important, but also the most technically complicated and costly harbor infrastructures. By the early Roman period a series of technologies had developed and were: rock-cut harbors, simple rubble moles, ashlar moles created by lowering blocks from the surface to the seabed, wooden jetties and maritime concrete[22].

There is relatively little evidence for the different technologies of Aegean harbor works during the Hellenistic period. This is due to the lack of thoroughly excavated and dated material from important sites, many of which have also been obstructed by modern development (e.g., Rhodes, Piraeus), and to the fact that many harbors continued using pre-existing protective works (e.g., the "Great Mole" at Delos, the Northern Mole of Thasos or Polycrates' mole in Samos. **Fig. 2C**)[23]. Where adequate

20. Morton 2001, pp. 13-29.
21. Nakas 2022, pp. 12-14.
22. Blackman 1982a, 1982b, 2008; Rickman 1996; Wilson 2011, pp. 46-47.
23. On Delos' "Great Mole"see Duchene *et alii* 2001, p. 147 and Hellman 1980; on Thasos' Northern Mole see Empereur-Simossi 1993, p. 647 and Grandjean-Salviat 2000, pp. 52-53; on Samos' mole see Simossi 1991.

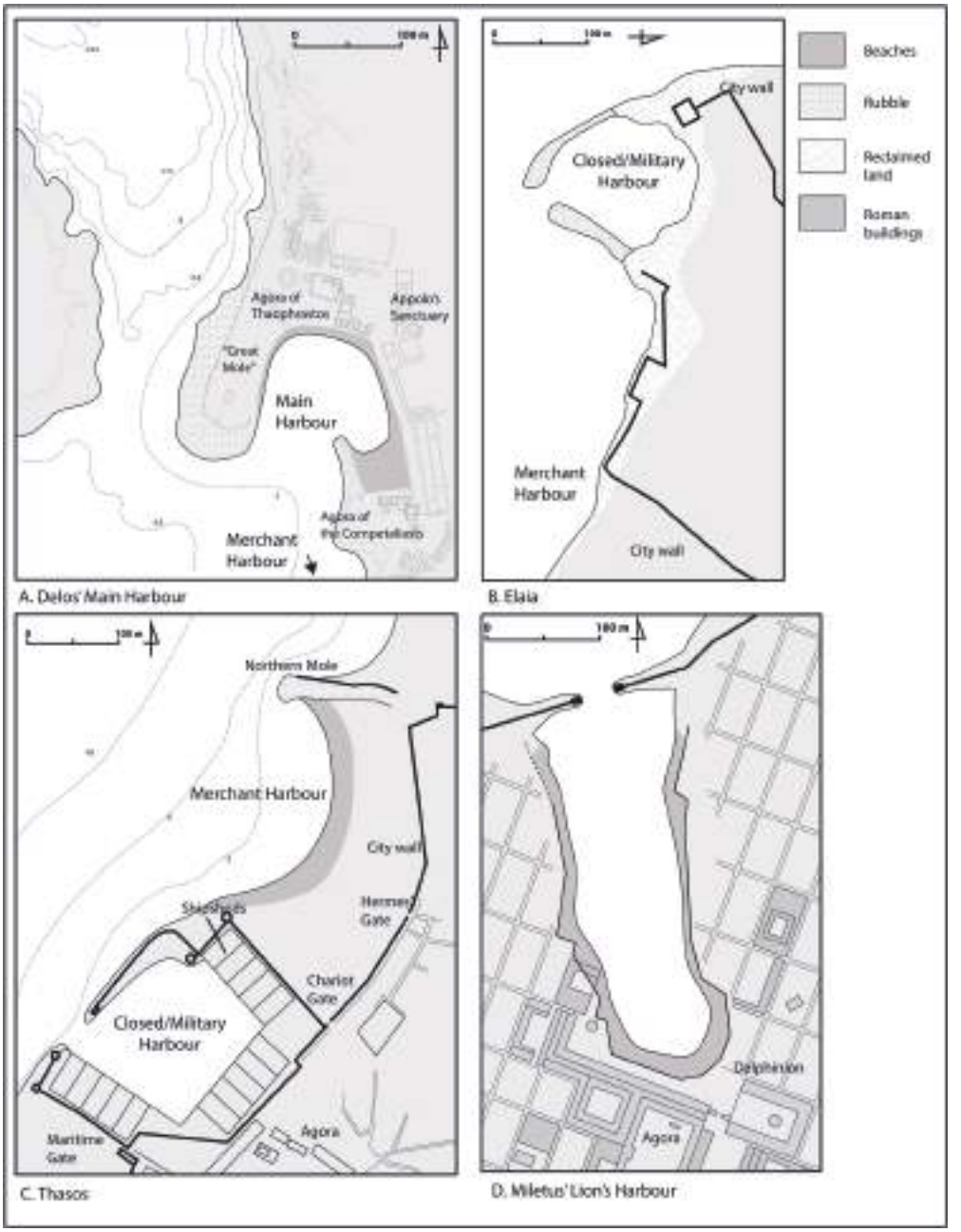

Fig. 2. Plans of Hellenistic Harbors (Delos, Thasos, Elaia, Miletus; drawing by the author).

data is available it appears that the creation of simple rubble moles, on which ashlar quays and other structures were erected, remained the predominant method (**Fig. 2 B and D**)[24]. This simple and efficient technique must have been ideal for local builders, since it required only large masses of rubble to create very sturdy and resilient structures, although these did not allow the direct berthing of ships[25]. A solution to this problem was the erection of moles by lowering ashlar blocks directly onto the seabed, a technique employed in the monumental, but likely never finished, harbor of Amathus (c. 300 BC)[26], and possibly Delos' Gourna[27], and described by Tacitus concerning the late-2nd century BC harbor of Centumcellae[28]. This method, although it could create steep and firm stone moles in the water, required sizeable ashlar blocks and raised technical complications of leveling the seabed. Such moles were probably short-lived, their foundations exposed to wave action, which may help explain why they never became widespread[29].

Other technologies were available in the period. Wooden piers were well-known in the harbors of Italy (Naples, Pisa) and southern France (Marseille) by the 4th century BC[30]. Such structures would have been cheap and easy to build, even with recycled timber in the arid islands of the Aegean, but none survives in the region, nor do they appear in written sources. Finally, geoarchaeological data confirm dredging in Mediterranean harbors such as Marseilles, Pisa, Naples, Tyre, and Sidon from the 3rd century BC onward[31], although the data available indicates simple operations no more than 0.5 m deep[32]. These have not yet been documented in the Aegean for the period and do not appear in the written sources[33].

The Roman period is marked by an increase in the number and size of harbor works around the Mediterranean, as well as the introduction of the new technology of maritime concrete[34]. This state-of-the-art method allowed for the creation of harbor

24. For Elaia see Pirson 2014, pp. 349-356 and Seeliger *et alii* 2018, pp. 10-12, Fig. 9; for Miletus' Lion's Harbor see Brückner *et alii* 2014 and Feuser 2020, pp. 31-33.
25. Nakas 2022, pp. 111-112.
26. Empereur-Kozelj 2017, pp. 114-115.
27. Zarmakoupi 2015, pp. 124-126; Zarmakoupi-Athanasoula 2018, p. 98, Fig. 10.
28. Tac.Ep.6.31.15-17; cfr. Quilici 1993.
29. Nakas 2022, p. 117.
30. On Naples see Boetto *et alii* 2009, pp. 461-462, Fig. 4; on Pisa see Bruni 2002, p. 36; on Marseilles see Hesnard 1994, pp. 207-210, Figs. 8-9.
31. Marriner-Morhange 2007, p. 172, Fig. 28; Morhange-Marriner 2010.
32. Hesnard 1994, pp. 209-210; Giampaola *et alii* 2005, p. 60; Giamie *et alii* 2019, p. 145.
33. The harbor of Lechaion is mentioned by the 1st-century BC geographer Diosynsius Calliphontis (108-109) as a dug-out ("χωστός") harbor. The harbor (at least its inland part) had apparently been dredged several times, as the great mounds along its banks show (Theodoulou 2002, p. 90), whereas an important dredging operation has been documented in a honorific statue inscription of 353-358 CE mentioning the proconsul of Achaea Flavius Hermogenes as the "benefactor and builder of the harbor," most likely of Lechaion (IG IV 209; Kent 1966, p. 164, Pl. 42; Rizakis *et alii* 2001, pp. 315-316).
34. Brandon *et alii* 2021, pp. 223-230.

works in any coastal environment, and the erection of proper docks in deep water, on which even the largest merchantmen could berth directly. Maritime concrete technology was swiftly transferred during the Augustan period to all regions and allowed the creation of some of the most impressive and monumental harbors, including Portus and Caesarea Maritima. Nevertheless, a closer look at the diffusion of this technology shows that it was not an even process. In the Aegean it remained virtually unknown, with only the harbor of Chersonnesos in Crete known through field research to have been built with maritime concrete[35]. Technical complexity and cost may have limited its use, since it required the knowledge of the proper application of concrete underwater as well as the provisioning of large quantities of volcanic pumice from Italy (chemical analysis has shown that only material from Campania was used in maritime concrete structures)[36]. The cost must have been so great that only state authorities and the imperial family could support it. Furthermore, in contrast to the simple rubble moles of the past, maritime concrete had limited longevity, and it could easily be defective if not employed correctly. The great harbor of Caesarea Maritima was unusable by the end of the 1st century AD[37], and the concrete of the Claudian basin of Portus was of deficient quality, as shown by chemical analysis[38]. Maritime concrete probably depended on imperial intervention and was therefore tied to environments of great political importance but debatable practicality.

The old methods of rubble and ashlar protective works survived well in the Roman Aegean. Important new harbors like Kenchreai were protected by simple rubble moles, although maritime concrete and state funding were available[39]. The same seems to have been the case in other developing regions like North Africa where, despite the creation of an important network of new harbors after the 2nd century AD, all appear to have been built with simple rubble moles[40].

Dredging developed in the Roman imperial period and some important operations took place in the region, including at Ephesus and at Side in Pamphylia, where written sources tell us of the never-ending dredging[41]. Nevertheless, compared with other areas such as Latium (Ostia and Portus)[42], the Aegean has few examples of dredging, since no written evidence or geomorphological data have documented any such operations, and harbors such as Miletus and Elaia were largely left to gradually silt up. Others, however, such as at Kos and Rhodes, remained operational throughout the Roman period[43].

35. Nakas 2022, pp. 115-116.
36. Robinson *et alii* 2020, pp. 105-107; Brandon *et alii* 2021, p. 233.
37. Reinhardt-Raban 1999, p. 814; Goodman Tchernov-Austin 2015, pp. 452-453.
38. Brandon *et alii* 2021, pp. 79-81.
39. Scranton *et alii* 1978, pp. 39-46; Nakas 2022, p. 151.
40. Wilson 2011, Fig. 2.25; Brandon *et alii* 2021, pp. 138-140, Fig. 3.2.
41. Wilson 2011, p. 51
42. Goiran *et alii* 2010, 2014; Salomon *et alii* 2016.
43.For Rhodes see Blackman 1999; Filimonos-Tsopotou 2004, pp. 46-70; for Kos see Livadioti 2018, Figs. 1-2, 25.

Elaborate harbor works in the Aegean were limited by their complexity and high cost, but also by geomorphology. The largely fragmented coastline of the mainland and islands and the many different spaces that could be used to accommodate vessels offered plentiful choices for mariners. The small distances between anchorages, often scattered around the same island (e.g., at Delos)[44], allowed mariners to find shelter easily, without having to depend on artificial harbors. This brought less pressure on authorities to create new harbors than in regions like the Levant or Latium that had fewer natural harbors.

In general, the "poverty" of harbor technology in the Roman Aegean reflects specific economic and political realities. The necessary know-how, skilled personnel, and material for maritime concrete had to be imported to regions outside Campania, and this process was so costly that only the upper echelons of the Roman imperial administration could support it[45]. The construction and maintenance of harbors both in the Hellenistic and Roman periods were commonly related to royal intervention[46]. With the Aegean having lost some importance as a financial and political center and being largely outside the commercial networks supplying the great cities of the Empire and the army, it is not surprising that the construction of concrete harbors was not common, with few exceptions (e.g., Chersonessos. **Fig. 3B**). Imperial intervention here was directed towards roads, aqueducts and public buildings, which were much easier to build and lasted much longer than harbors. Even in the 2nd century AD, when the harbor façades of several cities were extensively revamped, harbor works remained simple and few.

Lighthouses

In the Hellenistic and Roman periods, lighthouses became navigational aids as well as harbor symbols[47], but are few in the Aegean. Thasos was equipped with a network of well-built but small and simple lighthouses or beacons already by the 5th century BC (**Fig. 4**)[48]. Small, unexcavated square buildings along the coasts of Delos have also been interpreted as lighthouses, but there is no clear evidence[49]. In the Roman period, although lighthouses become more common and larger across the Empire, they remain virtually unknown in the Aegean, and do not appear on local coinage, which regularly includes images of harbor structures[50]. A lighthouse

44. Zarmakoupi 2018, pp. 37-38.
45. Brandon *et alii* 2021, p. 233.
46. Arnaud 2015; Nakas 2022, pp. 118-119.
47. Giardina 2010; Robinson *et alii* 2020, pp. 106-107; Feuser 2020, pp. 237-240.
48. Koželj-Wurch-Koželj 1991.
49. Bruneau 1979, pp. 102-103; Bresson 2016, p. 91; cfr. Nakas 2022, p. 76.
50. Boyce 1958, Pl. 14; Rosen *et alii* 2011, Fig. 2. A possible exception is a coin of Commodus from Corinth depicting a lighthouse and a ship (Price-Trell 1977, p. 84, Fig. 147). The image most likely depicts the harbor of Lechaion, since no lighthouse remains have been identified in Kenchreai.

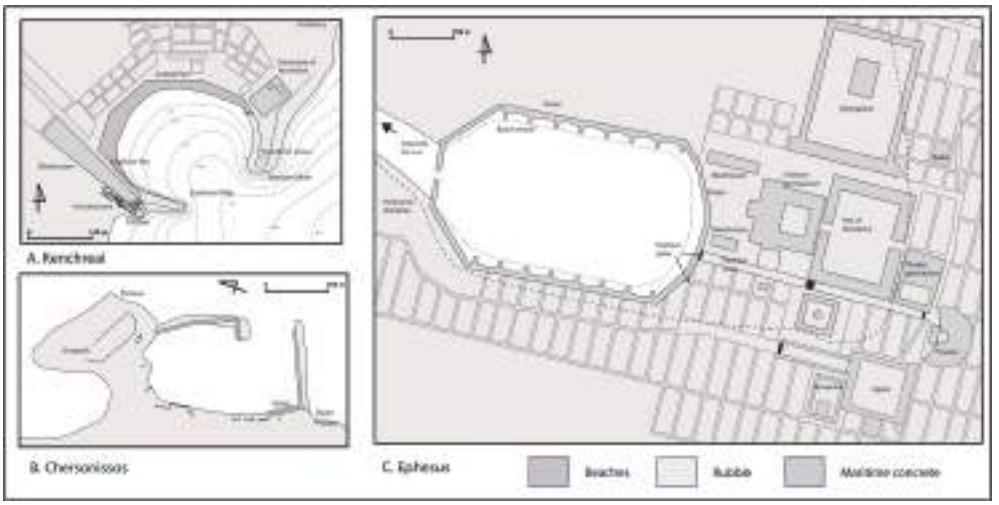

Fig. 3. Plans of Roman Harbors (Kenchreai, Chersonissos, Ephesus; drawing by the author).

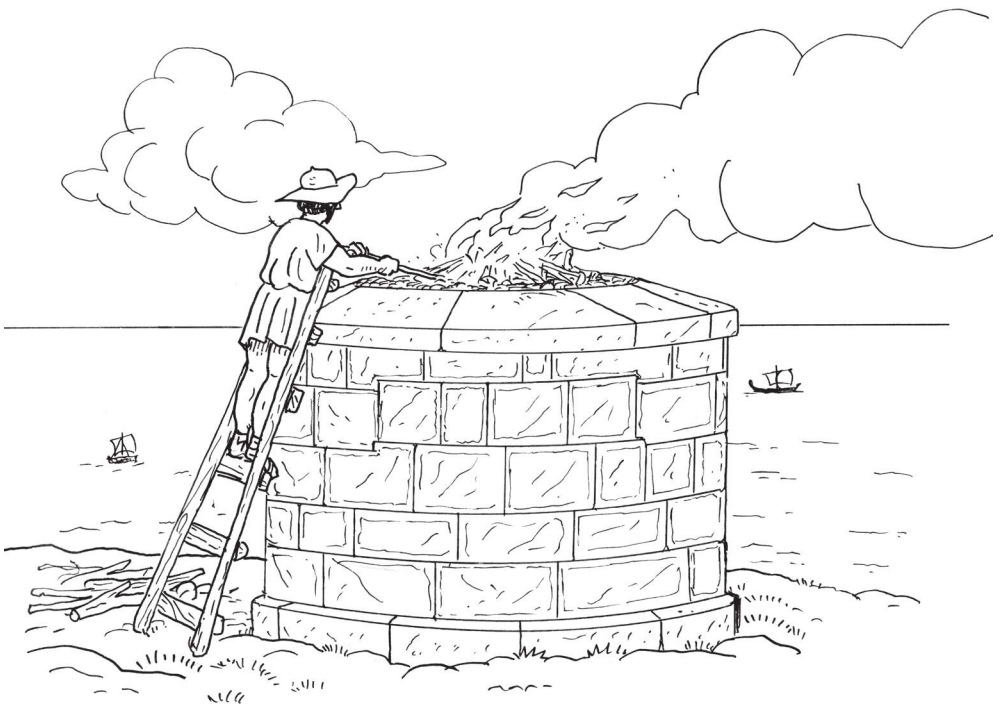

Fig. 4. Lighthouses (Thasos, Patara; drawings by the author).

is mentioned at Smyrna by written sources but without further details[51]. Some of the most active harbors at Ephesus or Kenchreai (**Fig. 3A and C**) appear to have never been equipped with lighthouses and it is only at Patara where a monumental but relatively small lighthouse overlooking the harbor was built to honor Nero[52]. Their rarity could be related to the Aegean's geomorphology, since local coastal terrain gave ample landmarks for mariners to navigate[53].

Storage facilities

A vital element of harbor operation is the ability to accommodate various goods for short- and long-term storage, which is related to the location of storage in relationship to the seafront and the volume of goods contained (calculated from its dimensions)[54]. For reasons of clarity, a maximum capacity in cubic meters (m^3) and tons is proposed here, based on the study of Boetto et al. concerning the Ostia *horrea*, as is a division between the storage of containers or sacks as high as possible within these spaces and the storage of bulk cargos, which would naturally give a lower capacity due to limits of creating piles in such space.

Hellenistic agoras were commonly equipped with identical rectangular spaces attached to porticos or peristyle buildings, often in close proximity to harbors and waterfronts. This is the case at Miletus, Delos, Thasos and Kos. (**Fig. 5**)[55]. It remains doubtful, however, whether such spaces were used exclusively for cargo storage, whether they included shops and workshops, or whether they had a mixed use of commercial activities. In the case of Hellenistic Delos, a multifunctional and interchanging use has been firmly supported by recent research[56]. The storage capacity of these spaces, either public or private, is relatively small, not exceeding 100 m^3, which, by using the Ostia *horrea* calculations, corresponds to a maximum of 35 tons of cargo in containers (sacks or amphorae) or 73 tons of bulk cargo if piled on the floor[57]. This meant that each storage unit could accommodate the cargo of a single ship of small to medium capacity[58]. Similar were the dimensions of possible storage spaces in other Hellenistic harbors such as Thasos (agora's southeastern portico: 25 tons)[59], Kos (spaces around the agora: 84 tons)[60], and Miletus (shops at the "Ha-

51. AG 9, 671, 675.
52. Koçak 2019, Fig. 3; cfr. Feuser 2020, pp. 238-239, Fig. 124.
53. Morton 2001, pp. 198–199.
54. Boetto *et alii* 2016.
55. Von Gerkan 1915, pp. 4-23; Sielhorst 2015, pp. 125-132, 153-159, 291-292.
56. Duchêne 1993, p. 125; Karvonis 2008; Zarmakoupi 2018, pp. 33-34.
57. Boetto *et alii* 2016; Nakas 2022, p. 74.
58. On the categorization of Hellenistic and Roman commercial ships based on their tonnage see Boetto 2010, Table 1; Nantet 2016, pp. 139-142; Nakas 2022, Table 2.1.
59. Salviat 1956, pp. 416-418; Grandjean-Salviat 2000, p. 71, Figs. 31, 40.
60. Rocco-Livadioti 2011, Figs. 2-3, 14a; Livadioti 2018, Figs. 7, 22a. In the case of the agora of Kos some of the units are divided in three spaces and some not (the long rooms at the northeast corner of the agora), but they all have the same overall size.

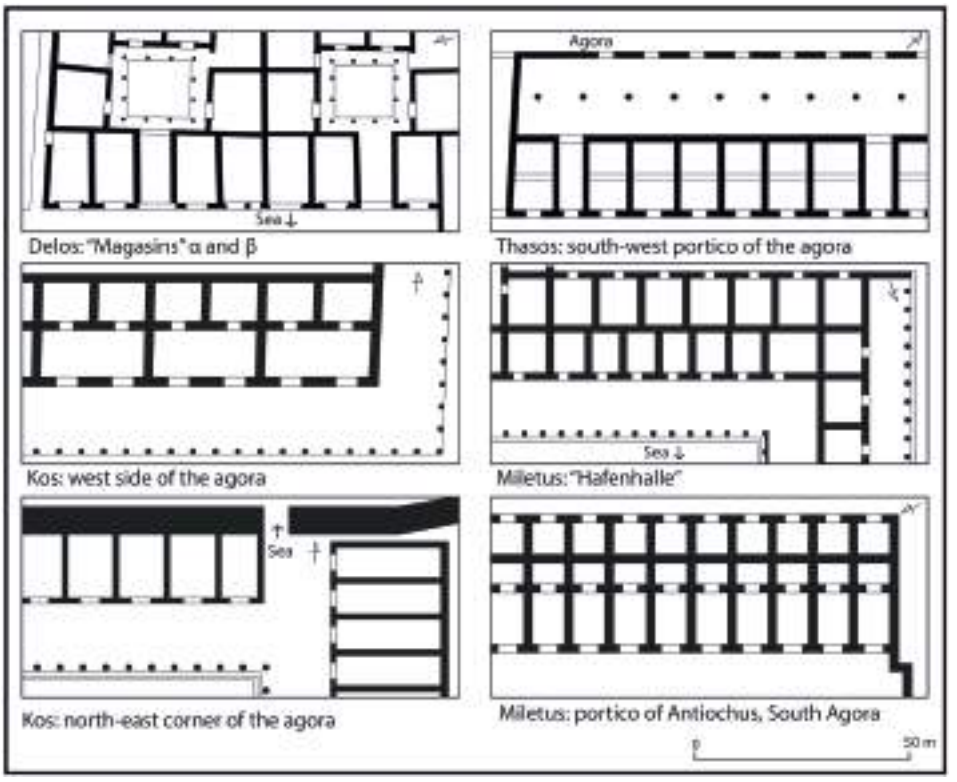

Fig. 5. Hellenistic Storage Facilities (Delos, Kos, Thasos, Miletus; drawing by the author).

fenhalle" portico facing the Lion's Harbor: 26 tons; shops at the Southern Marker: 80 tons; **Fig. 5**)[61]. Furthermore, buildings of commercial character, such as at Delos' Merchant Harbor, included both storage as well as rooms for habitation, reception and worship. Such multifunctional establishments, most likely distributed around the urban fabric of most Aegean harbor cities, reflect the nature of trade in such centers, where the population was too small to require storage of large quantities, and the *deigma* practice, where only parts of the cargos were unloaded and inspected as specimens before the whole cargo was sold[62]. It should be noted here that much larger hypostyle rooms, such as the 4th-century BC Arsenal of Philo in Piraeus or the 2nd-century BCE "Speicherbau" in Miletus, were in use, but were likely never used for commercial storage[63].

61. Knackfus 1924, pp. 47-51, Fig. 40.

62. Bresson 2008, pp. 101-105; 2016, pp. 309-313; Arnaud 2011, p. 67.

63. On the Arsenal of Philo see Hoepfner-Schwandner 1994, pp. 44-50, Figs. 35, 37, 39; on Miletus' "Speicherbau" see Kleiner 1968, p. 119, Fig. 87.

Roman-period storage infrastructures were much larger than their predecessors and matched the increasing volumes of goods exchanged in harbors, especially those of the imperial period, following the models of the massive *horrea* of Rome, Ostia, or Portus[64]. In the Aegean, one of the earliest examples of Roman-type storage facilities are the *horrea* of Kenchreai (**Fig. 6**)[65]. These include storage units larger than the ones known from Delos (83.2–182 m^2), covering a minimum of 4,500 m^2 and accommodating at least 10,000 tons[66]. They are also organized in a single building complex that precludes other functions apart from the storage and/or selling of goods. The Kenchreai *horrea* could have been part of the developing *annona* system of grain supply and date to the second half of the 1st century AD, a period in which emperors like Claudius started offering incentives to merchants to support it[67]. Similar establishments are not known in other Aegean harbors, where pre-existing storage infrastructures continued in use. Even at Kenchreai, the warehouse complex could be interpreted as an effort of local administrators to control and coordinate the flow of products to and from the rapidly developing metropolis of Corinth and its hinterland. Much larger, monumental establishments started appearing in the east after the 2nd century AD at sites like Patara (Hadrian's *horrea*)[68], Andriake (**Fig. 6**) in Lycia, Maximianopolis in Pamphylia, and Korasion in Cilicia[69]. In the case of Patara, each of the eight storage units could accommodate 80–160 tons of merchandize (depending on arrangement) and the whole building could accommodate 2,000–4,000 tons of goods. Very similar were the dimensions, planning, and capacity of the *horrea* at Andriake[70]. These structures share great dimensions and unified spaces, in contrast to earlier warehouses that were divided into separate units, ideal for the use of individual merchants or cargos. Nevertheless, it remains only a hypothesis that these could have been built for *annona*, since alternatively they could have served the different and fluctuating needs of contemporary commerce[71].

In general, a rather linear development from smaller and less centralized Hellenistic storage facilities towards larger and better organized Roman establishments can be observed. Although it remains unclear whether these spaces housed *annona* grain, they illustrate a change in the volume of trade as well as state involvement in creating infrastructures to facilitate trade. Nevertheless, such monumental buildings

64. Keay 2012, pp. 37-39, 44-46; Van Oyen 2020, pp. 122-157. Cfr. Boetto *et alii* 2016, pp. 183-184.
65. Scranton *et alii* 1978, pp. 39-46; Nakas 2022, p. 92.
66. Nakas 2022, p. 99, forthcoming. The variation in the size of the Kenchreai *horrea* was caused by the wedge-like form of the storage complex.
67. Sirks 1991, pp. 39-44; Temin 2013, pp. 32-33.
68. Rickman 1971, pp. 140-144; Koçak 2019, p. 76, Fig. 4.
69. Rizos 2015, pp. 289-290.
70. Rickman 1971, Fig. 30.
71. See Van Oyen 2020, pp. 129-130 for a review of criticism of views that all great storage infrastructures of the Roman Empire were related to state-controlled commerce.

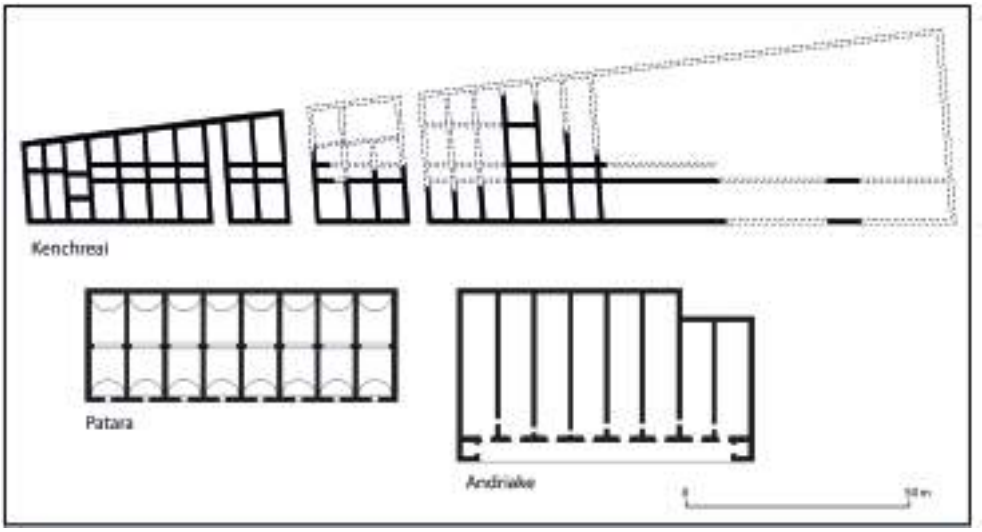

Fig. 6. Roman Storage Facilities (Kenchreai, Patara, Andriake; drawing by the author).

were not universal and some of the most monumental harbors like Kos were never equipped with such complexes, probably since they did not receive large cargos[72]. Local communities would likely have had little interest in such massive storage (which involved dangers of decay and parasites), with most of their needs being covered by local production and short-haul trade[73]. As harbors would serve both "high trade" as well as short-haul regional systems, large storage facilities would develop only in specific sites and under specific conditions.

The market and the public space

The existence of an organized public space around a harbor as one of the "parameters of attractiveness" can largely guarantee success[74]. Public infrastructures such as agoras, porticos, commercial buildings and roads would make harbors more appealing to merchants and mariners, as well as to the people from the adjacent hinterland.

The construction of agoras around harbors was a common trend in the Classical and Hellenistic Aegean. Since the 5th century BC, Piraeus was equipped with an *em-*

72. Nakas 2023a, p. 152.
73. Hopkins 1983, pp. 94-96; Alcock 2007, p. 687; Leidwanger 2020, pp. 71-76; Nakas 2022, p. 110.
74. Kotarba-Morley 2015, pp. 287-289.

porion, a spacious, designated commercial area adorned with porticos and temples[75], whereas Miletus and Thasos had developed similar, well-planned harbor agoras by the 3rd century BC (**Fig. 2**)[76]. These agoras were either directly open towards the harbor or communicated with it through wide roads, often parts of a hippodamean grid, and paved[77]. In Hellenistic Delos, a deliberate effort to create a functional and imposing harbor landscape is evident. Epigraphic and archaeological data indicate the steady funding of reclamation works in the two adjoining agoras and impressive public buildings such as the great Hypostyle Hall, the extension of Phillip's Portico, and the paving of the surrounding area and erection of imposing votives (**Fig. 7A**)[78]. The situation in Thasos, Miletus or Kos was similar: porticos were built near the waterfront or behind the seaside fortifications, and public spaces were delineated and embellished[79]. The buildings combined monumentality with function, featuring porticos with shops or warehouses, public offices, and sanctuaries (often dedicated to patron deities of mariners, like Poseidon in Delos and Thasos or Apollo in Miletus)[80].

With the Roman conquest most Hellenistic harbors survived intact, especially in areas where the transition was peaceful[81], and infrastructures continued to be used, extended, and embellished. Few new large buildings were erected, mainly due to the lack of space which would have required either the demolition of pre-existing structures or reclamation (*cfr. Ephesus*; **Fig. 3C**)[82]. But even when space was available, more practical solutions were chosen. Kenchreai's maritime façade remained simple, with warehouses, shops and *oikos*-style sanctuaries (**Fig. 7B**)[83]. A similar solution was chosen at Delos, where simple, non-monumental commercial buildings covered part of pre-existing agoras around the harbor, although in this case the simplicity must be linked to the general decline of the island, which had lost most of its population and splendor when it was sacked by pirates in the early 1st century BC (**Fig. 2A**)[84].

Things changed in the 2nd-century AD Aegean, especially in the east. Under the Antonines, as Asia Minor grew in importance[85], several harbors were monumentali-

75. Garland 1987, pp. 151-153.
76. Hoepfner-Schwandner 1994, pp. 7-20, Figs. 5-8.
77. Grandjean-Salviat 2000, pp. 57-61, Figs. 17-18.
78. Vallois 1923, Pl. X; Duchêne *et alii* 2001, Doc. VIII; Nakas 2022, p. 122.
79. Feuser 2020, pp. 252-265.
80. On the sanctuary of Poseidon Nauklarios, patron of ship commanders, in the harbor of Delos see Moretti-Fincker 2016, p. 98; on the Poseidonion of Thasos see Seyrig-Bon 1929; Grandjean-Salviat 2000, Fig. 124, pp. 125-126; on the sanctuary of Delphinium of Miletus see Herda 2005, pp. 248 f.
81. Yegül-Favro 2019, pp. 557, 598-599.
82. Sielhorst 2015, pp. 181-186; Ladstätter 2016, pp. 262-265, Fig. 22; 2019; Yegül-Favro 2019, pp. 598-599.
83. Scranton *et alii* 1978, pp. 88-89; Nakas 2022, p. 122.
84. Pâris 1916, p. 29; Hasenohr 2002, p. 101; Nakas 2022, pp. 61-63.
85. Alcock 2007; Yegül-Favro 2019, pp. 598-599.

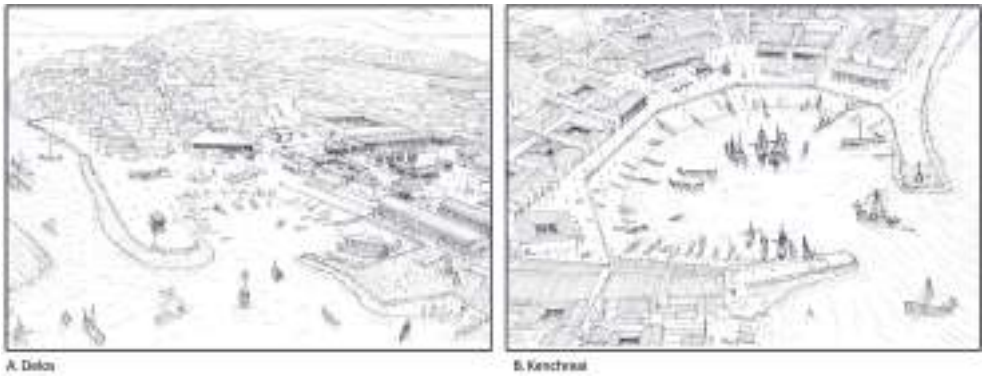

Fig. 7. Artistic Reconstruction of the Harbor of Hellenistic Delos and of Roman Kenchreai (drawing by the author.)

zed. In Rhodes the *Tetrapylon* archway was built over the Hellenistic shipshed complex, whereas in Kos and Ephesus massive gateways and arches were erected facing the harbor and marking the ends of major urban roads (**Fig. 8**)[86]. Such buildings did little to improve accommodation of ships or merchandize, but acted as symbols of imperial and civic power and prosperity. What is remarkable is the effort to establish a monumental façade of the harbor toward the sea (the propylon of Kos' harbor agora or Rhode's *Tetrapylon*) and simultaneously toward the hinterland (the free-standing arched gateways of Ephesus; **Fig. 8B**)[87]. These harbors thus acquired the role of coastal scenography reflected in Roman art and the idealistic representation in mosaics, reliefs and frescoes[88]. This monumentality, however, is only observed in the eastern Aegean and Ionia and possibly relates to very specific local conditions, an increased role in commercial networks, and in the provisioning of agricultural goods for the Empire and army.

The existence of an elaborate harbor with advanced infrastructure was not a prerequisite for the development of a harbor city and vice versa. Harbor cities developed, in a way, independently of their harbors, which often remained simple, as in the case of Delos whose unique growth was dictated by the free port status granted by the Romans in 166 BC[89]. In other cases, such as Kenchreai, the advanced harbor works were not matched by a monumental city, and the local settlement remained simple

86. For Rhodes' Tetrapylon see Hoepfner-Schwandner 1994, p. 64; Mühlenbrock 2003, pp. 274-277; for the propylon of the agora of Kos see Rocco-Livadioti 2011, pp. 401-420; Livadioti 2018, pp. 64 f; for the free–standing gateways of Ephesus' harbor see Feuser 2020, pp. 131-135, Figs. 60-63.
87. Bouras 2012, p. 150.
88. Picard 1959; Ugolini 2020; Zarmakoupi 2020.
89. Hatzfeld 1912; Roussel 1916; Rauh 1993.

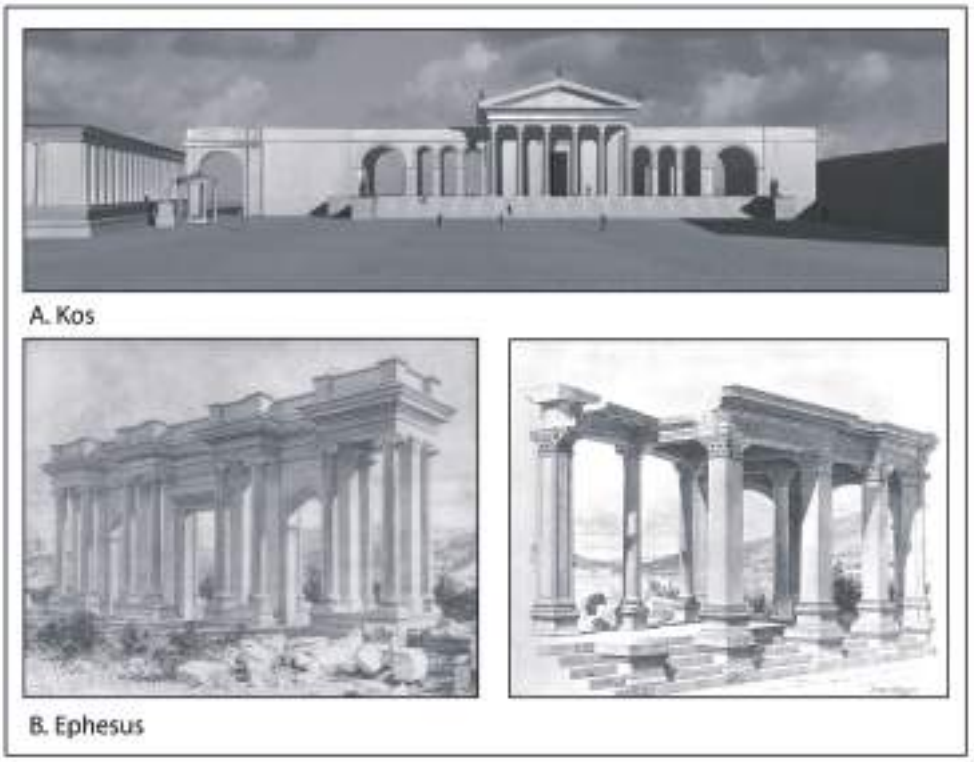

Fig. 8. Roman Gateways in the Harbor of Kos (Rocco-Livadioti 2011, Fig. 43) and Ephesus (©Photo: OeAW-OeAI).

but functional[90]. Nonetheless, there was a clearly dialectic relationship between harbors and urbanism. Harbors supported the development of urban centers as foci of commerce and interaction, which created surplus for investment in their improvement[91], and also attracted locals and foreigners to become consumers, producers, and traders[92]. This intricate relationship went beyond whether 'the harbor made the city or the city made the harbor'. Their development depended on factors that each followed their own course, especially concerning the relationship between them.

90. Nakas 2022, pp. 100-101.
91. Homolle 1882, p. 67; Velissaropoulos 1980, pp. 208, 215; Vial 1984, p. 231, n. 207. Cfr. Nakas 2022, p. 53, n. 31.
92. Boehm 2018, p. 127.

Harbor networks

It is difficult to trace harbor networks in the Hellenistic and Roman Aegean. The datasets that can show relationships between harbors come from shipwrecks, other regions[93], or other periods[94], and not from harbor sites, many of which (e.g., Delos and Rhodes) have not yet been properly studied and contextualized. An important source of information are geographical texts, which indicate harbors were visited within specific travel itineraries[95], but give little evidence about their infrastructures. Nevertheless an approach that considers inclusive harbor networks or strict hierarchies might be misleading for several reasons.

The densely populated coastline of the archipelago already had a pre-existing network of harbors as early as the Archaic years or even the Bronze Age[96], which were reused and enhanced by Hellenistic and Roman authorities. Furthermore, the lack of any central political control in the Aegean during the Hellenistic period prevented the construction or administration of a number of harbors by the same authority[97], and each harbor site developed differently. Although the creation of harbor networks became easier under Rome, the norms of the previous period persisted and there is no evidence for any newly built networks like those in Southern Gaul or North Africa, where the lack of good natural havens forced authorities to create artificial ones[98]. The new rulers relied on pre-existing commercial networks the same way they used pre-existing harbors.

Nevertheless, this lack of centralized initiative and control does not necessarily mean there were no functional harbor networks. This is reflected in the use of specific harbors by travelers as documented in geographical texts[99]. Harbors like Delos, Ephesus or Kenchreai are often mentioned in connection to Aegean crossings as the most convenient ports-of-call. Even if they did not all serve large consumption and production centers[100], they were located at geographically convenient places vis-à-vis distances and shelter, and it is not by accident that they were intensively used in much earlier periods too. Although some were situated in well-protected natural bays and along beaches ideal for shipyards and the unloading of vessels with lighters (e.g., Rhodes, Halicarnassus, Kenchreai)[101], some remained rudimentary in

93. See, for example, Harpster 2017, 2019; Harpster-Chapman 2019 on the application of catchment and polygon analysis on Roman shipwreck finds in the western Mediterranean.
94. Broodbank 2000. On the practical issues of establishing maritime networks see Leidwanger *et alii* 2014.
95. Bouras 2016.
96. Mauro 2019.
97. Wilson 2011, p. 51; Seeliger *et alii* 2018, p. 2. An exception was the Attalids' scheme of building new harbors like Elaia and drastically renovating Ephesus.
98. Schörle 2011; Wilson 2011, p. 49; Robinson *et alii* 2020, Figs. 2-4.
99. Bouras 2016.
100. Roussel 1916, p. 338; Bruneau 1968, pp. 698-700; Nakas 2022, p. 55.
101. Nakas 2022, pp. 112-113.

terms of protective works (e.g., Delos), or heavily affected by siltation (e.g., Ephesus, Miletus)[102]. This did not prevent their use and prosperity. There is also no evidence that certain harbors served certain types of ships or cargos. Bulk goods carriers likely stopped in any harbor for protection and provisioning but did not unload their cargoes, which were to be delivered to specific markets such as Rome (e.g., the massive Isis grain-freighter that arrived in Piraeus c. 150 AD on its way to Italy from Egypt)[103]. This parallel operation of "secondary" or short-haul/local networks alongside long-haul networks was a major characteristic of Aegean harbors. Short-haul networks were extremely important for local communities, which would base their provisioning on nearby production centers[104]. Within such networks it is almost certain the natural, "opportunistic" harbors flourished, as has been observed for later periods[105]. Nevertheless, this would have had a relatively limited impact on harbor infrastructures, since such networks engaged small vessels carrying limited goods that would not have considerably increased incomes through harbor fees.

CONCLUSIONS

The Aegean economy changed radically from the limited confines and regionalism of the Classical period to the complicated and expansive economy of the Roman Empire, in which sea networks, ships, and harbors played a vital role. Harbor infrastructures adapted to economic needs, and had shifted from the less organized and simpler establishments towards monumental, centralized, and often massive Roman foundations built to serve greater numbers of larger ships, and to administer greater volumes of goods and people. Powerful authorities and benefactors gave a further push toward the creation of monumental harbors and harbor cities. Nevertheless, this development was by no means linear and universal. Many harbors, such as Delos or Kenchreai, remained limited to natural protection or to works undertaken in the Archaic or Classical period. New technologies, such as maritime concrete, were never introduced widely in the region, whereas dredging was limited to specific harbors that could not function otherwise, like Ephesus or Side. More focus was placed on land infrastructures, such as agoras, porticoes, auctioning facilities, and other types of buildings serving cargos, merchants, and travelers, and by the 2nd century AD several harbors of the eastern Aegean, like Kos or Rhodes, were adorned by monumental buildings that created unique coastal scenographies of great political symbolism but little practical use[106]. Before the 2nd century AD storage

102. Brückner *et alii* 2014; Ladstätter 2016, 2019.

103. Luc.Nav. 5–9. Cfr. Casson 1971, pp. 186-188; Houston 1987.

104. Hopkins 1983; Lawall 2005, p. 202; Arnaud 2016; Leidwanger 2020, pp. 207-208; Nakas 2023a, pp. 139-140.

105. Leidwanger 2013, 2020; Nakas 2023b, pp. 152-153.

106. Arnaud 2015, pp. 64-65; Nakas 2022, p. 127.

facilities also remained limited, small, and distributed across the urban fabric. This changed when larger spaces were built, either to facilitate cargos in busy harbors or to serve the growing needs of the *annona* grain supply. Furthermore, the Roman authorities seemed to have lacked a central plan to create new harbor networks and infrastructures, with very few exceptions such as Kenchreai or Chersonnesos (**Fig. 3A-B**); imperial patronage remained uneven. Most Hellenistic harbors survived and were used with minimum changes and improvements.

This relative poverty in harbor infrastructures of the Hellenistic and, most importantly, the Roman Aegean should, nevertheless, not be seen as a sign of neglect or backwardness. The Aegean was already served by many harbors, both natural and artificial, enhanced and used as early as the Archaic period. Most of these never stopped operating throughout the Hellenistic and Roman period, so there was little practical need for new establishments (e.g., Kenchreai). Furthermore, the natural topography of the region, with a multitude of islands, bays, gulfs, and estuaries, offered multiple solutions to mariners, who could practice the "selective" use of different locations at the same site, such as at Delos and Rhodes. Thus, there was little need to build or organize new harbors when mariners had such options within a sea of small distances. Most of the Aegean harbors were not terminal harbors for whole cargos but rather operated as stops in the long-haul networks serving the "mega-cities" and provinces of the Empire. There was simply no need for the great infrastructures seen in harbors like Alexandria, Lepcis Magna or Portus, major centers of production and consumption of goods.

In general, the configuration and infrastructures of the harbors of the Hellenistic and Roman Aegean were as variable as the ships, cargos, and people they served, something that was influenced also by the ever-changing political conditions, the availability of funding, and even sheer luck. Whenever there was state funding and political initiative, certain harbors acquired impressive works and maritime scenographies, whereas in other cases harbors remained rudimentary but still functional. Despite the similarities between different harbors, each was different in terms of its urban and commercial realities and should be approached as such.

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