**Johannes Preiser-Kapeller – Falko Daim (eds.),**

**Harbours and Maritime Networks as Complex Adaptive Systems**

International Workshop "Harbours and maritime Networks as Complex Adaptive Systems" at the Römisch-Germanisches Zentralmuseum in Mainz, 17.-18. 10. 2013, within the framework of the Special Research Programme (DFG-SPP-1630) "Harbours from the Roman Period to the Middle Ages"

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*Harbours and Maritime Networks as Complex Adaptive Systems* **(Interdisziplinäre Forschungen zu den Häfen von der Römischen Kaiserzeit bis zum Mittelalter in Europa/RGZM Tagungen). Mainz 2014**

This volume collects selected papers given at the International Workshop "Harbours and maritime Networks as Complex Adaptive Systems" at the Römisch-Germanisches Zentralmuseum in Mainz, 17.-18. 10. 2013, within the framework of the Special Research Programme (SPP-1630) "Harbours from the Roman Period to the Middle Ages", funded by the Deutsche Forschungsgemeinschaft (http://www.spp-haefen.de/en/home/). The volume is devoted to the conceptualisation and analysis of maritime history within the framework of complexity theory on various levels: the selection, construction, utilisation, maintenance or abandonment of a harbour site depended on the interactions of a multiplicity of actors (population on-site and in the hinterland; local, regional and central authorities; merchants and sailors, etc.) against the background of an equally complex interplay between society and environment (natural conditions on land and on sea and their dynamics). Within this framework, also the concept of path dependence is of relevance: decisions and efforts made for the selection and construction of a harbour determine the parameters for subsequent contexts of decision making. Ports are integrated into local and regional settlement systems via multiplex connections with their hinterland and co-determine the distribution of demographic and economic potentials within these systems. Local, regional and over-regional sea-routes link ports of various sizes and importance in complex maritime networks, which are equally characterized by the emergence of hierarchies of harbours. On the basis of these sea-routes, also individuals and groups in various localities are connected in social networks, which can be characterised by mercantile, political, religious or cultural interactions, but especially through the mobility of individuals. A systematic survey of these entanglements between individuals, groups and localities contributes to a more adequate analysis of the complexity of these phenomena as do detail studies on the interplay between social and environmental factors for the development of selected ports.

**Contributions:**
- Falko Daim, *Preface*
- Johannes Preiser-Kapeller, *Harbours and Maritime Networks as Complex Adaptive Systems - Thematic Introduction*
- Franck Goddio, Damian Robinson and David Fabre, *The life-cycle of the harbour of Thonis-Heracleion: the interaction of the environment, politics and trading networks on the maritime space of Egypt's northwestern Delta*
- Myrto Veikou, *Byzantine ports and harbours within the complex interplay between environment and society. Spatial, socio-economic and cultural considerations based on archaeological evidence from Greece, Cyprus and Asia Minor*
- Pascal Arnaud, *The interplay between actors and decision-makers for the selection, organisation, utilisation and maintenance of ports under the Roman Empire*
- Flora Karagianni, *Networks of Medieval City-Ports in the Black Sea (7th-15th cent.). The Archaeological Testimony*
- Søren M. Sindbæk, *Northern Emporia and Maritime Networks. Modelling past Communication using Archaeological Network Analysis*
- Johannes Preiser-Kapeller, *The Maritime Mobility of Individuals and Objects: Networks and Entanglements*

**Preface**

The establishment of the Special Research Programme (SPP) of the Deutsche Forschungsgemeinschaft 1630 "Harbours from the Roman Period to the Middle Ages. The archaeology and history of regional and over regional traffic systems" in spring 2013 for a period of six years provides the opportunity to study the conditions under which anchorages, harbours and port cities emerged, were used and disappeared. Within this framework, three major European shipping zones are scrutinized, which at first sight are characterised by very different conditions and dynamics: the Mediterranean, the Northern and Baltic Seas and inland waterways. For all three areas, the same fundamental questions are posed: How and under what conditions interfaces between water and land were designed and organised in space and time? Yet, natural and historical parameters as well as the available written and materials source evidence very much differ. Moreover, these various regions and periods are embedded in different and highly sophisticated scientific cultures with their own systems of concepts and thinking styles. The research focus therefore faces not only also otherwise existing challenges of major research projects to organise the analysis of immense amounts of data and the systematic exchange between the individual projects, but also to overcome "cultural" barriers between disciplines in order to ultimately provide large syntheses.

Besides the necessary explanations of terms and a discussion of criteria by which comparisons are to be drawn, it is also important to consider different theoretical approaches for their applicability and to use tools of the digital humanities in order to collect and analyse the evidence and to gain new scientific ground. Special meeting held at the RGZM in Mainz for the SPP-1630 are devoted to these issues. The first one focused on "Harbours and Maritime Networks as Complex Adaptive Systems" and took place on October 17th and 18th 2013. Through the contributions of the speakers and extensive discussions, it became clear that network theory and the accompanying digital tools are well suited to analyse complex systems, such as maritime and terrestrial transport systems and their interfaces.

Our thanks go to Johannes Preiser-Kapeller for the concept and organisation of the meeting as well as to the speakers who provided not only perfect presentations but also written versions of their contributions. May this collection of papers stimulate the working groups within the SPP "Harbours" and also beyond.

The initiators of the SPP "Harbours"

Claus von Carnap-Bornheim

Falko Daim

Peter Ettel

Ursula Warnke

**Harbours and Maritime Networks as Complex Adaptive Systems – a thematic Introduction**

Johannes Preiser-Kapeller

The theory of complex systems was intensively discussed and integrated in archaeology in the last decades[1], but much less so in other historical disciplines. As we intend to demonstrate on the following pages, this approach provides a most useful conceptual framework for various phenomena of maritime history to be discussed within the framework of the DFG-funded Special Research Programme (SPP 1630) "Harbours from the Roman Period to the Middle Ages".

Complex systems elude attempts for simplification and mechanistic disintegration into single parts; but they show a number of common characteristics[2]:

- Complex systems can be conceptualised as networks of individual components, whose interactions at the microscopic level produce "complex" changing patterns of behaviour of the entire system on the macroscopic level ("emergence"). In the field of social systems, these patterns stem from the actions and interactions of individuals, families, communities, etc. up to the globalized society of today.[3]

- These systems show a nonlinear character, which means that they answer to certain stimuli (actions of individuals on different scales or external influences and events, for instance) or minimal differences in initial conditions not in a linear way (which would mean that the output is proportional to its input), but because of the interactions between the parts of the system these stimuli can be reinforced (or weakened) through

  feedback mechanisms in an unexpected way ("non-linearity", "butterfly effect").

- Complex systems are often "path-dependent"; their trajectory does not only depend on current conditions, but also on the "history" of the system.

- Change within complex systems is described as transition between alternative (more or less) stable states or "attractors". At the same time, complex systems are typically open systems, which are entangled with their environment in equally complex interrelations. The transition from one state to another can emerge because of endogenous interactions which sum up and reinforce each other ("positive feedback") until a certain "tipping point" or "bifurcation point" is reached, at which the transition to a new attractor takes place; Marten Scheffer also calls attention to the fact that "systems may gradually become increasingly fragile to the point that even a minor perturbation can trigger a drastic change toward another state"; this depends on "the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks.", for which Scheffer (as others) uses the term "resilience".[4]

This volume is devoted to the conceptualisation and analysis of aspects of maritime history within the framework of complexity theory on various levels; contributors use narratives as well as more formalised approaches (such as network analysis) to integrate these concepts into their studies: the selection, construction, utilisation, maintenance or

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[1] Cf. Tainter 1988; Chapman 2003; Hodder 2012, with further literature.
[2] Mainzer 2007 and 2008; Miller / Page 2007; Mitchell 2009; Füllsack 2011.
[3] On complexity and social theory cf. esp. Castellani / Hafferty 2009.
[4] Scheffer 2009, 6, 103.

abandonment of a harbour site depended on the interactions of a multiplicity of actors (population on-site and in the hinterland; local, regional and central authorities; merchants and sailors, etc.) against the background of an equally complex interplay between society and environment (natural conditions on land and on sea and their dynamics) (see the contributions of Arnaud, Robinson and Veikou). Within this framework, also the concept of path dependence is of relevance: decisions and efforts made for the selection and construction of a harbour determine the parameters for subsequent contexts of decision making. Equally of interest in this regard is the concept of "stigmergy", introduced by Pierre-Paul Grasse in the 1950's to describe the indirect communication taking place among individuals in social insect societies; it indicates that a trace left in the environment by an action stimulates the performance of a next action, by the same or a different agent. In that way, subsequent actions tend to reinforce and build on each other, leading to the emergence of coherent, apparently systematic activity.[5] Yet, such processes did not only leave traces in the landscape. The usage of routes and the encounter of spatial features (landmarks) as well as communities (with their commercial opportunities, for instance) were combined into "mental maps", which were communicated and passed on within "communities" of navigators, seamen and traders and later maybe also visualised in the form of maps or written down and then used by others in an attempt to follow the traces of their antecessors.[6]

Ports were also integrated into local and regional settlement systems via multiplex connections with their hinterland and co-determine the distribution of demographic and economic potentials within these systems.[7] Local, regional and over-regional sea-routes link ports of various sizes and importance in complex maritime networks, which are equally characterized by the emergence of hierarchies of harbours.[8] On the basis of these sea-routes, also individuals and groups in various localities are connected in social networks, which can be characterised by mercantile, political, religious or cultural interactions, but especially through the mobility of individuals or objects (see the contributions of Karagianni, Sindbæk and myself).

The contributions in this volume demonstrate various approaches towards the survey and analysis of these complex entanglements from the local up to the global level and from the micro- to the macro-perspective.

**(H1) Decision-making in a complex environment: establishing and maintaining harbours**
**(H2) Factors of harbour site selection and harbour design**
Within the Special Research Programme (SPP 1630) "Harbours from the Roman Period to the Middle Ages", maritime structures of different scales and degrees of organisational complexity are analysed, from relatively simple landing sites without any artificial installations to the elaborate artificial basins of Portus, the harbour of Rome, for instance. Recently, Thomas Tartaron has presented a typology for the Bronze Age Aegean, which could be adapted also for the wider framework of the SPP 1630: "An anchorage is any coastal location at which a vessel can be brought to a safe landing position, by any means including being pulled up onto a sandy shore, lying at anchor in shallow offshore waters, or being moored to a natural feature or an artificial construction such as a quay or jetty. There is no necessary implication in this term of the existence of durable, artificial constructions to accommodate vessels, or of a

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[5] Hölldobler / Wilson 2009, 479-481.
[6] Downs / Stea 1977; Gould / White 1986; Brodersen 2003.
[7] On the concept of multiplexity cf. also Preiser-Kapeller 2012.
[8] Cf. also Schörle 2011.

permanent settlement associated with these activities. Many anchorages, past and present, are used episodically, often tied seasonally to environmental conditions and agricultural calendars and providing temporary safe haven in times of danger at sea. The term harbor carries the stronger implication that certain coastal locations are earmarked for the role of accommodating maritime traffic. The morphological attributes of harbors range from entirely natural embayments with few or no artificial constructions to enhance their maritime functions, to fully artificial harbors fashioned by means of breakwaters, quays, and elaborate drainage and maintenance systems. Still, there is no requirement that a permanent settlement accompany a harbor, although the greater the maritime traffic or the number of artificial enhancements, the more likely that this will be the case. The connotation of the term port, finally, is of the existence of a "port town," thus a permanent settlement with a primary function as a major node in a maritime network. The port town typically possesses more than the bare essentials to accommodate maritime traffic: there may be complex facilities for storage, recording, and exchange of commodities; processing of raw materials; transshipment to interior regions or further seaward destinations; and quartering of crews for short- or longer-term residence. "[9]

The possibility or necessity to construct and maintain more sophisticated maritime installations depended on the topographical conditions of a coastal location. Again, Tartaron presents a useful topographic typology of ancient anchorages, differentiating between sites at "high energy" or steep coasts (with natural bays, bays on either side of an anvil-shaped headland [see **fig. 1** for one example], sites in lee of a promontory, in sheltered valleys or in lee of an islet or offshore reef) and "low energy" or flat coasts (with riverine anchorages, sites at inland lakes up rivers, at natural embayments, in deltas or in lagoons [see the contribution of Robinson in this volume for one example]).[10] In an earlier paper, he also tried to establish determinants for prehistoric Aegean harbour sites for the purpose of predictive modelling. Besides environmental determinants such as relief, the usable area for agriculture or the access to water and "harbour determinants" such as protection from wind and bathymetry, the also defined "cultural determinants", meaning typical parameters of landscape utilisation in the respective period.[11]

Thereby, an interplay between environmental and social factors for the establishment and construction of a harbour is introduced. Nick Marriner and Christophe Morhange, two leading experts in the geoarchaeology of ancient harbours in the Mediterranean, also state: "The layout of a port depends on navigation conditions (winds and waves) and on the types of ship that use it. The size of the ships defines the acceptable wave-induced disturbance and the possible need to build a breakwater providing protection against swell and storms. The number of ships using the port dictates the length of quays and the area of the basins required. The ships' draught defines the depth at the quayside and thus the height and structure of the quay. Locally available materials (wood, stone and mortar) and construction methods define the specific structures for a region and historical period."[12] The "feedback" between ship design and harbour layout was also recently discussed by Kristin Ilves, who asked: "do shops shape the shore?"[13] A well-studied example for the impact of technological innovations in harbour construction

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9 Tartaron 2013, 4-5.
10 Tartaron 2013, 172-174. Cf. also Walsh 2014, 46-61.
11 Tartaron / Rothaus / Pullen 2003. Cf. also Walsh 2014, 65-66. See also Veikou 2014 and the contribution of Veikou in this volume for factors of harbour site selection in the Byzantine period.
12 Marriner / Morhange 2007, 146; Walsh 2014, 51-64
13 Ilves 2012.

and their diffusion along maritime routes is the usage of hydraulic concrete for the building of installations and basins in the ancient Mediterranean: invented in Italy around 200 BC, this technology spread across the sphere of the Pax Romana in the following centuries. As an analysis of the remains in the harbour of Caesarea maritima in Palestine, a project initiated by King Herodes between 22 and 10 BC, demonstrated, not only the expertise, but also the necessary building material (volcanic sands) were transported across the sea from Italy to the East.[14] The necessary organisational complexity to undertake such projects in order to modify the coastal topography of a landing site must have been considerable. Kevin Walsh, however, stated: "We should not assume that Rome imposed technology for technology´s sake; technological solutions were only employed in locations where the environment did not proffer a natural solution within given economically instrumental parameters."[15]

**(H2) Environmental and social factors of harbour maintenance and usage**
At the same time, coastal environments are dynamic and provide constant challenges for the maintenance of both "natural" and "artificial" harbours[16]; Nick Marriner and Christophe Morhange have systematically analysed long term processes of erosion and aggradation as well as short term "extreme events" (such as earthquakes or landslides) which damaged or even destroyed the functionality of ancient harbours. In Ampurias in Spain, one can identify for instance a silted harbour basin from the Greek and an eroded basin from the Roman period of the city´s history (see **fig. 2**).[17] In addition to "natural processes", again human activity, which lead to increased sedimentation, played a role; as Marriner and Morhange have pointed out, accentuated coastal progradation due to the intensification of agriculture around a harbour as well as "cultural inputs" (the usage of harbour basins as waste dump) could lead to an increase of the annual rate of sedimentation from 1-2 mm per year to 10-20 mm per year.[18] One well-documented case is the city of Ephesus in Western Asia Minor: "The citizens of Ephesus were causing their own environmental problems. The Ephesians were using the Great Harbor as a dump. Owing to the topography of the city of Ephesus, it had an excellent city drainage and sewer system, as all the sewage was diverted into the Great Harbor. In addition, the literature alludes to considerable dumping of "industrial debris" into the harbor. As much of the city was built of stone and brick, the materials dumped into the harbor included silt, sand, and coarser construction debris."[19]
"Unintended" consequences of the economic and demographic growth emerging from the flourishing of a port city thereby endangered the very functionality of one central factor for this process in a kind of feedback process. As a consequence, an even higher degree of organisational complexity became necessary: "in the face of rapid accumulation rates, maintaining a navigable water column, or draught depth, engendered clear management strategies."[20] Technology provided the option to restore a sufficient water depth by dredging, for which both geoarchaeological evidence and artefacts (a Roman dredging boat in the ancient harbour of Marseille) have been found.[21] In addition, authorities could decide on regulations to avoid a further pollution

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[14] Oleson / Brandon / Hohlfelder 2011.
[15] Walsh 2014, 60.
[16] See esp. also the contribution of Robinson to this volume as a most illuminating case study for the observations in this part of the introduction.
[17] Marriner / Morhange 2007; Walsh 2014, 33-39.
[18] Marriner / Morhange 2007, 180.
[19] Kraft / Brückner / Kayan / Engelmann 2007, 141.
[20] Marriner / Morhange 2007, 146; cf. also Walsh 2014, 46-47, 57, and Mainzer 2008, 91.
[21] Morhange / Marriner 2010; Walsh 2014, 57-59.

of the harbour basin by the residents, as is documented in the case of Ephesus. Yet, Ephesus also demonstrates the limited effectiveness of such measures (as well as attempts to forbid the pollution of the harbour basin); both natural and cultural sedimentation forced the city to abandon and relocate harbours in what has been described as a "race to the sea" from the 6th century BC until the late medieval period (see **fig. 3**).[22]

There is also something like a "marginal value" of infrastructure investments, when any further input of manpower or material would not produce corresponding benefits for a community.[23] This would especially be the case when a society simultaneously suffered otherwise from losses with regard to its demographic, economic or organisational potential, as one can observe in the period of transition from Late Antiquity to the Early Middle Ages both in the Western Mediterranean (from the 5th century AD onwards) and in the Eastern Mediterranean (from the 7th century AD onwards); Marriner and Morhange stated: "A relative decline in harbourworks after the late Roman and Byzantine periods is manifest in a return to 'natural' sedimentary conditions comprising coarse-grained sands and gravels. Following thousands of years of accelerated anthropogenic confinement, reconversion to a natural coastal parasequence is typified by high-energy upper shoreface sands. A change in geometry is also observed with transition from aggradational to progradational strata. This progradation significantly reduced the size of the basins, burying the heart of the anchorages beneath thick tracts of coastal and fluvial sediments. (…) In the absence of clear management strategies, port basins rapidly infilled with thick tracts of coastal and fluvial sediments"[24]

Societies, of course, did not only react ad hoc to such "external stimuli" or catastrophic developments, but established more permanent institutional and cultural frameworks for decision-making and organisation. In any case, faced with complex interplays between social and environmental dynamics, actors have to reduce the complexity in order to make their decisions, and here "the cultural matrix", "organizational habits and routines", "tradition and culture" and "rules of thumbs" play an important role.[25] But historians, economists and other researchers have also demonstrated that some outcomes of social, political and economic change are "strongly self-reinforcing" because of "positive feedback"-processes; once "a dense network of institutions and interests had developed" around a certain system or institution, it later became often "virtually impossible to switch over" to a more appropriate practice. A "competitive selection of practices" could not take place any more.[26] Well-established practices also influence the perception of decision-makers, since "actors who operate in a social context of high complexity and opacity are heavily biased in the way they filter information into existing 'mental maps' (…). Confirming information tends to be incorporated, while disconfirming information is filtered out."[27] In general, "an increasingly complex system will become increasingly 'path-dependent' and lose its adaptive flexibility".[28]

On the other hand, maritime communities were able to find solutions also in the absence or even by avoiding more elaborate organisational or edificial structures. Horden and

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[22] Kraft / Brückner / Kayan / Engelmann 2007, esp. 141-142, and also the contribution of Arnaud to this volume (with relevant sources).

[23] Cf. esp. Tainter 1988, 118-126.

[24] Marriner / Morhange 2007, 177 and 180.

[25] Mainzer 2007, 335–336; Wilkinson 2008; Goergen et al. 2010. Cf. also Walsh 2014, 8. See especially the contribution of Arnaud to the present volume.

[26] Pierson 2004, 3–4, 17–53. Cf. also Walsh 2014, 8.

[27] Pierson 2004, 38–39. Cf. also Wilkinson 2008; Goergen et al. 2010.

[28] Scheffer 2009, 243–250.

Purcell for instance in their now classic volume on the Mediterranean asked: „Why, for example, did some coastal settlements flourish as commercial towns without artificial ports?" and highlight several examples for a dynamic and against a too deterministic understanding of factors for the emergence of nodes of maritime exchange.[29] Ruthy Gertwagen in her analysis of the history of the port of Candia on Crete in the 13th-15th century illustrates how traders despite the controlling efforts of the Venetian Colonial regime avoided the usage of the developed harbour of that city (and accompanying taxes) and unloaded their cargo in nearby natural bays, accepting the higher risks for the safety of their ships (see **fig. 4**); similar observations are made by Veikou in her contribution to this volume.[30] Against this background, it seems also legitimate to put into question "whether there was a direct relationship between the building of ports and the location of major shipping lanes, or whether the construction of a port can lead to a shift in shipping routes".[31] The emergence of harbours and ports cannot be understood without their embedding in wider maritime networks.

**(H2) A simple port – harbour feedback model**
In order to study some possible dynamics of a complex system emerging from feedbacks between the operability of a harbour and the size of a port city, I created a simple mathematical model (see **fig. 5**): the two main elements of this model are the population of a port city and its umland and the activity of its harbour, which are connected through a feedback mechanism (the attractiveness of the harbour depends on the size of the population whose [natural] rate of growth in turn increases with increasing harbour activity). In addition, the size of the population is limited by the carrying capacity of its umland (for the sustentation of the population) which in turn is augmented (or not) by the activity of the harbour (simulating the possibility to import foodstuff by sea, for instance). The increasing population in turn leads to an increasing sedimentation, which reduces the attractiveness of the harbour if is exceeds a certain threshold. This feedback mechanisms I integrated in a system of equations, modifying the basic equation for population growth with limited carrying capacity developed by Pierre F. Verhulst[32]:

$P_{n+1} = (r + H_n/100)(C_n - P_n) P_n$

$C_{n+1} = 1 + H_n i$

$H_{n+1} = P_n + O_n$

$O_n = 1$ if $D_n > D_{suf}$, otherwise $O = -0.5$

$D_{n+1} = D_n - S_n$

$S_n = P_n s$

where $P$ is the port and umland population, $H$ the harbour activity, $C$ the carrying capacity of the port umland, $O$ the harbour operability, $D$ the harbour basin depth, $D_{suf}$ the threshold for a sufficient harbour basin depth for a positive value of O (in the basic model $D_{suf} = 0.4 D_0$) and S the strength of sedimentation per time period; $r$ is the rate of natural growth of P (in the basic model r = 0.015), $i$ a parameter for the impact of H on C (in the basic model i = 0.01) and $s$ a parameter for the impact of P on S (in the basic model s = 0.002).
I run several iterations of the model on a computer, plotting the trajectories for the critical parameters "port and umland population", "harbour activity", "carrying capacity" and "basin depth" for 1000 time periods. In the basic model (see **fig. 6**), these

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[29] Horden / Purcell 2000, 391-400.
[30] Gertwagen 2000.
[31] Gertwagen 2000.
[32] Cf. Mainzer 2008, 46-49.

feedbacks lead to the growth of port and umland population, harbour activity and carrying capacity until a certain equilibrium is reached at which the system remains. At the same time, the increase in population leads to an increasing sedimentation and a loss of depth of the harbour basin until a certain threshold is reached below which the harbour basin become inoperable and the attractiveness of the harbour collapses. This leads to a dramatic decrease of both the carrying capacity and the port and umland population, but not to a total collapse; since in the model harbour activity not only depends on harbour operability, but to the same degree on the port and umland population (as source of consumption and attractor of commerce), a smaller amount of harbour activity (of maritime trade, maybe using other, less advantageous landing sites nearby) is maintained; this allows for a new equilibrium of population and carrying capacity on a smaller level than before the collapse of the basin, but still above the carrying capacity without any harbour effects.

A modification of the rates of influence between the basic parameters of course modifies the temporal dynamics of the model. If one increases the augmenting effect of harbour activity on carrying capacity (simulating a higher amount of foodstuff imported by sea), carrying capacity, population and harbour activity grow more rapidly; but also the basin due to increased sedimentation fills more rapidly – and the effects of the collapse of the operability of the harbour are much more dramatic than in the basic model ("boom and bust") (**fig. 7**). On the other hand, one could integrate a population threshold above which sedimentation would have an effect on the basin depth; this of course would extend the time span until the harbour becomes inoperable with all its impacts (**fig. 8**). One could also integrate a changing sedimentation dynamics, which fills in the basin above a certain population threshold, but leads to a "natural cleaning" of the basin below this threshold; the result would be a cyclic trajectory of the basic parameters with continuing sequences of a phase of growth, equilibrium and collapse – depending of the dynamics of the basin sedimentation (**fig. 9**).

The retarding effect can also be observed if we assume that a one-time dredging measure takes place before an insufficient harbour depth is reached (**fig. 10**). If such a measure takes place after a first collapse of the basin, it initiates a second period of growth up to the earlier equilibrium until the basin gets again insufficient (**fig. 11**). In this model, only frequent and timely dredging would allow for an undisturbed maintenance of the high level equilibrium if once reached (**fig. 12**).

Dredging of course is an "exogenous" impact on the system and not a phenomenon emerging from the internal dynamics of the model; in a similar way, other exogenous shock can be simulated. If we assume a major population loss at some point during the first equilibrium phase (due to a plague epidemic as it occurred in the period of Emperor Justinian in the 6th century AD or in 14th century Europe, for instance), we see that the system processes this impact with a new period of growth until the earlier equilibrium is reached; the effects of the inoperability of the harbour basin take place later, since the loss of population temporarily also increases the rate of sedimentation (**fig. 13**). But if we assume that this major population loss would also be accompanied by a total collapse of maritime trade (a "dark age"-scenario), we observe that the trajectories for population and carrying capacity in absence of any "harbour effects" never reach the pre-collapse level again; the period until population reaches a new equilibrium at the level of the (reduced) carrying capacity is also significantly longer in the absence of maritime trade (**fig. 14**).

Although this model reduces the complex interplay of society and environment to four parameters and some simple equations, some basic properties of a complex system as outlined above, such as the power of feedbacks, the existence of various states of

equilibrium or the processing of external stimuli become visible. Therefore, similar (and of course even more refined) models can be used a heuristic tools to reflect on possible dynamics of harbour-port systems between demography, economy and environment.[33]

**(H1) Navigation in a complex environment: routes and maritime networks**
**(H2) Navigational conditions and route selection**

Even more than the maintenance of harbour sites, the selection of routes between them took place against a background of highly dynamic environmental conditions, which "are produced by complex interactions of atmospheric, hydrospheric, and lithospheric (terrestrial) forces operating at different scales, i.e., global; basin-scale (Mediterranean); sub-basin-scale (the eastern or western basin of the Mediterranean, or one of its constituent bodies of water such as the Aegean Sea); mesoscale (e.g., contained within the Aegean); or microscale (local)".[34] Again, "average" conditions of wind speed and wave height could make way for "extreme events", and seafarers had to be aware of the specific risks of passages in specific regions at specific times; as a matter of fact, climatic phenomena were among the first detected to show "complex", "non-linear" or "chaotic characteristics".[35] Therefore, "there can be little doubt that environmental factors strongly influenced the routes that sea travelers followed (…). Winds, currents, topography, and seasonal weather patterns combined with technologies of shipbuilding, propulsion, and navigation to give shape to a range of possible routes and seasonal schedules".[36]

In absence of written evidence for the routes actually selected, it is therefore tempting to model these routes on the basis of deterministic assumptions on the impact of sailing conditions as reconstructed with the help of modern day data, as Papageorgiou did for the Bronze Age Aegean.[37] Also attempts to calculate cost surfaces and optimal paths for specific sea regions in pre-modern time have to rely on such assumptions.[38] Yet, as in the case of the selection of landing sites, while landscape and contour lines or wind and waves may have suggested "ideal" routes across various regions, factors of socio-economic, factors of socio-economic, political or religious "push" and "pull", for instance, often proved stronger and incited individuals to put up with dangerous detours in order to visit a famous shrine. Tartaron correctly states: "it is plainly inadequate to map maritime interactions based solely on environmental factors. It is the human response, operating within the opportunities and constraints of natural environment and socioeconomic milieu, which is decisive."[39] On the other side, the total absence of naturally reliable harbour situations could very much limit the attractiveness of a site even if located in the centre of frequently used routes, as Bevan and Conolly have demonstrated for the island of Antikythera (21 km ), situated in the important straits between the Peloponnese and Crete. But also in this case, artefacts and other evidence document far reaching maritime contacts at specific periods, even within the framework of pirate activity.[40] The sea thus provided a multitude of possible routes

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[33] For the value and limits of such models in general see also Hatcher / Bailey 2001, for another example see Davies 2005.
[34] Tartaron 2013, 90. Cf. also Pryor 1992, and Bevan / Conolly 2013, 31-34 (for a local case study of navigational conditions in the Aegean).
[35] Soukissian et al. 2008; Sachweh 2013; Mainzer 2007, 79-81.
[36] Tartaron 2013, 114.
[37] Papageorgiou 2008.
[38] Indruszewski / Barton 2008; Leidwanger 2013
[39] Tartaron 2013, 116.
[40] Bevan / Conolly 2013, 34-36. 163-175. 187-196.

between a multitude of (more or less advantageous) landing places; ports are "simply nodes of density in the [general] matrix of connectivity".[41]

## (H2) Some concepts and tools of network analysis

Concepts and tools to survey, visualise and analyse the structure and dynamics of this matrix of connectivity and to determine the relative significance of ports as emerging nodes are provided by network theory. In general, network theory assumes "not only that ties matter, but that they are organized in a significant way, that this or that individual has an interesting position in terms of his or her ties."[42] One central aim of network analysis is the identification of structures of relations which emerge from the sum of interactions and connections between individual, groups or sites and at the same time influence the scope of actions of everyone entangled in such relations. For this purpose, data on the categories, intensity, frequency and dynamics of interactions and relations between entities of interest is systematically collected in a way which allows for further mathematical analysis. This information is organised in the form of matrices (with rows and columns) and graphs (with nodes and edges [links]), which are not only instruments of data collection and visualisation, but also the basis of further mathematical operations (on the basis of matrix algebra and graph theory).[43]

Once a quantifiable network model has been created, it allows for a structural analysis on three main levels:

* the level of single nodes; respective measures take into account for instance the immediate "neighbourhood" of a node – such as "degree", which simply measures the number of direct links of a node to other nodes (**fig. 15**)[44] or the relative centrality of a node within the entire network due to its position on many or few possible paths between nodes otherwise unconnected – the measure of "betweenness", which can be interpreted as a potential for intermediation (**fig. 16**).[45]

* the level of groups of nodes; this includes sets of two nodes (= dyads), which can be distinguished as "null" (no link exists between the two nodes), "directed" (or "asymmetric", meaning that an interaction leads from one node to the other, e. g. "a ship sails from port A to port B") or "symmetric" (leading in both directions, e. g. "ships sail between ports A and B") as well as being "un-weighted" (only the presence or absence of a link is taken into account) or "weighted" (indicating a quantity of an interaction, such as the number of ships sailing between port A and B). Directions and quantities can be attributed to links also a priori.[46] Even more elaborate approaches exist for the analysis of "triads" (sets of three nodes) and the dynamics of relations within them, which in turn influence the structuring of an entire network. Triads can be categorised according to the kind of dyads (null, asymmetric, symmetric) existing within them.[47] The preponderance of one type of triads or the other also influences the tendency towards "clustering" within a network (which can also be expressed in an

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[41] Horden / Purcell 2000, 393; cf. also Walsh 2014, 51-52.

[42] Lemercier 2012, 22. Cf. also Brughmans 2012, and the contributions in Knappett 2013 for an overview of concepts and tools. For a more entertaining introduction see also Barabási 2003.

[43] Wassermann / Faust 1994, 92-166; Prell 2012, 9-16; Burkhardt 2009, 55-59.

[44] Wassermann / Faust 1994, 178-183; de Nooy / Mrvar / Batagelj 2005, 63-64; Newman 2010, 168-169; Prell 2012, 96-99.

[45] Burt 2005; Wassermann / Faust 1994, 188-192; de Nooy / Mrvar / Batagelj 2005, 131-133; Newman 2010, 185-193; Prell 2012, 103-107.

[46] Wassermann / Faust 1994, 505-555; Prell 2012, 135-140; Kadhushin 2012, 21-22.

[47] Wassermann / Faust 1994, 220-243; de Nooy / Mrvar / Batagelj 2005, 84-92, 205-212; Prell 2012,140-147; Kadhushin 2012, 22-26.

overall "clustering coefficient"[48]), meaning the existence of groups of nodes more closely connected to each other than to the rest of the network; if all nodes within such a group are directly connected with each other, they are called "clique".[49] In order to detect such cliques and clusters, an inspection of a visualisation of a network can be already quite helpful; common visualisation tools arrange node more closely connected near to each other ("spring embedder"-algorithms) and thus provide a good impression of such structures (Lothar Krempel calls them "social topographies", which allow for orientation within a network similar to maps).[50] For exact identification, there exist various algorithms of "group detection", which aim at an optimal "partition" of the network (see **fig. 17**). It is course also of interest to see if the presence of nodes within such clusters can be related to specific qualitative attributes ("similarities"), for instance.[51] A different approach is the concept of "structural equivalence" of nodes; here, nodes are not attributed to the same "block" because of being connected to each other, but having the same (or very similar) structure of ties to other actors (thus, within a network of a school, one would encounter a block of "teachers" and one of "disciples", between which similar structures of relations could be identified). Again, several tools of "blockmodelling" exist.[52]

**✱** the level of the entire network: basic key figures are the size (= number of nodes), the maximum distance between two nodes (expressed in the number of links necessary to find a path from one to the other; "diameter") and the average distance (or path length) between two nodes.[53] "Density" indicates the ratio of possible links actually present in a network: theoretically, all nodes in a network could be connected to each other (this would be a density of "1"). A density of "0.1" for instance, indicates that 10 % of these possible links exist within a network; the higher the number of nodes, the higher of course the number of possible links – thus, in general, density tends to decrease with the size of a network. Therefore, it only makes sense to compare the densities of networks of (almost) the same size. Density can be interpreted as an indicator for the relative "cohesion" of a network.[54] Other measurements are based on the equal or unequal distribution of quantitative characteristics such as degree among the nodes; a high "degree centralisation" for instance indicate, that many links are concentrated on a relatively small number of nodes.[55] These distributions can also be statistically analysed and visualised for all nodes (by counting the frequency of single degree values) and used for the comparison of networks.[56]

Networks are of course dynamic: relationships may be established, maintained, modified or terminated; nodes appear in a network and disappear (also from the sources). Standard tools of network analysis (still) force us to integrate these changes into one more or less static model. The common solution to capture at least part of these dynamics is to define "time-slices" (divided through meaningful caesurae in the

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[48] Newman 2010, 262-266. It measures the average probability that two nodes connected to a node are also directly connected themselves.
[49] Wassermann / Faust 1994, 254-257.
[50] Cf. Krempel 2005; Dorling 2012.
[51] de Nooy / Mrvar / Batagelj 2005, 66-77; Newman 2010, 372-382; Prell 2012, 151-161; Kadhushin 2012, 46-49; Burkhardt 2009, 52-54.
[52] Wassermann / Faust 1994, 461-493; de Nooy / Mrvar / Batagelj 2005, 259-285; Prell 2012, 176-194.
[53] de Nooy / Mrvar / Batagelj 2005, 125-131. Prell 2012, 171-172.
[54] Prell 2012, 166-168; Kadhushin 2012, 29.
[55] Prell 2012, 168-170.
[56] Newman 2010, 243-261.

development of the object of research, as defined by the researcher knowing the material) and to model distinct networks for each of them.[57]

**(H2) The modelling of maritime networks**
A network analysis along these lines was done by Ducruet et al. for the Atlantic liner shipping network for two time slices (1996 und 2006), based on data on the number of ships travelling between ports in these two years; this data was used to weight the strength of a connection (link) between two ports (nodes). Interesting enough, these networks show the same structural properties across scales: on the level of the entire network as well as on the level of sub-networks and clusters of various size, the numbers of connections ("degree") are distributed among nodes in a highly unequal pattern, with very many nodes with only a few links and a few hubs with a large number of links (a so-called "power law distribution"). While the relative significance of individual ports change over time, this overall distribution pattern is maintained.[58] Such or similar distribution patterns were observed for many large complex networks (such as the world wide web, for instance) and interpreted as "signatures of complexity", emerging from dynamic processes of the establishment and relocation of links between nodes within the system (**fig. 18**).[59]
While modern-day maritime network thus can be understood as complex systems[60], we do not possess an approximately comparable density of evidence for the ancient or medieval period. For relatively well-documented periods, the most important routes can be reconstructed up to a certain amount, as Pascal Arnaud did for the ancient Mediterranean.[61] His study was used by Walter Scheidel and colleagues for the modelling of the maritime route network for their Orbis-project in Stanford, which offers something like a "route planer" both on land and on sea for the Roman Empire. Also "Orbis" provides a network analytical tool, which allows for the determination of the relative centrality of nodes with regard to degree, betweenness and other measures.[62] In comparison with Ducruets network, "Orbis" of course lacks any information on the relative frequency of the usage of specific routes in specific periods; still, even a very rough impression of the overall structural framework of the "matrix of connectivity" can be helpful for further considerations.

In many cases, we may lack any information on the actual routes between sites and can only rely on the distribution of artefacts among sites as evidence for exchange and contact between them. Especially Søren Sindbæk (see also his contribution in this volume) has illustrated how such data can be used to construct "affiliation" networks between localities; in such a model, first sites and various types of artefacts are connected with each other (**fig. 19**). This "2mode-network" (with two categories of nodes) is transformed into a "1mode-network", in which two sites are connected with each other if at least one type of artefact can be found in both of them (**fig. 20**). Links in such a network thus are "ties of similarity" between artefact assemblages in sites and not ties of direct interaction or exchange as in the network model of Ducruet et al., for instance (a fact sometimes overlooked, especially if such networks are visualised on a

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[57] de Nooy / Mrvar / Batagelj 2005, 92-95. Lemercier 2012, 28-29.
[58] Ducruet / Rozenblat / Zaidi 2010; cf. also Ducruet / Zaidi 2012
[59] Albert / Barabási 2002; Barthélemy 2011; Newman 2010, 247-260; Estrada 2012, 27-31 and 243-250; Mainzer 2008, 25-30.
[60] Cf. also Rodrigue / Comtois / Slack 2013.
[61] Arnaud 2005.
[62] Scheidel et al.

geographic map, see **fig. 21**). Through the integration of several distributed types of artefacts these "ties of similarity" are weighted; centrality measures for individual nodes therefore indicate different degrees of integration in what we can assume was one system of distribution and exchange. As Sindbæk had outlined, through this approach we are not able to knack the "black box" of the actual routes and channels of maritime transport ("the actual links are broken"), but we gain some insights into difference between "hubs" and peripheries within the distribution system and may be able to identify "clusters of similarities" indicating more intense exchange among these sites (on the basis of the current data available – as every reconstruction open for modification in the case of further findings).[63] A parallel present-day example may illustrate the potential of this approach further: along similar lines, B. Derudder, P. J. Taylor et al. constructed a network model among "world cities" for several time slices between the years 2000 to 2008 based on the co-occurrence of "artefacts" of the modern-day globalised financial distribution system, namely the branches of the most important "large professional, financial and creative service firms".[64] Thereby, they made visible differences in the degree of integration of cities in this distribution system (which in this case can be checked against other information we have on the structure of the global economy) as well as the strength of "ties of similarities" between hubs across large distances. Such an approach therefore has the potential to visualise the complex processes of differentiation between centres and peripheries in networks of exchange – now and then.

Another possibility to use archaeological data for the construction of networks models is the usage of parameters such as spatial proximity (an example in my contribution to this volume[65]) or navigational conditions in order to determine "optimal paths" (links) between sites (nodes). An advantage of this approach is the potential to integrate at least some aspects of what Leif Isaksen has called "transport friction" into network analytical calculations; otherwise, the actual costs of communication and exchange between sites, which would have influenced the frequency and strength of connections, are often ignored in network building.[66] An especially sophisticated model along these lines was created by Knappett, Evans and Rivers in 2008 for the Bronze Age Aegean; they tried to determine both the cost of connections and the relative attractiveness of sites (due to their agricultural hinterland or other resources) for maritime traffic in order to create a dynamic model of the "matrix of connectivity" in this region in this period.[67]

In any case, we create more or less elaborate probabilistic models, which may allow for a glimpse at the complexity of past traffic systems – an impressive accomplishment already. Yet all those factors discussed above as "cultural matrix", "organisational habits and routines", "tradition and culture" or "rules of thumbs" which may have influenced maritime communities to ignore optimal routes and to overcome the logic of "spatial proximity" still elude our attempts of reconstruction (if not illuminated by other evidence or replaced by "proxy data" from other pre-modern maritime communities more accessible to observation). This may lead to the situation that

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[63] Sindbæk 2007; Sindbæk 2013, and his contribution to this volume, especially also on distortive effects of different densities and qualities of data on the results of such network models.

[64] Derudder / Taylor et al. 2010, 1861-1877; cf. also Sassen 2012.

[65] Cf. also Estrada 2012, 250-252 and 389-395; Preiser-Kapeller 2013.

[66] Isaksen 2008; for an elaborate modelling of cost factors see also the project of A. W. Mees and G. Heinz from the RGZM on the routes of distribution of Terra Sigillata: http://web.rgzm.de/no_cache/forschung/schwerpunkte-und-projekte/a/article/untersuchungen-zum-absatzmarkt-und-zur-organisation-der-toepfereien-im-suedgallischen-sigillatazentr.html.

[67] Knappett / Evans / Rivers 2008. For a further example for terrestrial routes cf. Bevan / Wilson 2013.

phenomena of "less" complex societies for which we do not possess any written evidence are modelled after modern perceptions of "effectivity" or "rationality" to a higher degree than for societies for which we have such sources.

**(H2) The significance of local maritime communities and "small worlds"**

A further issue is the scale and "resolution" of such models; while data may allow us to construct networks for the North Sea, the Aegean or even the entire Mediterranean ("Orbis"), they tend to overlook the significance of regional and local connectivity. Again, Thomas Tartaron has stressed this aspect: "More importantly, such long-distance connections were dwarfed in quantity by dense networks of local and regional maritime connections among (…) communities. The latter routes and relationships have received little attention, but they must have dominated the use of anchorages, large and small (…). There were many shades of activity in the spectrum between local and international interaction. Local and microregional maritime networks are best expressed by the concept of the "small world" (…), composed of communities bound together by intensive, habitual interactions due to geography, traditional kinship ties, or other factors. There may be a high level of interdependence and communities may come to think of themselves as forming a natural entity, defined by the dense web of connections that supports a combination of political, social, and economic relationships. Small worlds are nested within larger regional and interregional economic and sometimes political networks."[68]

From a structural point of view, such small worlds should be identifiable as clusters of nodes, which are more densely connected among each other than with the rest of the networks (see **fig. 22**); at the same time, such clusters should be observed at different hierarchical levels, nested within each other and contributing to a "self-similar" structure of the entire network.[69] As analytical results for the model of Ducruet et al. for the modern period or for the model of Sindbæk of the early medieval North Sea indicate, such dense clusters do not necessarily emerge among nodes spatially near to each other. Especially ties of long distance exchange could connect ports more densely with other hubs of commerce oversea than with nearby sites of less mercantile activity. Irad Malkin in his book on the "Small World" of the Greek colonisation of the 7th-6th century BC has equally illustrated how traditional ties of exchange and identification could connect clusters of colonies with their mother towns over long distances.[70]

Yet, of course in many cases there existed a "logic of spatial proximity". Port cities often relied on the import of foodstuffs from nearby sites for which it in turn they were attractive due to the commercial opportunities and demand created by their trans-regional mercantile communities. Horden and Purcell have highlighted the significance of "micro-regions" and "micro-ecologies" for the Mediterranean.[71] Spatial proximity has also been identified by Ducruet and Zaidi as one factor for the emergence of port systems, while other factors such as "trade preferences" or "specialization" of sites may lead to the establishment of connections among ports over wider distances.[72] Every port thus could serve as hub in several "small world" clusters, from the local to the regional to the global level. The relative impact of these networks on the stability and identity of a port city could vary from case to case, but any attempt to model maritime networks

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[68] Tartaron 2013, 6-7, 80, 88.
[69] Watts 1999; Estrada 2012, 238-243. See also my contribution to this volume.
[70] Malkin 2011.
[71] Horden / Purcell 2000, esp. 53-88.
[72] Ducruet / Zaidi 2012.

should take into consideration the embedding of sites at these various levels and the interplay between them.

## (H1) Conclusion

As the contributions in this volume will illustrate in detail, the emergence, development or abandonment of harbour sites can only be understood against the background of the interplay between social and environmental factors on the local and trans-local level. Complexity theory and network analysis provide a conceptual framework to describe these interplays via understanding both social configurations (cities, maritime communities, polities) and environmental phenomena (hydrosphere, pedosphere, climate) as complex systems, entangled via mechanisms of feedbacks, adaptation or disruption. Depending on the density and quality of evidence, various tools – such as network analysis – allow us to quantify and visualise aspects of these complex systems (such as the "matrix of maritime connectivity" among ports) or to approach them with the help of models. Beyond the comparison of characteristics of selected harbour sites, within SPP 1630 this approach provides the potential to analyse harbours as "nodes of density" of interaction among societies and between society and nature in a trans-disciplinary and maybe more adequate way.

## (H2) Acknowledgements

**Bibliography:**

Albert / Barabási 2002: R. Albert / A.-L. Barabási, Statistical Mechanics of Complex Networks. Reviews of Modern Physics 74, 2002, 48-97.

Barabási 2003: A.-L. Barabási, Linked. How Everything is connected to Everything else and what it means for Business, Science, and Everyday Life (New York, London 2003).

Barthélemy 2011: M. Barthélemy, Spatial Networks. Physics Reports 499, 2011, 1-101.

Bevan / Conolly 2013: A. Bevan / J. Conolly, Mediterranean Islands, Fragile Communities and Persistent Landscapes. Antikythera in Long-Term Perspective (Cambridge 2013).

Bevan / Wilson 2013: A. Bevan / A. Wilson, Models of settlement hierarchy based on partial evidence. Journal of Archaeological Science 40, 2013, 2415-2427.

Brodersen 2003: K. Brodersen, Terra Cognita. Studien zur römischen Raumerfassung, Spudasmata 59 (Hildesheim, Zurich, New York 2003).

Brughmans 2012: T. Brughmans, Thinking through networks: a review of formal network methods in archaeology. Journal of Archaeological Method and Theory 20, 2012, 623-662.

Burkhardt 2009: M. Burkhardt, Der hansische Bergenhandel im Spätmittelalter: Handel – Kaufleute – Netzwerke (Vienna, Cologne 2009).

Burt 2005: R. S. Burt, Brokerage and Closure: An Introduction to Social Capital (Oxford 2005).

Castellani / Hafferty 2009: B. Castellani / F. Hafferty, Sociology and Complexity Science. A New Field of Inquiry (Berlin, Heidelberg 2009).

Chapman 2003: R. Chapman, Archaeologies of Complexity (London 2003).

Davies 2005: J. K. Davies, Linear and Nonlinear Flow Models for Ancient Economies. In: J. G. Manning / I. Morris (ed.), The Ancient Economy. Evidence and Models (Stanford 2005) 127-160.

de Nooy / Mrvar / Batagelj 2005: W. de Nooy / A. Mrvar, / Vl. Batagelj, Exploratory Social Network Analysis with Pajek, Structural Analysis in the Social Sciences (Cambridge 2005).

Derudder / Taylor et al. 2010: B. Derudder / P. J. Taylor et al., Pathways of Change: Shifting Connectivities in the World City Network, 2000-2008, Urban Studies 47 (9), 2010, 1861-1877.

Dorling 2012: D. Dorling, The Visualization of Spatial Social Structure (Chichester 2012).

Downs / Stea 1977: R. M. Downs / D. Stea, Maps in Minds. Reflections on Cognitive Mapping (New York, Hagerstown, San Francisco, London 1977).

Ducruet / Rozenblat / Zaidi 2010: C. Ducruet /C. Rozenblat /F. Zaidi, Ports in multi-level maritime networks: evidence from the Atlantic (1996–2006), Journal of Transport Geography 18, 2010, 508–518.

Ducruet / Zaidi 2012: C. Ducruet / F. Zaidi, Maritime constellations: A complex network approach to shipping and ports. Maritime Policy and Management 39, 2 (2012) 151-168.

Estrada 2012: E. Estrada, The Structure of Complex Networks. Theory and Applications (Oxford 2012).

Füllsack 2011: M. Füllsack, Gleichzeitige Ungleichzeitigkeiten. Eine Einführung in die Komplexitätsforschung (Wiesbaden 2011).

Gertwagen 2000: R. Gertwagen, The Concept of Ports in the Medieval Eastern Mediterranean: Construction and Maintenance on Crete to the End of the Fifteenth Century. International Journal of Maritime History 12/1, 2000, 177-241.

Goergen et al. 2010: M. Goergen et al., Corporate Governance and Complexity Theory (Cheltenham, Northampton 2010).

Gould / White 1986: P. Gould / R. White, Mental Maps (London, Sydney 1986).

Hatcher / Bailey 2001: J. Hatcher / M. Bailey, Modelling the Middle Ages. The History and Theory of England´s Economic Development (Oxford 2001).

Hodder 2012: I. Hodder (ed.), Archaeological Theory Today (Cambridge 2012).

Hölldobler / Wilson 2009: B. Hölldobler / E. O. Wilson, The Superorganism. The Beauty, Elegance, and Strangeness of Insect Societies (New York, London 2009).

Hohenberg / Hollen Lees: P. M. Hohenberg / L. Hollen Lees, The Making of Urban Europe 1000-1994 (Cambridge, Mass., London 1995).

Horden / Purcell 2000: P. Horden / N. Purcell, The Corrupting Sea. A Study of Mediterranean History (Malden, Oxford 2000).

Ilves 2012: K. Ilves, Do Ships Shape the Shore? An Analysis of the Credibility of Ship Archaeological Evidence for Landing Site Morphology in the Baltic Sea, The International Journal of Nautical Archaeology 41, Issue 1, 2012, 94–105.

Indruszewski / Barton 2008: G. Indruszewski / C. M. Barton, Simulating Sea Surfaces for Modeling Viking Age Seafaring in the Baltic Sea. In: J. T. Clark / E. Hagemeister (eds.), Digital Discovery: Exploring New Frontiers in Human Heritage. CAA 2006. Computer Applications and Quantitative Methods in Archaeology. Proceedings of the 34th Conference (Fargo 2008) 616-630.

Isaksen 2008: L. Isaksen, The Application of Network Analysis to Ancient Transport Geography: A Case Study of Roman Baetica, Digital Medievalist, 2008: Http://Www.Digitalmedievalist.Org/Journal/4/Isaksen/.

Kadhushin 2012: Ch. Kadushin, Understanding Social Networks. Theories, Concepts, and Findings (Oxford 2012).

Knappett / Evans / Rivers 2008: C. Knappett / T. Evans / R. Rivers, Modelling maritime interaction in the Aegean Bronze Age, Antiquity 82/318, 2008, 1009–1024.

Knappett 2013: C. Knappett (ed.), Network-Analysis in Archaeology. New Approaches to Regional Interaction (Oxford 2013).

Kraft / Brückner / Kayan / Engelmann 2007: J. C. Kraft / H. Brückner / I. Kayan / H. Engelmann, The Geographies of Ancient Ephesus and the Artemision in Anatolia, Geoarchaeology: An International Journal, Vol. 22, No. 1, 2007, 121–149.

Krempel 2005: L. Krempel, Visualisierung komplexer Strukturen. Grundlagen der Darstellung mehrdimensionaler Netzwerke (Frankfurt, New York 2005).

Leidwanger 2013: J. Leidwanger, Modeling distance with time in ancient Mediterranean seafaring: a GIS application for the interpretation of maritime connectivity. Journal of Archaeological Science 40, 2013, 3302-3308.

Lemercier 2012: Cl. Lemercier, Formale Methoden der Netzwerkanalyse in den Geschichtswissenschaften: Warum und Wie? In: A. Müller / W. Neurath (eds.), Historische Netzwerkanalysen, Österreichische Zeitschrift für Geschichtswissenschaften 23/1 (Innsbruck, Vienna, Bozen 2012) 16–41

Mainzer 2007: Kl. Mainzer, Thinking in Complexity. The Computational Dynamics of Matter, Mind, and Mankind (Springer Complexity), 5th ed. (Berlin, Heidelberg 2007).

Mainzer 2008: Kl. Mainzer, Komplexität, UTB Profile (Paderborn 2008).

Malkin 2011: I. Malkin, A Small Greek World: Networks in the Ancient Mediterranean. Greeks Overseas (Oxford, New York 2011).

Marriner / Morhange 2007: N. Marriner / Ch. Morhange, Geoscience of ancient Mediterranean harbours, Earth-Science Reviews 80, 2007, 137-194.

Miller / Page 2007: J. H. Miller / S. E. Page, Complex Adaptive Systems. An Introduction to Computational Models of Social Life, Princeton Studies in Complexity (Princeton 2007).

Mitchell 2009: M. Mitchell, Complexity. A guided tour (Oxford 2009).

Morhange / Marriner 2010: C. Morhange / N. Marriner, Mind the (stratigraphic) gap: Roman dredging in ancient Mediterranean harbours. Bollettino di Archeologia online I, 2010: http://151.12.58.75/archeologia/bao_document/articoli/4_Morhange_Marriner_paper.pdf.

Newman 2010: M. E. J. Newman, Networks. An Introduction (Oxford 2010).

Oleson / Brandon / Hohlfelder 2011: J. P. Oleson / Ch. Brandon / R. L. Hohlfelder, Technology, Innovation and Trade: Research into the engineering characteristics of Roman Maritime Concrete. In: D. Robinson / A. Wilson, A. (eds), Maritime Archaeology and Ancient Trade in the Mediterranean, Oxford Centre for Maritime Archaeology Monograph 6 (Oxford 2011) 107-119.

Papageorgiou 2008: D. Papageorgiou, The Marine Environment and Its Influence On Seafaring and Maritime Routes in the Prehistoric Aegean. European Journal of Archaeology 11/2-3, August/December 2008, 199-222.

Pierson 2004: P. Pierson, Politics in Time: History, Institutions, and Social Analysis (Princeton 2004).

Preiser-Kapeller 2012: J. Preiser-Kapeller, Networks of border zones – multiplex relations of power, religion and economy in South-eastern Europe, 1250-1453 CE. In: Proceedings of the 39th Annual Conference of Computer Applications and Quantitative Methods in Archaeology, "Revive the Past" (CAA) in Beijing, China (Amsterdam 2012) 381-393.

Preiser-Kapeller 2013: J. Preiser-Kapeller, Mapping maritime networks of Byzantium. Aims and prospects of the project "Ports and landing places at the Balkan coasts of the Byzantine Empire". In: F. Karagianni (ed.), Proceedings of the conference "Olkas. From Aegean to the Black Sea. Medieval Ports in the Maritime Routes of the East" (Thessalonike 2013) 467-492.

Prell 2012: Ch. Prell, Social Network Analysis. History, Theory and Methodology (Los Angeles, London 2012).

Pryor 1992: J. H. Pryor, Geography, Technology, and War: Studies in the Maritime History of the Mediterranean, 649–1571 (Cambridge 1992).

Rodrigue / Comtois / Slack 2013: J.-P. Rodrigue / Cl. Comtois / B. Slack, The Geography of Transport Systems (3rd ed., London, New York 2013).

Sachweh 2013: M. Sachweh, Segelwetter östliches Mittelmeer (Bielefeld 2013).

Sassen 2012: S. Sassen, Cities in a World Economy (Los Angeles 2012).

Scheffer 2009: M. Scheffer, Critical Transitions in Nature and Society (Princeton 2009).

Scheidel et al.: W. Scheidel et. al., ORBIS: The Stanford Geospatial Network Model of the Roman World: http://orbis.stanford.edu/.

Schörle 2011: K. Schörle, Constructing Port Hierarchies: Harbours of the central Tyrrhenian Coast. In: D. Robinson / A. Wilson (eds.), Maritime Archaeology and Ancient Trade in the Mediterranean, Oxford Centre for Maritime Archaeology Monograph 6 (Oxford 2011) 93-106.

Sindbæk 2007: S. M. Sindbæk, The Small World of the Vikings. Networks in Early Medieval Communication and Exchange. Norwegian Archaeological Review 40, 2007, 59-74.

Sindbæk 2013: S. M. Sindbæk, Broken links and black boxes: material affiliations and contextual network synthesis in the Viking world. In: C. Knappett (ed.), Network-Analysis in Archaeology. New Approaches to Regional Interaction (Oxford 2013) 71-94.

Soukissian et al. 2008: T. Soukissian et al., Assessment of the Wind and Wave Climate of the Hellenic Seas Using 10-Year Hindcast Results. The Open Ocean Engineering Journal, 2008, 1, 1-12.

Tainter 1988: J. A. Tainter, The Collapse of Complex Societies, New Studies in Archaeology (Cambridge 2008).

Tartaron 2013: Th. Tartaron, Maritime Networks in the Mycenaean World (Cambridge 2013).

Tartaron / Rothaus / Pullen 2003: Th. Tartaron / R. Rothaus / D. Pullen, Searching for Prehistoric Aegean Harbors with GIS, Geomorphology, and Archaeology, Athena Review 4, 2003, 27-36.

Veikou 2014: M. Veikou, Byzantine Histories, Settlement Stories: Kastra, "Isles of Refuge", and "Unspecified Settlements" as In-between or Third-Spaces. In: T. Kiousopoulou (ed.), Oi byzantines poleis 8os-15os aionas. Prooptikes tes ereunas kai nees ermeneutikes prosengiseis (Rethymno 2014) 159-206.

Walsh 2014: K. Walsh, The Archaeology of Mediterranean Landscapes. Human-Environment Interaction from the Neolithic to the Roman Period (Cambridge 2014).

Wassermann / Faust 1994: St. Wassermann / K. Faust, Social Network Analysis: Methods and Applications, Structural Analysis in the Social Sciences, Cambridge 1994.

Watts 1999: D. J. Watts, Small Worlds. The Dynamics of Networks between Order and Randomness. Princeton Studies in Complexity (Princeton, Oxford 1999).

Wilkinson 2008: N. Wilkinson, An Introduction to Behavioral Economics (Houndsmill, Basingstoke 2008).

**Figures for: Harbours and Maritime Networks as Complex Adaptive Systems – a thematic Introduction**



**Fig. 1: The Byzantine harbour site of Monembasia on the South-eastern Peloponnese: a "high energy" coastal situation (Greece) (J. Preiser-Kapeller, 2014)**



**Fig. 2: The ancient harbour of Ampourias in Spain, with a silted harbour basin from the Greek period (red line) and remains of an eroded harbour basin from the Roman period to its east (J. Preiser-Kapeller, 2014)**

**Fig. 3: The Roman harbour of Ephesos (Western Asia Minor) and the modern-day coastal situation in the environs of the city (J. Preiser-Kapeller, 2014)**
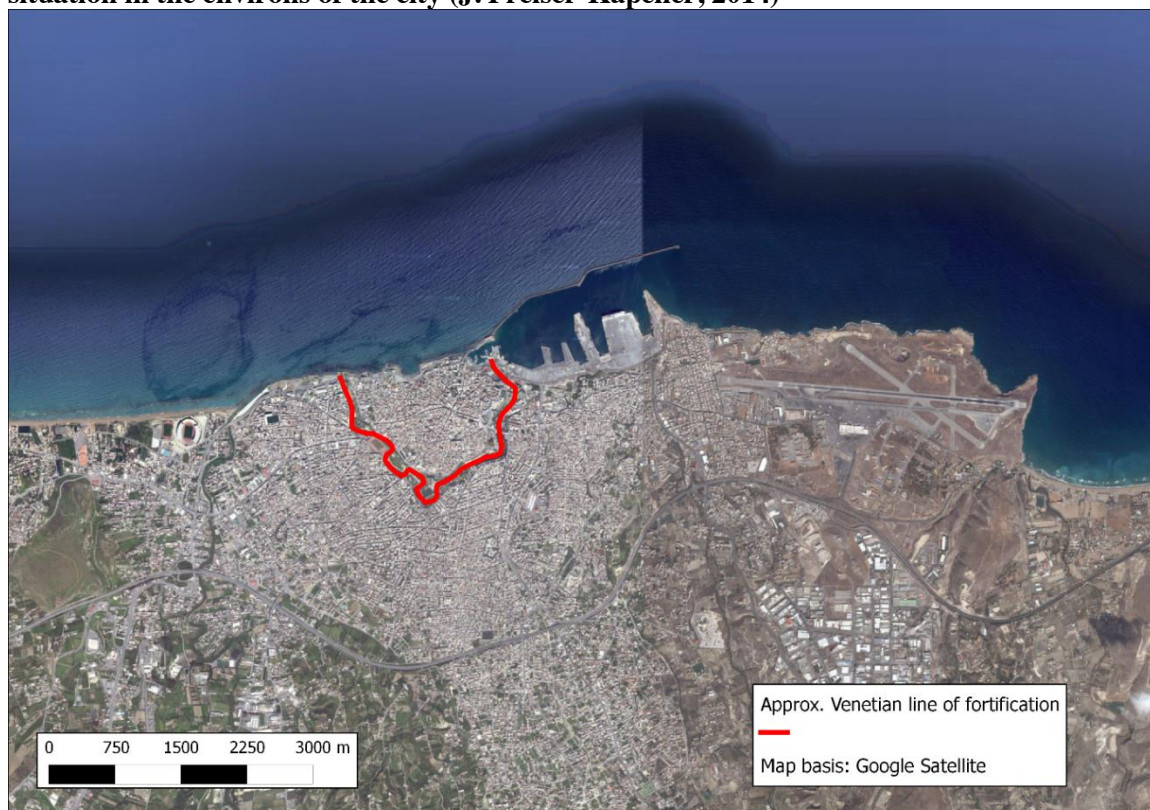


**Fig. 4: The Venetian port of Candia on Crete (Greece) and its environs (J. Preiser-Kapeller, 2014)**
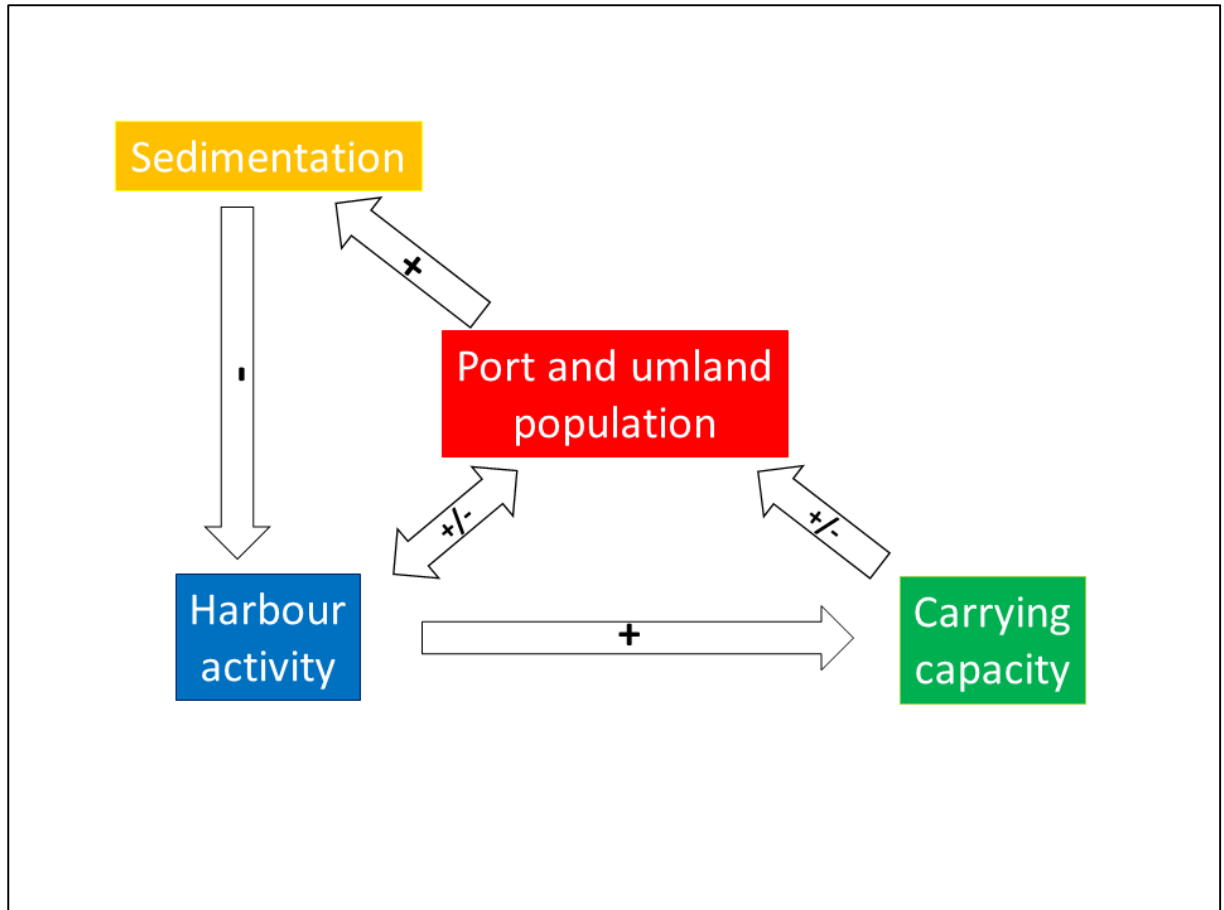
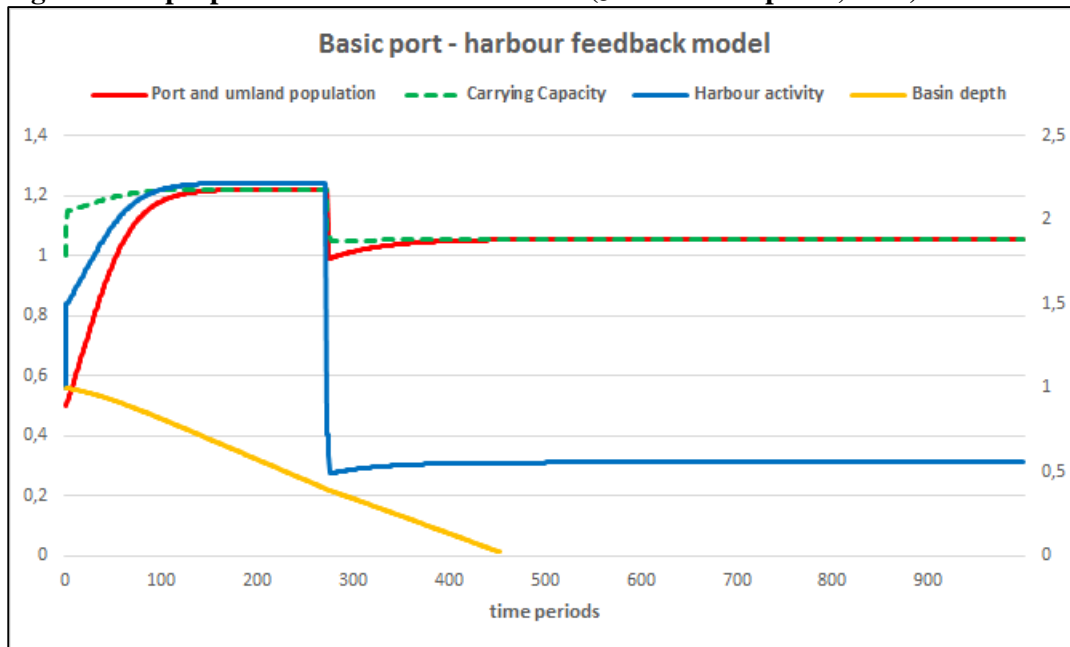**Fig. 5: A simple port-harbour feedback model (J. Preiser-Kapeller, 2014)**



**Fig. 6: Trajectories of the four parameters in the basic port-harbour feedback model (J. Preiser-Kapeller, 2014)**
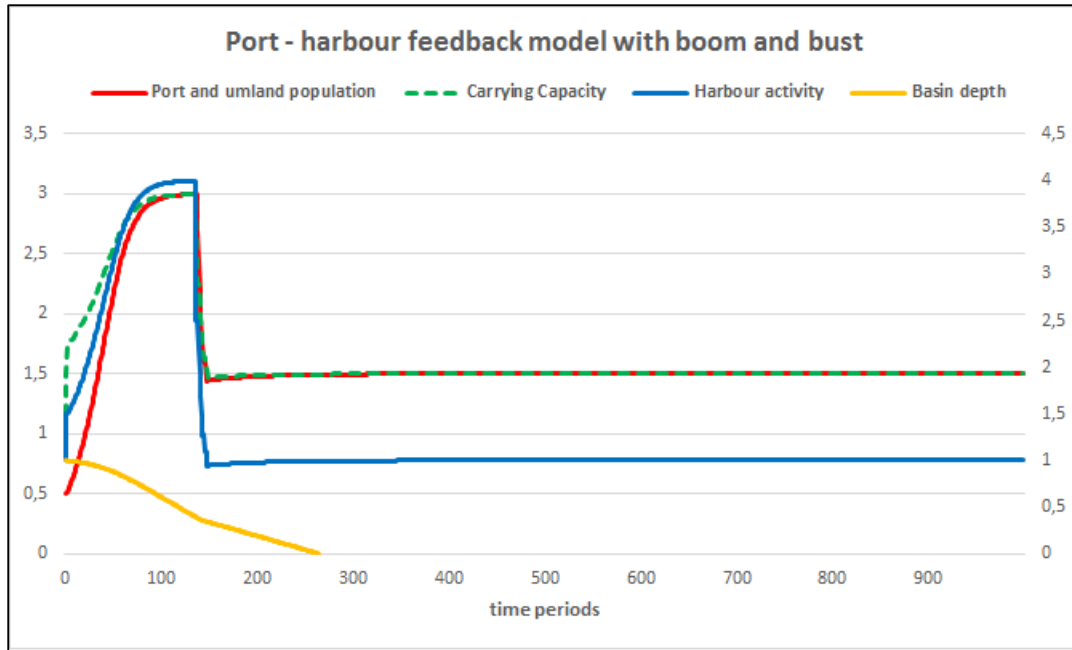
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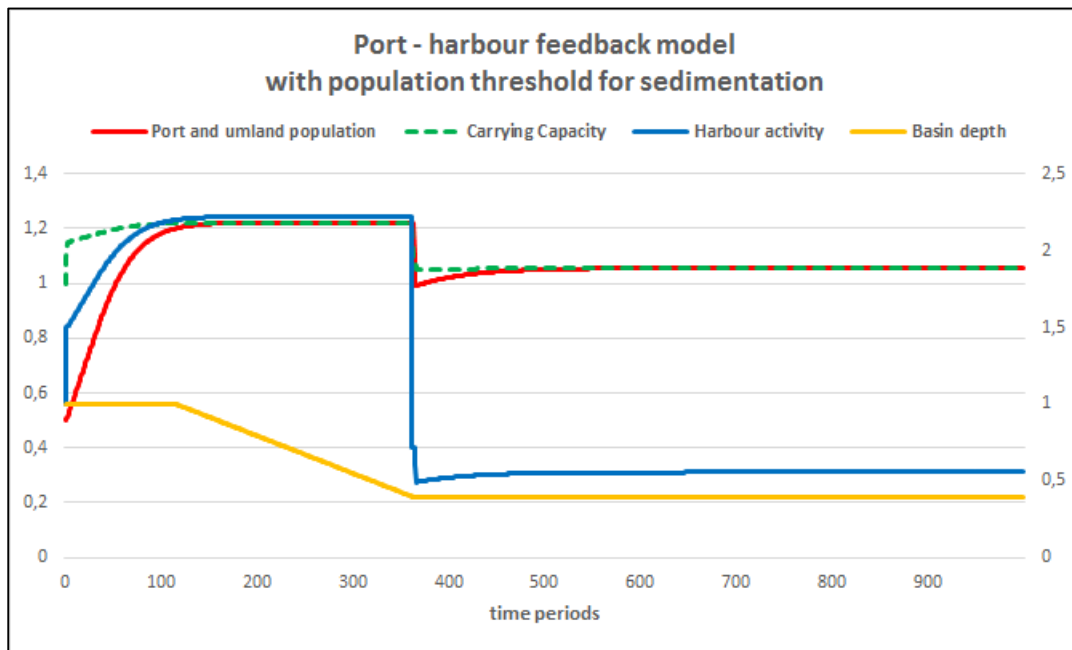


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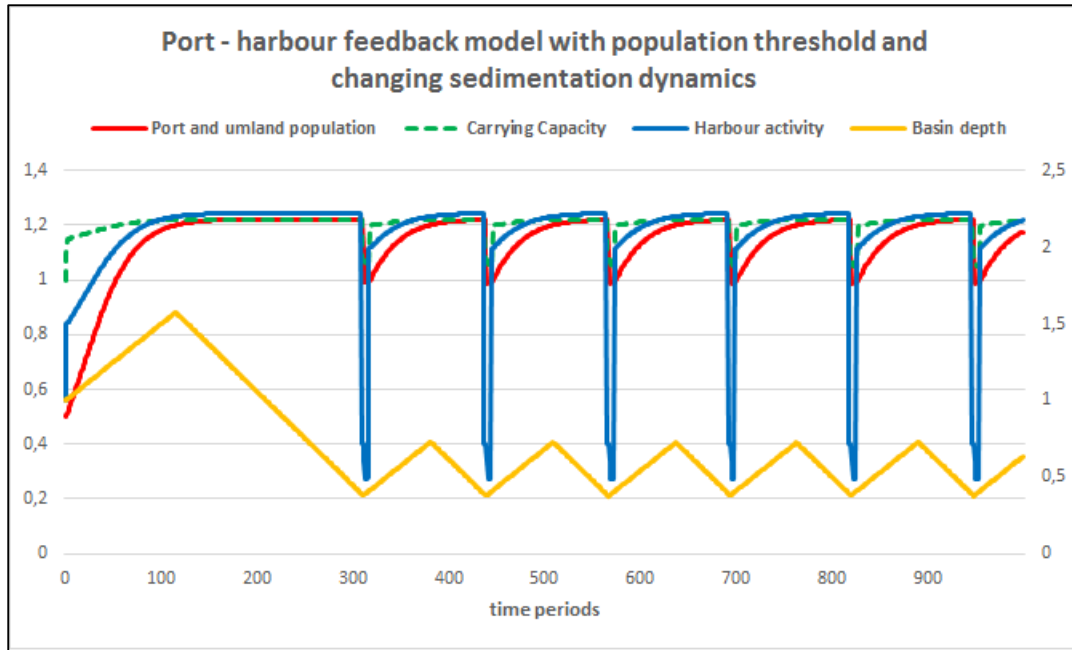
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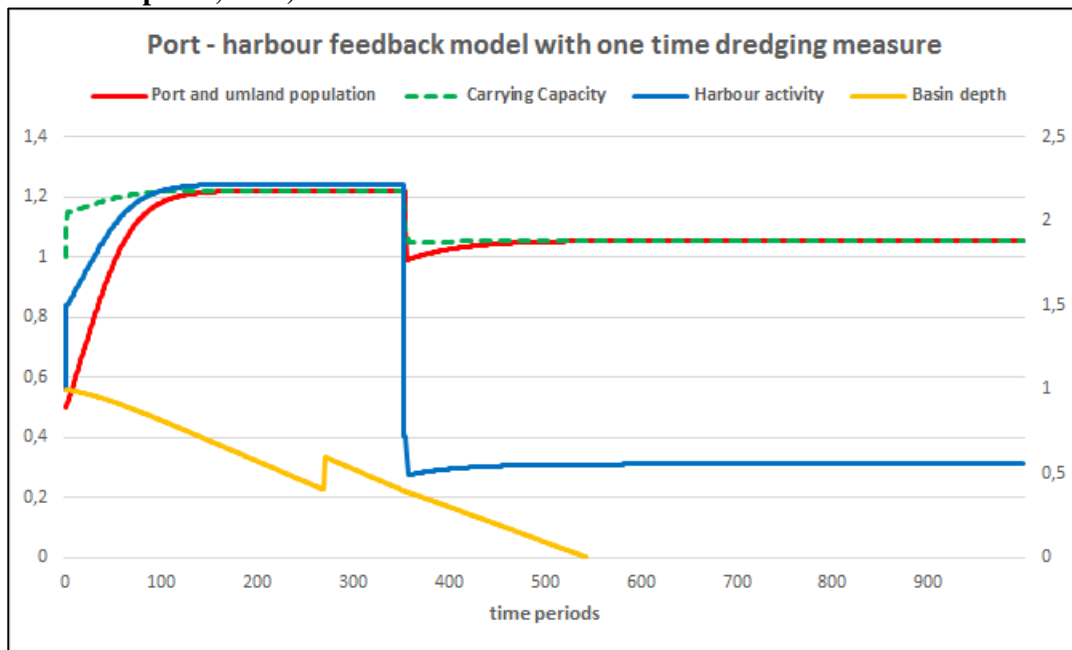


**Fig. 10: Trajectories of the four parameters in the port-harbour feedback model with a one-time dredging measure (J. Preiser-Kapeller, 2014)**
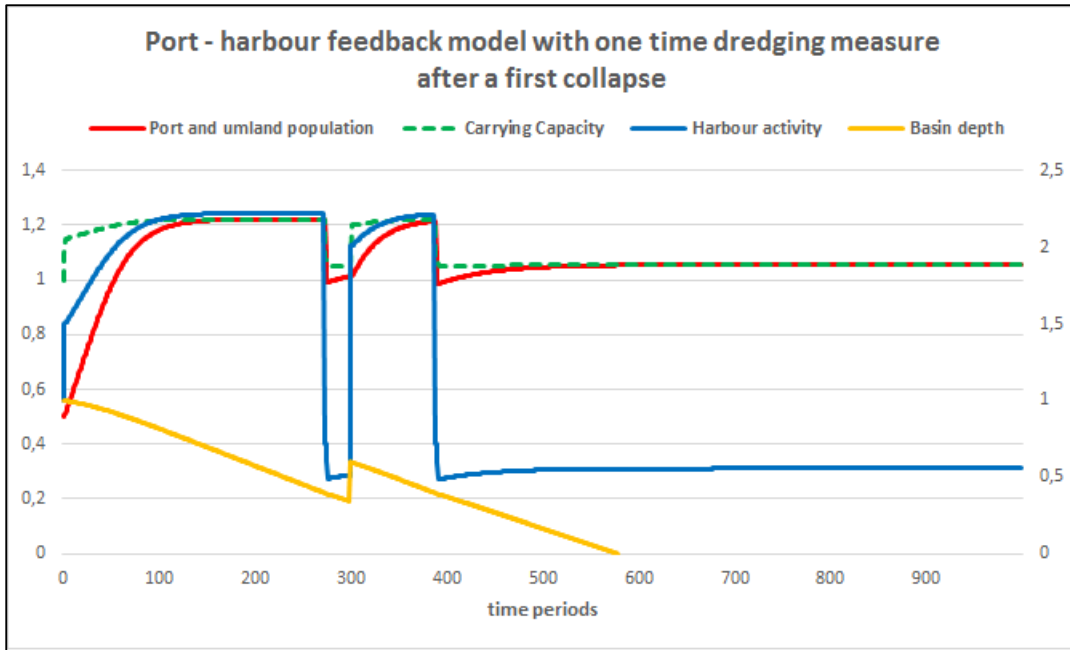
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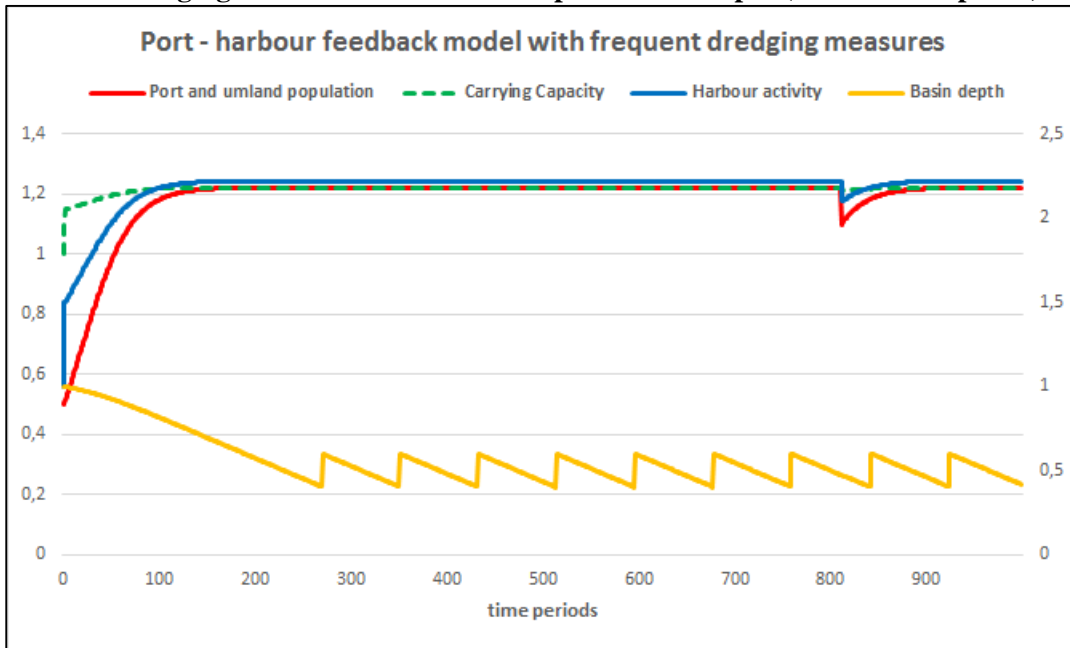


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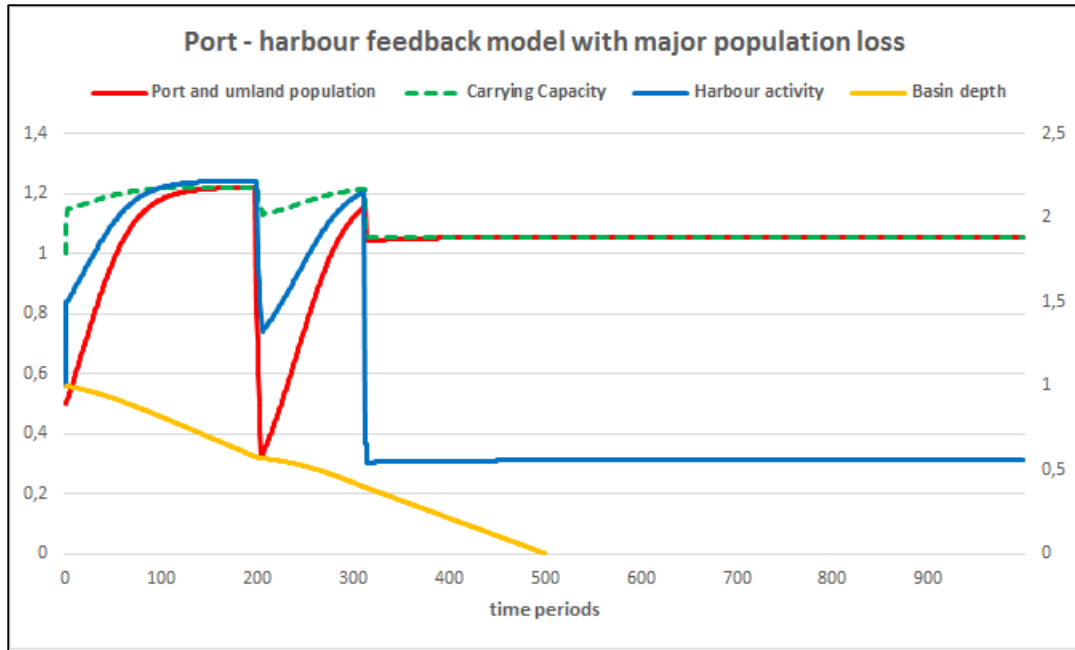
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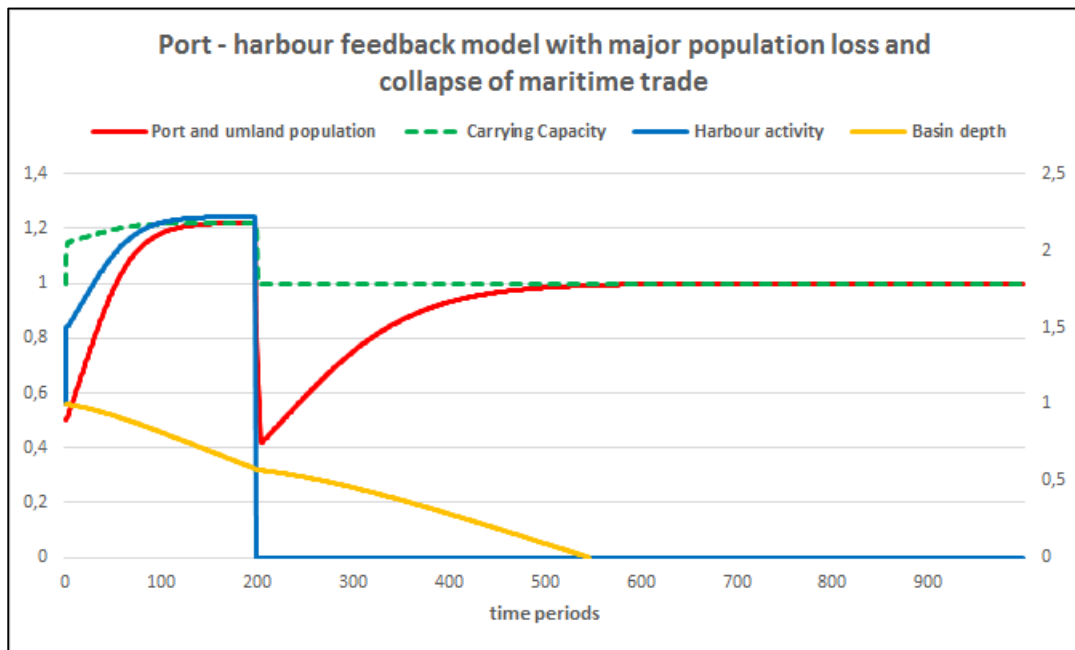


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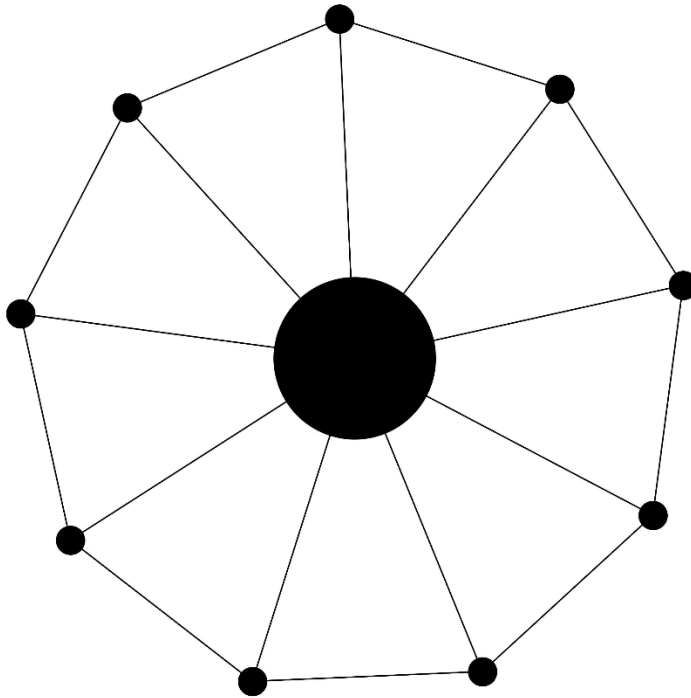
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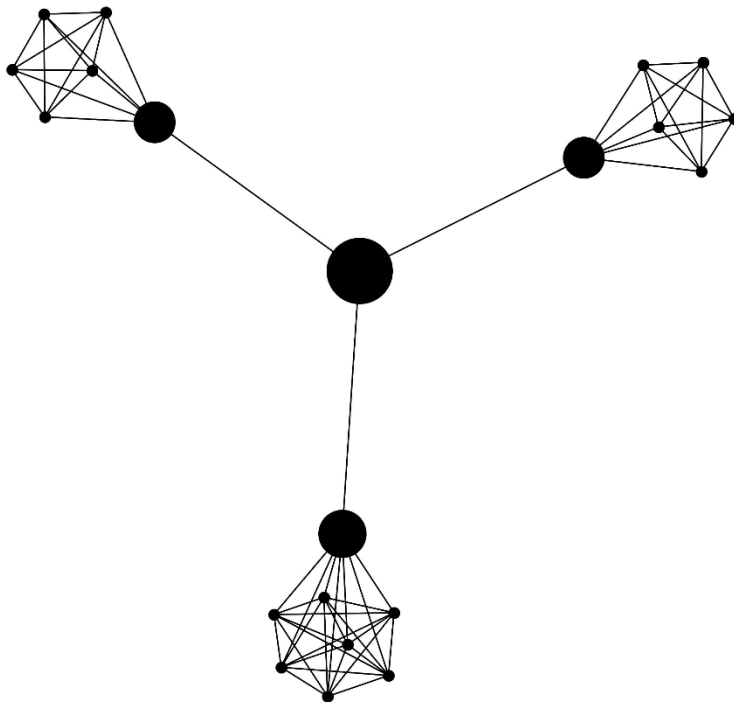


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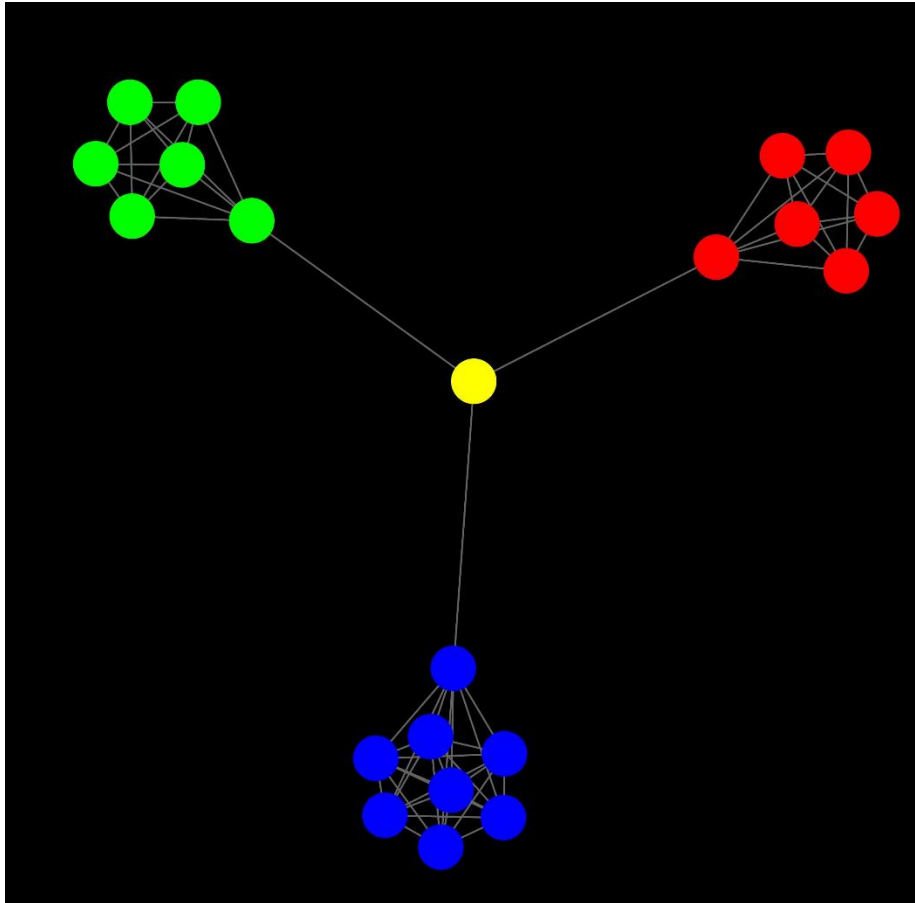
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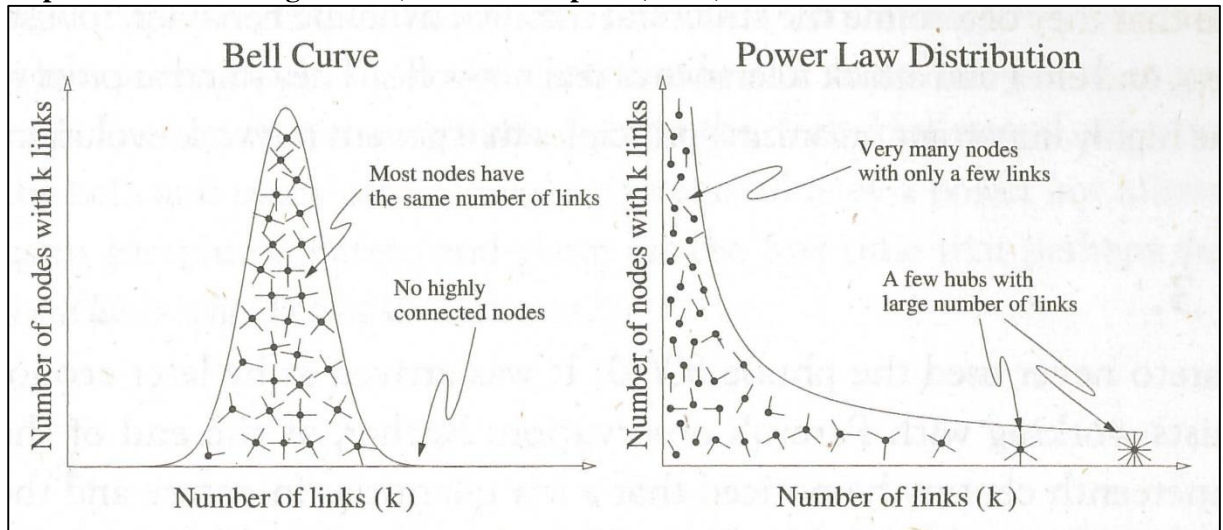


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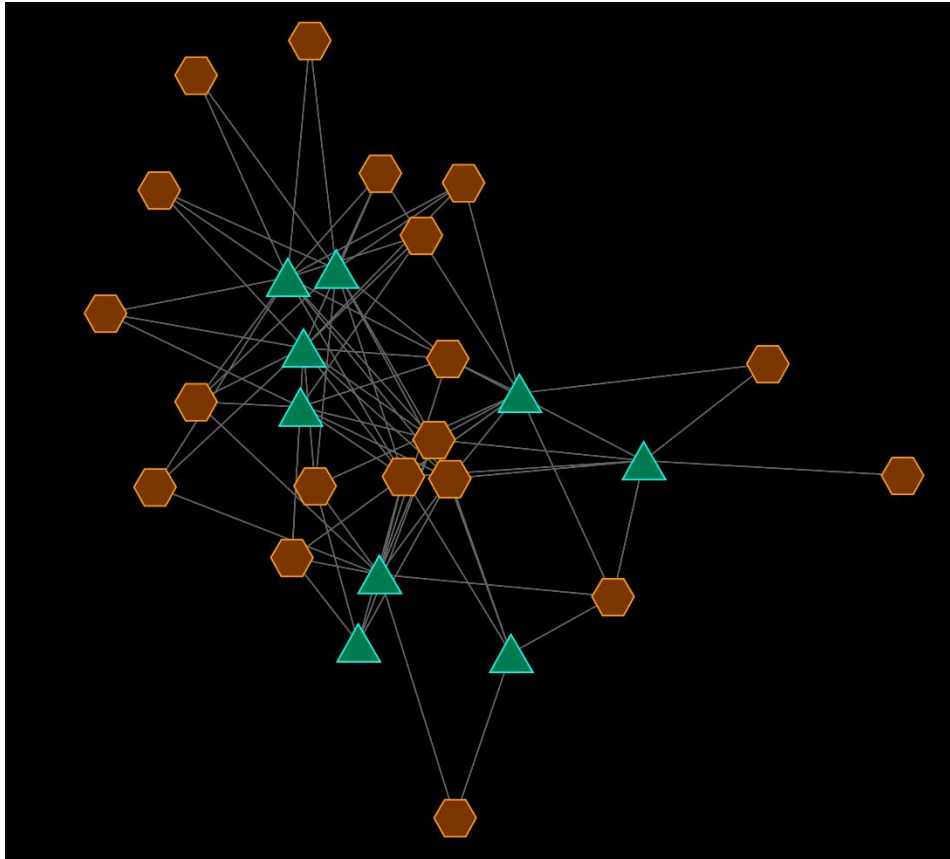
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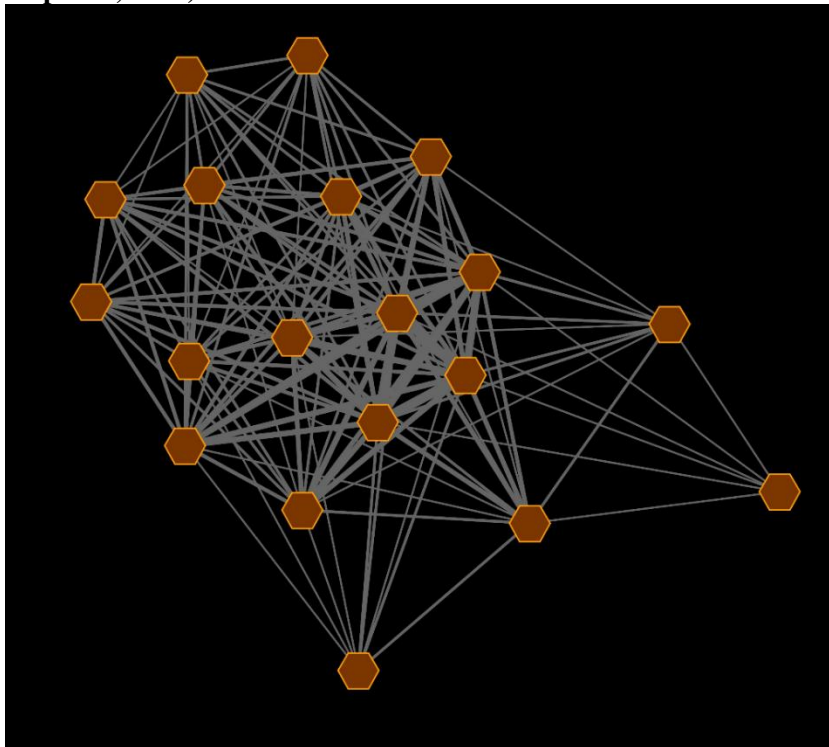


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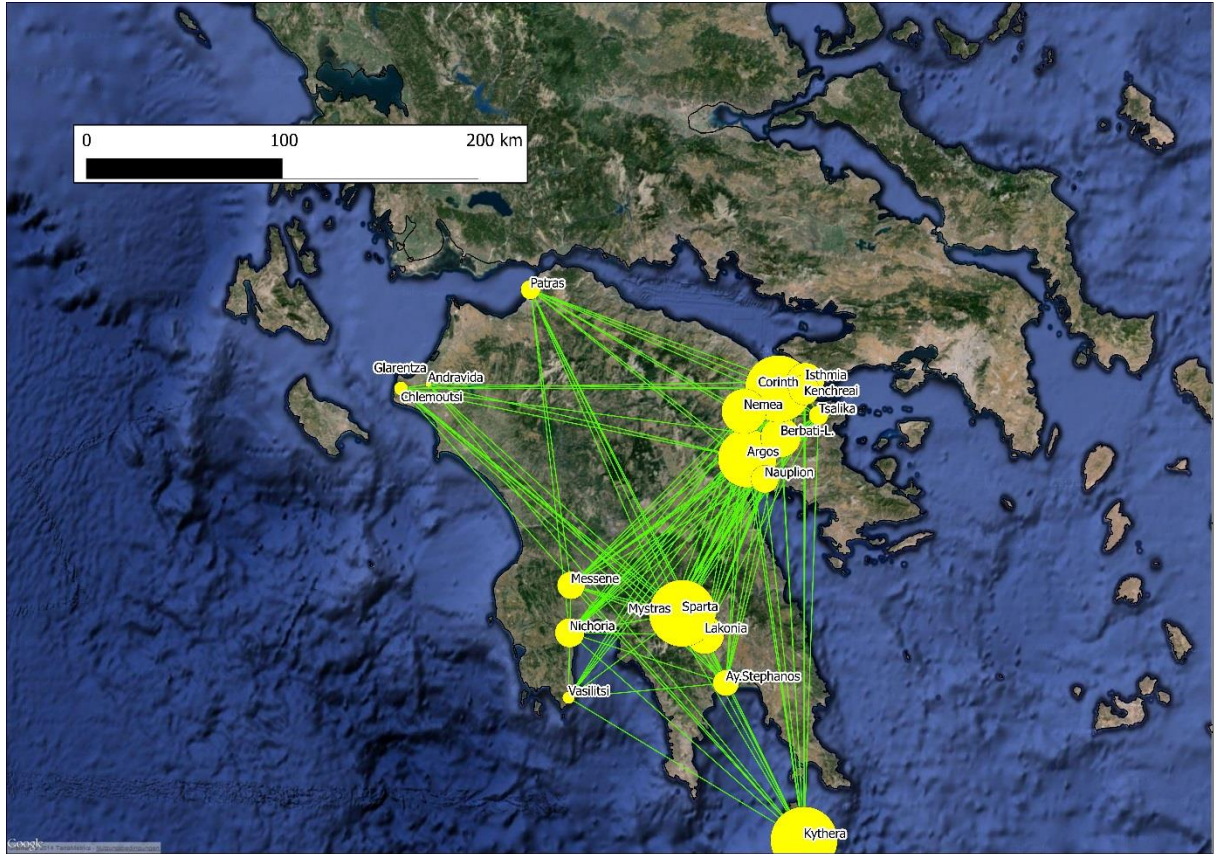
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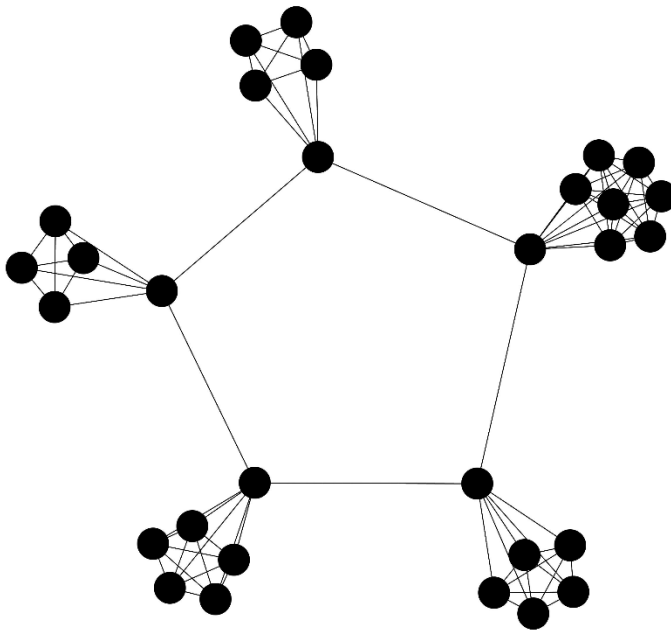


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**The life-cycle of the harbour of Thonis-Heracleion:**
**the interaction of the environment, politics and trading networks on the maritime**
**space of Egypt's northwestern Delta**

Franck Goddio, Damian Robinson and David Fabre

**(H2) Introduction**
Located at the end of the Canopic branch of the River Nile, at the edge of the Hau-Nebut, translated as 'The Sea of the Greeks',[73] the port city of Thonis-Heracleion lived and died through the agency of people and the social and economic networks that they created involving it. The very name of the city provides an insight into some of these important networks. Thonis, which should perhaps be more precisely translated as 'The *Hôné* of Saïs',[74] recalls both the environmental region in which the port was created and also its political links to the local dynasty at the nearby city of Saïs, for which the *hôné* was its port. Heracleion reflects the presence of a temple to Herakles at the site, with its clear indications of Greeks – either as visitors or as settlers.[75]

The name Thonis-Heracleion, therefore, neatly encapsulates the three main factors that favoured its growth into a port of some significance in the maritime networks of the central and eastern Mediterranean. The first set of factors is simply the environmental constraints of the Delta and the particular niche that the city came to occupy within it, which enabled the creation of a port in this specific location. The requirement for a port, the second set of factors, was the result of the rise in political importance of the northwestern Delta in Egypt during the Late Period. In particular, this involves the development of the nearby city of Saïs, which was the seat of an important local dynasty who rose to kingly power in Egypt and who required an outlet to the sea. It is here that the third set of factors comes in to play. The new port was founded to tap in to the developing set of trading networks with the expanding polities of the Greek world and Phoenicia. In particular, contacts with the Greek world were of major importance, as it was this network that provided the trading connections and mercenaries upon which Saïte and Egyptian political power and security became increasingly reliant.

These three interdependent factors allowed and supported the rise to prominence of Thonis-Heracleion in to a major emporium and transhipment port for both imports to and exports from Egypt and a discussion of them will form the first part of this paper. This is not just a tale of network growth and development, however, but also of what happens when those networks upon which a port relies shift and change with the social and economic winds. The port of Thonis-Heracleion fell victim to just such shifts.

The first nail in its coffin was the foundation of Alexandria in 331 BC. Although this was arguably institutional – a political gesture – the new port was located in a much more propitious environmental location and as the new centre of both political and economic power within the region it drew away trade, the lifeblood of Thonis-Heracleion. The city, however, continued in a reduced state, largely due to its religious role for the ruling dynasty and its continuation. Such a role though would have no place within the new formulation of Egypt that resulted from the downfall of the Ptolemies

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[73] von Bomhard 2012, 54 line 9 and 75–6 note e) for a discussion of the term HAw-nbwt.
[74] See Yoyotte 2008a, 238 no. 116 and von Bomhard 2012 on the Heracleion Stele and Yoyotte 2001, 25 on the etymology of the word '*hôné*'.
[75] Yoyotte 2008, 309 no. 115; Höckmann 2011

and the arrival of Roman hegemony a little over three centuries later. Shorn of its economic, political and religious place within the reconfigured networks of power within the region, the port and city of Thonis-Heracleion withered and died as its population left. The decline of the city will then form the second half of this paper, which will illustrate that a port is only as strong as the network that sustains it, and a port without a network is a port without a *raison d'être*.

This paper simply explores the archaeological and historical contexts and processes through which the *hôné* becomes a node in the social, cultural and material networks of Egypt and the eastern Mediterranean and then what happens when these links are broken. Through deliberately focusing on history and the roles of geography and of structure and agency, aspects of lifecycle of Thonis-Heracleion are forwarded that provide a flavour of the networks to which it was linked rather than a thorough computationally-derived evocation of the networks themselves.[76] This local analysis with its focus upon the trajectory of Thonis-Heracleion uses the concept of the network and the perspectives that it provides to inform the assemblage and interpretation of the data.[77] Such a concentration on the local rather than the global is not a contradictory but a complementary approach to writing histories of maritime connections and allows the depth of contextual detail from sites like Thonis-Heracleion to be located within the breadth of grand narratives. Here our analysis offers 'a magpie's bricolage of local truth(s)' about the port and its people at the edge of the Sea of the Greeks.[78]

**(H2) A brief introduction to the site of Thonis-Heracleion**
The European Institute for Underwater Archaeology (IEASM) has been working in the Bay of Aboukir since 1996 (Figure 1).[79] Located some 30 km west of Alexandria on the Mediterranean coast of Egypt, the western portion of the bay has been the subject of an integrated underwater archaeological survey and excavation project in collaboration with the Ministry of State for Antiquities. The aim of the work was to reveal the evolution of this landscape, through the study of its topography and submerged settlements, with the results demonstrating the complex interplay between environment and society.

Thonis-Heracleion was organised around the *temenos* of the Temple of Amun of the Gereb, which was located on a central promontory and overlooked the surrounding city (Figure 2). To the north and east stretched harbours and a large port, which opened onto the Nile by two passages through the sand dunes that protected the anchorage from the prevailing winds and from storms. There were several major port basins, interconnected by secondary waterways, all of which were centred upon the temple area.[80]

To date, 64 ancient ships have been discovered in its harbour basins and radiocarbon dating on the wood of their hulls, in combination with the evidence from pottery other pieces of material culture would suggest that the city was occupied from the 8th to the

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[76] cf. Knappett 2011 and papers in Knappett 2013; Sindbæk 2007.
[77] cf. Malkin 2011 and papers in Malkin / Constantakopoulou / Panagopoulou 2009; Horden / Purcell 2000; Broodbank 2013
[78] Broodbank 2013, 25
[79] About the history of Thonis-Heracleion, role and function, steps of its discovery, archaeological findings, see Yoyotte 2001, 24-34; Yoyotte 2004, 29-35; Goddio 2007, 1-28. 69-130; Goddio 2008, 26-48; Fabre 2008, 219-234.
[80] For discussions on the structure of the city see Goddio 2008 and 2010

2nd century BC, with the majority of material dating from between the 5th and the 2nd, indicating the highpoint of life in this port-town.[81]

**(H2) The environmental niche of the *hône* of Saïs**
The low-lying northern coast of Egypt was known in antiquity as being dangerous for navigation.[82] With a general absence of offshore islands and sheltered bays, false mouths, not to mention shifting offshore sand banks, the configuration of the Egyptian maritime façade was a daunting one for the sailor.[83] The branches of the Nile were mainly the only convenient places for anchoring and entering Egypt and of those mouths, the Canopic and the Pelusiac, were most frequently used, as they were the outlets of the two most navigable branches of the Nile. Both of these branches led up the river to Memphis, the hinge between the Delta to the north and the Nile valley to the south.[84]

While the Pelusiac branch of the Nile was in use from an early date, the relative unimportance of the western part of the Delta to the Pharaonic world resulted in the lack of a 'coastal' harbour in this location until the early in the first millennium BC.[85] This is not to say that the area was unsuitable as the location for a maritime settlement, simply that there would not have been the demand or opportunity for one before this date.

The environment consisted of coastal sand dunes alongside the mouth of the branches, which protected an inland area composed of marshes and lakes, interconnected by smaller rivulets. This hydrographical configuration was called a *hôné* by the Egyptians, from which Thonis – the *hôné* of Saïs – takes its name.[86] The *hôné* would have provided ideal conditions for a port with suitable anchorages in the lakes and the coastal dunes giving protection from the prevailing north-west winds and from north-easterly storms.

Obviously, a coastal-riverine port was also a place of transition from two different sailing regimes. Far from a benign sailing environment, the river itself would have been full of shifting sand banks, particularly after the flood, which posed hazards that served to block passage and even cause vessels to wreck. According to figures in the *Description de l'Egypte*, year-round sailing was restricted to boats drawing less than 0.5 m of water and consequently it is likely that flat-bottomed vessels would have been necessary for the transportation of goods along the Nile and its Delta throughout much of the year.[87] The Ahiqar scroll, a customs account written in Aramaic recording the tax dues collected at a Nile port from Ionian and Phoenician ships over the ten-month sailing season in 475 BC, gives a suggestion to how such a trans-shipment port would work. The scroll makes it clear that many of the ships from Greece arrive during the first part of the sailing season, which coincided with the period of the low Nile from

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[81] Fabre 2011; Fabre forthcoming, Fabre / Belov 2012; Belov forthcoming; Robinson forthcoming a and b on the ships, Grataloup 2008 and 2010 on the pottery, and Meadows 2008 and forthcoming on the coins.
[82] Diodorus 1.31.2-5 and see Bernand 1970, 22
[83] Cooper 2011, 2012a and b
[84] Chuvin / Yoyotte 1983, 54; Carrez-Maratray 2005; Cooper 2008; Stanley / Warne 2007.
[85] Pharaonic Egypt does not seem to have purposely built ports on its shores and at most there would have been landing piers and/or anchorage points, see Fabre 2004, 19-35.
[86] Yoyotte 2001, 25.
[87] Jomard 1809-28, 1, 112; Cooper 2011, 195-197.

March to June.[88] If these foreign vessels drew more than half a metre of water, it is highly likely that they would have needed to trans-ship their products onto a river barge if the goods were to go up river, or else it may have required a long period at anchor in the harbours of Thonis-Heracleion awaiting easier transport conditions.[89]

Consequently, it can be seen that there were a number of factors that would have favoured the creation of a port in this particular environmental location at the end of the Canopic branch of the Nile. There were suitable sheltered anchorages, a relatively 'easy' route down the branch to Memphis and the other main centres further up the Nile, and the river itself may well have necessitated the trans-shipment of goods from seagoing to river vessels. Yet, despite of the favourable environmental conditions, the development of Thonis-Heracleion as a port obviously required human needs and agency to also play their part – the environment allows and may even suggest the development of a port, but it is obviously only realised through social action.

**(H2) The social and political context in which the port develops**
The development of a port on the western side of the Nile Delta represents a break with traditional maritime networks in Egypt, which saw the eastern Pelusiac branch as the country's main outlet to the sea. The location of the important New Kingdom cities and ports such as Piramesse and later Tanis illustrate the paramount significance of the routes to Syria-Palestine, the clear focus of Egypt's maritime network at this time. By contrast, the lands of the western Delta were comparatively unimportant in the eyes of contemporary pharaohs, and were characterised by a low population density and an agricultural sector mainly involved with grazing cattle.[90]

It took the population movements, which started towards the end of the New Kingdom, to change this picture.[91] Although the major incursions by the Libu and Meshwesh – tribes from modern day Cyrenacia in Libya – had been repulsed by Merenptah and Rameses III, the settlement of immigrants, war captives and garrison troops continued throughout the Delta. The decentralisation of government in Egypt during the Third Intermediate Period saw the development of provincial power bases, and local dynasties of Libyan chieftains were able to increase their autonomy. In this way a number of principalities developed, each based at an important town, and several of these local princes declared themselves king.

The Meshwesh – probably the first tribe to come into the Delta in any force – settled in the eastern and central zones, where settlement was already long established at towns such as Tanis. While the Libu, who probably arrived later, settled on the less prosperous western edge.[92] Despite this initial disadvantage, it was this tribe who quickly rose to prominence throughout the Delta through their rapid territorial expansion and political cunning. This culminated in the Saïte Dynasty of the Late Period (664-525 BC) and the reunification of Egypt under a single leader.

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[88] Yardeni 1994; Briant / Descat 1998.
[89] cf. Höckmann 2008-9.
[90] Taylor 2000, 339. On the importance of grazing cattle in the Western Delta and the cult of Amun, see Fabre 2014.
[91] For an historical overview of the period see Taylor 2000
[92] Taylor 2000, 345

The growth of Thonis-Heracleion into a port of some importance is entirely bound up with the development of the western side of the Delta and the rise in Saïte power.[93] As was noted in the introduction to this paper, the very name of the site explicitly links it to Saïs, which would have required an outlet to the sea. The importance of the western facing arm of the Delta, the Canopic branch, increases not simply because it was that upon which the city of Saïs was located but crucially because of the foreland to which it provided access: the developing Greek networks of the central and western Mediterranean as well as the Libyan networks across the western desert and into Marmarica and Cyrenacia. For example, Psamtek I, a powerful Saïte king, employed Carian and Ionian mercenaries in the substantial and well-equipped army that he used to help him reunited Egypt under his authority.[94]

These Greek mercenaries made a profound contribution in that they not only helped Psamtek to reunite Egypt but they then helped to guarantee the country's security from both external and internal threats: notably from the *machimoi*, the native Egyptian warrior class. A port on the western side of the Delta would thus provide a natural point of entry for these soldiers, whose presence in Thonis-Heracleion is also borne out by the finds of Greek military equipment from the site (Figure 3).[95] It is also important to note that Psamtek's son, Nekau II, is credited in Herodotus as constructing a fleet of ramming war galleys, which given the regime's propensity for employing Greek mercenaries, may have been early Greek-style banked warships.[96] It has been suggested that as well as at Memphis, where there were naval shipyards, Tell Defenna, the port at the end of the Pelusiac branch of the Nile, would have been a naval base from which these vessels could operate.[97] With its similar location at the end of the Canopic branch, Thonis-Heracleion would equally have provided a base in the west and protection from pirates and the monitoring of foreign ships entering the Nile.

**(H2) The trading links with the Greek network**
Mercenary armies and fleets of specialist warships came at a substantial cost to the Egyptian state and here the second important focus for Saïte policy comes in: the development of the trading economy. Textual sources demonstrate that both the sailors and authors of the Greek world knew the port of Thonis-Heracleion from its earliest years, suggesting that Greek ships were putting in here from the 8th century BC onwards.[98] Here it is surely not a coincidence that this was also the time of the foundation of the Saïte principality.

These visiting trading vessels may have been sailing onto or trans-shipping cargo for the various early Greek trading stations, such as the 'Wall of the Milesians',[99] but from the 6th century BC their destination would have been Naukratis, a unique Greek settlement founded by the Milesians, but with members from other Greek cities, in an encampment within an Egyptian city.[100] Naukratis was located on the Canopic branch of the Nile and close to Saïs, to which a canal may have connected it. From about 570

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[93] For an historical overview of the period see Lloyd 2000
[94] Lloyd 2000, 371-372.
[95] Sekunda 2008, nos. 305, 307, 309, 310, 312, 313, 314, 315, 356.
[96] Herodotus 2.159.1; Lloyd 1972, although see also Basch 1969; James 1992, 720-723.
[97] Lloyd 2000, 373.
[98] Homer Odyssey 4.228. Yoyotte 1958, 427; Yoyotte 2001, 27; Fabre 2008.
[99] Strabo Geographica 17.1.18; Drijvers 1999
[100] Herodotus 2.178-9

BC Naukratis was the port through which all Greek trade was required to flow by law. The concentration of foreign trade in the Saïte *nome* is seen in Herodotus, where he notes that if a trading vessel sailed into one of the other mouths of the Nile, they were required to either sail directly to Naukratis, or have their goods put onto Egyptian barges and taken there.[101]   With time, it would appear that Thonis-Heralceion usurped the position of Naukratis as the main *emporion* on the western branch of the Nile, nevertheless, the continuing close relationship between these two settlements, and with Saïs and the trading economy is demonstrated by the text of the Decree of Saïs (Figure 4).[102] This decree, from 378 BC, the first year of the reign of Nectanebo I, reallocates some of the revenues from the taxation of exports and imports from Naukratis and Thonis-Heracleion to the temple of Neith at Saïs. It is at Thonis-Heracleion where these taxes would have been paid, where it would have been overseen by an administrative officer from the temple of Anum of the Gereb entitled 'the official at the gateway of the foreign countries'.[103]

The trading economy and the payment of taxes (not to mention also of mercenaries) was perhaps facilitated by the production of Athenian tetradrachmas in Thonis-Heracleion, as demonstrated by the coin die found at the site, which was produced and used in period between 350 and 330 BC.[104] While the text of the Decree of Saïs mentions imports of gold and silver, as well as finely and roughly worked wood,[105] further information about the types of products entering Egypt, as well as their place of origin, can be seen in the ceramic record from Thonis-Heracleion which demonstrates the flows of products from the Greek world, notably Corinth, the Cycladic and Ionian islands, and from Attica.[106] The pottery also helps to demonstrate how the trading relationships within the network develop over time, which Corinth being a particularly strong node during the early years of the network and Athens rising to prominence towards the end of the Saïte period and during the years of Persian dominance. The pottery also indicates that in addition to products from the Greek world, Phoenician sailors were also active in Thonis-Heracleion.[107] This is also seen in the anchors from the port, which has produces examples of both eastern and western Mediterranean and Aegean types.[108] This obviously provides an important counterpoint to the Greek-centred networks that are the focus of much of this paper. It must be noted though that in terms of material culture, the links with the Greek world would appear to be stronger despite the years of Persian rule over Egypt[109].

## (H2) The death of Thonis-Heracleion
It would appear that Thonis-Heracleion rose to prominence to become the Egyptian state's most important trading centre with the wider Greek world and possibly also with Phoenicia in the Late Period. Yet in the first century BC Diodorus Siculus wrote that "it is at the place called Thonis, which was **formerly** the Egyptian *emporion*, that the

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[101] Herodotus 2.179.
[102] Fabre 2008; Pfeiffer 2011; Höckmann 2011, 26; von Bomhard 2012, 95-97.
[103] Poesener 1947, 118; Tresson 1922, 126-144, pl.7-9; Fabre 2008, 233.
[104] Meadows 2011, 101; for the coinage more generally see Meadows forthcoming.
[105] von Bomhard 2012, 72-78
[106] Fabre 2008, 219-234; Grataloup 2008, 246-252; Grataloup 2010, 150-154.
[107] See Goddio / Fabre 2008, nos. 151-153, 225-228, 239-245, 247, 340, 347. See also Fabre / Goddio 2012
[108] Gregory Votruba pers com.
[109] Compare with Defernez 2003, spec. 514.

river flows into the sea".[110] For Diodorus, it is clear that by the time he was writing, Thonis had ceased to be the location of exchange, with Alexandria taking its place in the commercial networks of the region. Removed from its place within the various networks that sustained it, both economically and otherwise, Thonis-Heracleion simply slowly withered and died as its population abandoned the city for other more favourable locations.

### (H3) The environment

It is possible that the environment was a contributory factor in the decision to found another major port in the close vicinity to Thonis-Heracleion. The location of the port inland at the mouth of the Canopic branch was troublesome, as access to it was dependent upon the channels and passages linking it to the Canopic branch remaining clear and open. These connecting waterways were always liable to silt up, particularly following the annual flood, which could dramatically alter the local riverine topography.[111] There is evidence to suggest that connections between the basins of Thonis-Heracleion and the Nile changed several times during the active life of the port. Thus we cannot exclude the possibility that the decline of Thonis-Heracleion was caused in part by a geomorphological modification of the Delta.

It is also likely that there were also more dramatic environmental events that made the decision to abandon the port somewhat easier. Evidence for this comes from an area of destruction in the temple of Amun that seems to be the result of the catastrophic failure of the sediments leading to landslides or the collapse of the land. It would appear that one or more of these events in the second quarter of the 2nd century BC may have resulted in the almost complete abandonment of the city in the years shortly afterwards.[112] Indeed, the majority of Ptolemaic coinage from the port predates *c.* 170-163 BC, providing a *terminus ante quem* for the decline and possibly the large-scale abandonment of the site, or perhaps simply representing a substantial decline in its monetary economy.[113]

With its location on the coast and on a rocky part of the Egyptian shore, the new site of Alexandria, built over the former settlement of Rakotis, initially suffered from none of these environmental problems. Consequently, the decision to create a new settlement at Rakotis may well have been motivated as much by the desire to overcome the geological inconveniences of Thonis-Heracleion, as much as the creation of a new showpiece port on the Mediterranean coast.

### (H3) Institutional effects 1: the removal of trade

It is clear, however, that there was also an official transferral of economic and administrative powers to Alexandria, albeit one that was done in a very underhand manner. This occurred soon after the foundation of the new city and port as Pseudo-Aristotle reports that Cleomenes, who was charged by Alexander to execute the

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[110] Diodorus Siculus, Bibliotheca historica 19.1.4

[111] Cooper 2011, 196

[112] Between 2009 and 2011, the IEASM conducted excavations to the south of the temple of Amun, where there was clear evidence of a destruction layer. The material culture amongst the limestone blocks of the collapsed areas of the temple wall included intact Ptolemaic ceramics dating to between the 3rd and 2nd century BC. It appears that the wall 'moved' southwards following a landslide due to an earthquake and/or soil liquefaction.

[113] Meadows forthcoming.

transfer, extorted a huge sum from the citizens of Thonis-Heracleion to leave the *emporion* there.[114] Following payment of this bribe, he returned again to demand even more and knowing that they could not pay such a stupendous sum the transfer was made, which condemned Thonis-Heracleion to slowly recede into economic background as the trade that was formerly its lifeblood was switched to Alexandria.

By the time of the partial destruction of the temple of Amun of the Gereb, the decline in the commercial activity in city is clearly evident. The ceramics from this period are not characteristic of a large commercial centre, rather they are for local use and were mostly locally made and not of a particularly good quality. A comparison of this with the contemporary material from Alexandria is striking, where there is evidence of a thriving trading economy characterised by the presence of imported materials, such as Italian *sigillata* vessels.[115]

The place of the port of Thonis-Heracleion was further marginalised in the local and regional transport network of river channels and canals. In the early canal network it would appear that the important city of Canopus and the western Delta was linked to the Nile via the port of Thonis-Heracleion.[116] While this canal was later extended to Alexandria, offering an inland route between the two ports, the major Alexandria canal, which leads from the *kibotos* in the western harbour to the Nile, made its connection further up river at Schedia. Here a Ptolemaic-Roman city functioned as a customs harbour for goods moving through it from both directions, which effectively cut Thonis-Heracleion off from the major movements of cargo into and out of the Nile.[117] Within this it is interesting to note that the site of Schedia offers almost a mirror image of that of Thonis-Heracleion with a substantial increase in production and storage facilities at the time that the coastal port fell into decline.

**(H3) Institutional effects 2: the continuation of religion**
Initially, it would appear that the city of Thonis-Heracleion retained some power and influence in the Ptolemaic period despite the decline in its economic fortunes. For example, a gold plaque inscribed in Greek denotes that Ptolemy III had founded – or renovated – a gymnasium to Herakles.[118] While the largest monument from the site, the 6 m high bilingual Stele of Ptolemy VIII was set up sometime after 118 BC, which reiterates the rights of the priests to revenue and a right to asylum.[119] It is likely that this continued interest in the site was due to the importance of the temple of Amun of the Gereb as the place of the celebration of the rite of dynastic continuity. It was to this temple that new Ptolemaic rulers would come in order for their role and therefore their power to be legitimised, which as a foreign dynasty would have been of particular importance for the Lagids.[120]

This role, however, did not outlast the Ptolemaic dynasty following its fall from power with the death of Cleopatra VII and the incorporation of the country into the Roman empire. Indeed, it is not clear whether later Ptolemaic rulers would have come to

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[114] Pseudo-Aristotle, Oeconomica 2.33e
[115] Grataloup in preparation.
[116] Goddio 2010.
[117] Bernand 1970, 406-431; Rougé 1987; Clauss 2005, 297-328.
[118] Yoyotte / Clauss 2008
[119] Thiers 2008; Thiers 2009.
[120] Goddio forthcoming

Heracleion for this ceremony, particularly following the partial destruction of the temple in the mid-2nd century. What is certain though is that the victorious Octavian would have had no desire to be crowned king of Egypt – having fought a long and vicious publicity campaign against Mark Antony and Cleopatra and being wary of the dangers associated with kingship in Roman society – and thus for him, as much as for successive emperors, there was no political or religious requirement for a temple to dynastic continuity and the Temple of Amun of the Gereb was evidently erased from the religious landscape of Roman Egypt.

Beset by environmental difficulties and shorn of its place within the political, economic and religious networks that formerly sustained it, Thonis-Heracleion fell into a terminal decline and ceased to exist as a centre of any real size. Thus by the time of its final destruction in the middle of the eight century AD, only a small community of nuns lived amongst the ruins of a once great city.[121]

**(H2) Conclusions**
This paper has illustrated the life cycle – the rise and the fall – of a seaport. For Thonis-Heracleion, while its environmental location may have been suitable for the development of a port, it took the social and economic development of the north-western Nile Delta and in particular the rise to power of the Saïte dynasty for this potential to be realised. For the Saïtes, accesses to the sea was imperative for their regime as it provided both the mercenary soldiers and sailors who secured their continued power and also the trade, the taxes from which helped to fund the expansion of the military. Consequently, it was through the agency of the institutions of Saïte power that Thonis-Heracleion rose to prominence.

Ports though do not simply exist in a vacuum but as nodes within larger and more complex maritime networks. For Thonis-Heracleion, its location on the western Canopic branch of the Nile was critical as it was this branch of the waterway that was most conveniently located facing the Aegean and central Mediterranean. It was the ports of Corinth and Miletus and elsewhere in the burgeoning maritime networks of the Greeks towards which Thonis-Heracleion looked and it was into these networks that the Saïtes wished to place themselves.

The paper has also offered a vision of what happens when maritime networks adapt to changing socio-political and economic circumstances. The foundation of Alexandria and the reorientation of the political and economic networks onto it, simply removes Thonis-Heracleion as a node from the trading networks, which resulted in a collapse in its local economy and the end of it as an *emporion*. The temple continued to function, albeit it without out its economic role, due to its place within the religious network and it may well have been possible for the city to have survived as a religious centre under continuing Royal patronage. Yet with removal from power of the Ptolemies, the temple of Amun of the Gereb did not fit ideologically within the new religious landscape of the Roman period, from which it is likely that the institutions of the new regime officially removed it.

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[121] Sophronius, Laudes in SS. Cyrum et Iohannem 29; Bernand 1970, 215; Goddio 2007, 3.

Cut adrift from its networks, Thonis-Heracleion simply returned full-circle, back to a *hone* at the edge of the Sea of the Greeks, albeit one littered with the ruins of a once-great past.

**Bibliography**

Basch 1969: L. Basch, Phoenician Oared Ships. Mariner's Mirror 55 (2), 1969, 139-162.

Belov forthcoming: A. Belov, Archaeological evidence for Egyptian *baris* (Herodotus 2.96). In: D. Robinson / F. Goddio (eds.), Thonis-Heracleion in context: the maritime economy of the Egyptian Late Period, Oxford Centre for Maritime Archaeology Monograph (Oxford forthcoming).

Bernand 1970: A. Bernand, Le Delta Égyptien d'après les texts Grecs. Les confines Libyques, Mémoires publiés par les members de l'Institut Français d'archéologue orientale 91 (Cairo 1970).

Bomhard 2012: A.-S. von Bomhard, The Decree of Saïs, Oxford Centre for Maritime Archaeology Monograph 7 (Oxford 2012).

Briant / Descat 1998: P. Briant / R. Descat, R. Un registre douanier de la satrapie d'Égypte à l'époque achéménide (TAD C 3, 7). In : N. Grimal / B. Menu (eds.), Le commerce en Égypte ancienne, Bibliothèque d'Étude 121 (Cairo 1998) 59-104.

Broodbank 2013: C. Broodbank, The Making of the Middle Sea – A History of the Mediterranean from the Beginning to the Emergence of the Classical World (London 2013).

Carrez-Maratray 2005: J.-Y. Carrez-Maratray, Réflexions sur l'accès des Grecs au littoral égyptien aux époques saïte et perse. Topoï 12-13, 2005, 193-205.

Chuvin / Yoyotte 1983: P. Chuvin / J. Yoyotte, Le delta du Nil au temps des pharaons. L'Histoire 54, 1983, 52-62.

Clauss 2005: M. Clauss, *Claustra Aegypti*. Alexandria und seine Häfen. *Millennium-Studien* 2, 2005, 297-328.

Cooper 2011: J. P. Cooper, No Easy Option: The Nile Versus the Red Sea in Ancient and Medieval North-South Navigation. In: W. V. Harris / K. Iara (eds.), Maritime Technology in the Ancient Economy: Ship Design and Navigation, Journal of Roman Archaeology Supplementary Series 84 (Portsmouth, RI, 2011) 189–210.

Cooper 2012a: J. P. Cooper, "Fear God; Fear the Bogaze": The Nile Mouths and the Navigational Landscape of the Medieval Nile Delta, Egypt'. Al-Masaq: Islam and the Medieval Mediterranean 24 (1), 2012, 53–73.

Cooper 2012b: J. P. Cooper, Nile Navigation: 'towing all day, punting for hours'. Egyptian Archaeology 41, Autumn 2012, 25-27.

Defernez 2003: C. Defernez, La céramique d'époque perse à Tell El-Herr, Étude chrono-typologique et comparative, CRIPEL suppl. 5 (Lille 2003).

Drijvers 1999: J. W. Drijvers, Strabo 17.1.18 (810C): Inaros, this Milesians and Naucratis. Mnemosyne Fourth Series 52 (1), 1999, 16-22.

Fabre 2004: D. Fabre, Seafaring in Ancient Egypt (London 2004).

Fabre 2008: D. Fabre, Heracleion-Thonis: Customs Station and Emporium. In: F. Goddio / D. Fabre (eds.), Egypt's Sunken Treasures (Munich 2008) 219-234.

Fabre 2011: D. Fabre, The Shipwrecks of Heralceion-Thonis: a preliminary study. In: D. Robinson / A. Wilson (eds.), Maritime Archaeology and Ancient Trade in the Mediterranean, Oxford Centre for Maritime Archaeology Monograph 6 (Oxford 2011) 13-32.

Fabre 2014: D. Fabre, "Tous ceux qui ont élevé un sanctuaire à Zeus thébain (…) considèrent les béliers comme sacrés": http://www.ieasm.org/downloads/IEASM_religion_Belier_Amon_df.pdf

Fabre forthcoming: D. Fabre, The shipwrecks of Thonis-Heracleion in context. In: D. Robinson / F. Goddio (eds.), Thonis-Heracleion in context: the maritime economy of the Egyptian Late Period, Oxford Centre for Maritime Archaeology Monograph (Oxford forthcoming).

Fabre / Belov 2012: D. Fabre / A. Belov, The shipwrecks of Heracleion-Thonis (Egypt). An Overview. In: G. A. Belova (ed.) Achievements and Problems of Modern Egyptology, Proceedings of the International Conference held in Moscow on September 29 - October 2, 2009, Russian Academy of Sciences, Center for Egyptological Studies (Moscow 2012) 108-120.

Fabre / Goddio 2012: D. Fabre / F. Goddio, Une statuette chypriote découverte à Thônis-Héracléion'. In: Studies dedicated to Professor Zsolt Kiss, Études et Travaux 25 (Warsaw 2012) 82-101.

Goddio 2010: F. Goddio, Geophysical Survey in the Submerged Canopic Region. In: D. Robinson / A. Wilson (eds.), Alexandria and the North-Western Delta, Oxford Centre for Maritime Archaeology Monograph 5 (Oxford 2010) 3-13.

Goddio 2007: F. Goddio, Topography and Excavation of Heracleion-Thonis and East Canopus (1996-2006). Underwater Archaeology in the Canopic Region in Egypt, Oxford Centre for Maritime Archaeology Monograph 1 (Oxford 2007).

Goddio 2008: F. Goddio, Rediscovered Sites. In. F. Goddio / D. Fabre (eds.), Egypt's Sunken Treasures (Munich 2008) 26-48.

Goddio forthcoming: F. Goddio, The Sacred Topography of Thonis-Heracleion. In: D. Robinson / F. Goddio (eds.), Thonis-Heracleion in context: the maritime economy of the Egyptian Late Period, Oxford Centre for Maritime Archaeology Monograph (Oxford forthcoming).

Goddio / Fabre 2008: F. Goddio / D. Fabre (eds.), Egypt's Sunken Treasures (Munich 2008).

Grataloup 2008: C. Grataloup, Daily Life in the Canopic Region. In: F. Goddio / D. Fabre (eds.), Egypt's Sunken Treasures (Munich 2008) 246-255.

Grataloup 2010: C. Grataloup, Occupation and Trade at Heracleion-Thonis. The Evidence from the Pottery. In: D. Robinson / A. Wilson (eds.), Alexandria and the North-Western Delta, Oxford Centre for Maritime Archaeology Monograph 5 (Oxford 2010) 151-159.

Grataloup in preparation: C. Grataloup, Thonis-Heracleion: The Pottery. A preliminary typological and chronological study from the Saïte to the Ptolemaic Period, Oxford Centre for Maritime Archaeology Monograph (Oxford in preparation).

Höckmann 2008-9: O. Höckmann, Griechischer Seeverkehr mit dem archaischen Naukratis in Ägypten. Talanta XL-XLI, 2008/2009, 73-135.

Höckmann 2011: U. Höckmann, Heracleion, Herakles and Naukratis. In: D. Robinson / A. Wilson (eds.), Alexandria and the North-Western Delta, Oxford Centre for Maritime Archaeology Monograph 5 (Oxford 2010) 27-36.

Horden / Purcell 2000: P. Horden / N. Purcell, The Corrupting Sea – A Study of Mediterranean History (Oxford 2000).

James 1992: T. G. H. JamesEgypt: the Twenty-fifth and Twenty-sixth Dynasties. In: J. Boardman / I. E. S. Edwards / N. G. L. Hammond / E. Sollberger (eds.), The Assyrian and Babylonian Empires and Other States of the Near East, from the Eight to the Sixth Centuries B.C., The Cambridge Ancient History, Volume 3, 2nd Edition (Cambridge 1992) 677-747.

Jomard 1809-28: E. F. Jomard, Description de l'Égypte, ou Recueil des observations et des recherches qui ont été faites en Égypte pendent l'expédition de l'armée française, publié par les orders de Sa Magesté l'Empereur Napoléon le Grand (Paris 1809-1828).

Knappett 2011: C. Knappett, An Archaeology of Interaction: Network Perspectives on Material Culture and Society (Oxford 2011).

Knappett 2013: C. Knappett (ed.), Network Analysis in Archaeology – New Approaches to Regional Interaction (Oxford 2013).

Lloyd 1972: A. B. Lloyd, Triremes and the Saïte Navy. Journal of Egyptian Archaeology 58, 1972, 268-279.

Lloyd 2000: A. B. Lloyd, The Late Period (664-332 BC). In: I. Shaw (ed.), The Oxford History of Ancient Egypt (Oxford 2000) 369-394.

Malkin 2011: I. Malkin, A Small Greek World: Networks and the Ancient Mediterranean (Oxford 2011).

Malkin / Constantakopoulou / Panagopoulou 2009: I. Malkin / C. Constantakopoulou / K. Panagopoulou (eds.), Greek and Roman Networks in the Mediterranean (London 2009).

Meadows 2008: A. Meadows. In: F. Goddio / D. Fabre (eds.), Egypt's Sunken Treasures (Munich 2008) no. 435, 436.

Meadows 2011: A. M. Meadows, Athenian Coin Dies from Egypt: The New Discovery at Herakleion. Revue Belge de Numismatique et de Sigillographie CLVII, 2011, 95-116.

Meadows forthcoming: A. M. Meadows, Coin circulation and coin production at Thonis-Heracleion and in the Delta region in the Late Period. In: D. Robinson / F. Goddio (eds.), Thonis-Heracleion in context: the maritime economy of the Egyptian Late Period, Oxford Centre for Maritime Archaeology Monograph (Oxford forthcoming).

Pfeiffer 2011: S. Pfeiffer, Naukratis, Heracleion-Thonis and Alexandria: Remarks on the Presence and Trade? Activities of Greeks in the North-West Delta from the Seventh Century BC to the End of the Fourth Century BC. In: D. Robinson / A. Wilson (eds.), Alexandria and the North-Western Delta, Oxford Centre for Maritime Archaeology Monograph 5 (Oxford 2010) 17-26.

Posener 1947: G. Posener, Les douanes de la Méditeranée dans l'Égypte Saïte. Revue de Philologie 21 (2), 1947, 117-131.

Robinson forthcoming a: D. Robinson, Ship 43 and the formation of the ship graveyard in the central basin at Thonis-Heracleion. In: D. Robinson / F. Goddio (eds.), Thonis-Heracleion in context: the maritime economy of the Egyptian Late Period, Oxford Centre for Maritime Archaeology Monograph (Oxford forthcoming).

Robinson forthcoming b: D. Robinson, Some Initial Observations on Ship 43 from Thonis-Heralceion, Egypt. British Museum Studies in Ancient Egypt and Sudan (forthcoming).

Rougé 1987: J. Rougé, Emporion nomimon. Reserches sur la terminologie du Périple de la mer Erythrée. Camerti di Studi Romanistici, International Survey of Roman Law 15, 1987, 405-412.

Sekunda 2008: N. Sekunda. In: F. Goddio / D. Fabre (eds.), Egypt's Sunken Treasures (Munich 2008).

Sindbæk 2007: S. Sindbæk, The Small World of the Vikings. Networks in Early Medieval Communication and Exchange. Norwegian Archaeological Review 40 (1), 2007, 59-74.

Stanley / Warne 2007: J.-D. Stanley / A. G. Warne, Nile Delta Geography at the Time of Heracleion and East Canopus. In: J.-D. Stanley (ed.), Geoarchaeology, Oxford Centre for Maritime Archaeology Monograph 2 (Oxford 2007) 5-22.

Taylor 2000: J. Taylor, The Third Intermediate Period (1069-664 BC). In: I. Shaw (ed.), The Oxford History of Ancient Egypt (Oxford 2000) 330-368.

Thiers 2008: C. Thiers, Underlining the Good Deeds of a Ruler – The Stele of Ptolemy VIII. In: F. Goddio / D. Fabre (eds.), Egypt's Sunken Treasures (Munich 2008) 134-137.

Thiers 2009: C. Thiers, La stèle de Ptolémée VIII Évergète II à Héracléion, Oxford Centre for Maritime Archaeology Monograph 4 (Oxford 2009).

Tresson 1922: P. Tresson, La Stèle de Koubân, Bibliothèque d'Étude 9 (Cairo 1922).

Yardeni 1994: A. Yardeni, Maritime Trade and Royal Accountancy in an Erased Customs Account from 475 BCE on the Aḥiqar Scroll from Elephantine. Bulletin of the American School of Oriental Research 293, 1994, 67–78.

Yoyotte 1958: J. Yoyotte, Notes de toponymie égyptienne. In: Festschrift zum 80. Geburtstag von Professor Dr. Hermann Junker. Mitteilungen des Deutschen Archäologischen Instituts, Abt. Kairo 16 (Cairo 1958) 414-430.

Yoyotte 2001: J. Yoyotte. Le second affichage du décret de l'an 2 de Nekhtnebef et la découverte de Thônis-Héracleion. Égypte, Afrique & Orient 24, 2001, 24-34.

Yoyotte 2004: J. Yoyotte, Les trouvailles épigraphiques de l'institute européen d'archéologie sous-marine dans la baie d'Abû Qîr'. Bulletin de la Société Française d'Egyptologie 159, 2004, 29-35.

Yoyotte 2008a: J. Yoyotte, Stele of Thonis-Heracleion. In: F. Goddio / D. Fabre (eds.), Egypt's Sunken Treasures (Munich 2008) 236-240.

Yoyotte 2008b: J. Yoyotte, Naos of the Temple of Amun-Gereb. In: F. Goddio / D. Fabre (eds.), Egypt's Sunken Treasures (Munich 2008) 309.

Yoyotte / Clauss 2008: J. Yoyotte / M. Clauss, Gold for the House of the Gods – Ptolemy III Foundation Plaque. In: F. Goddio / D. Fabre (eds.), Egypt's Sunken Treasures (Munich 2008) 140-143.
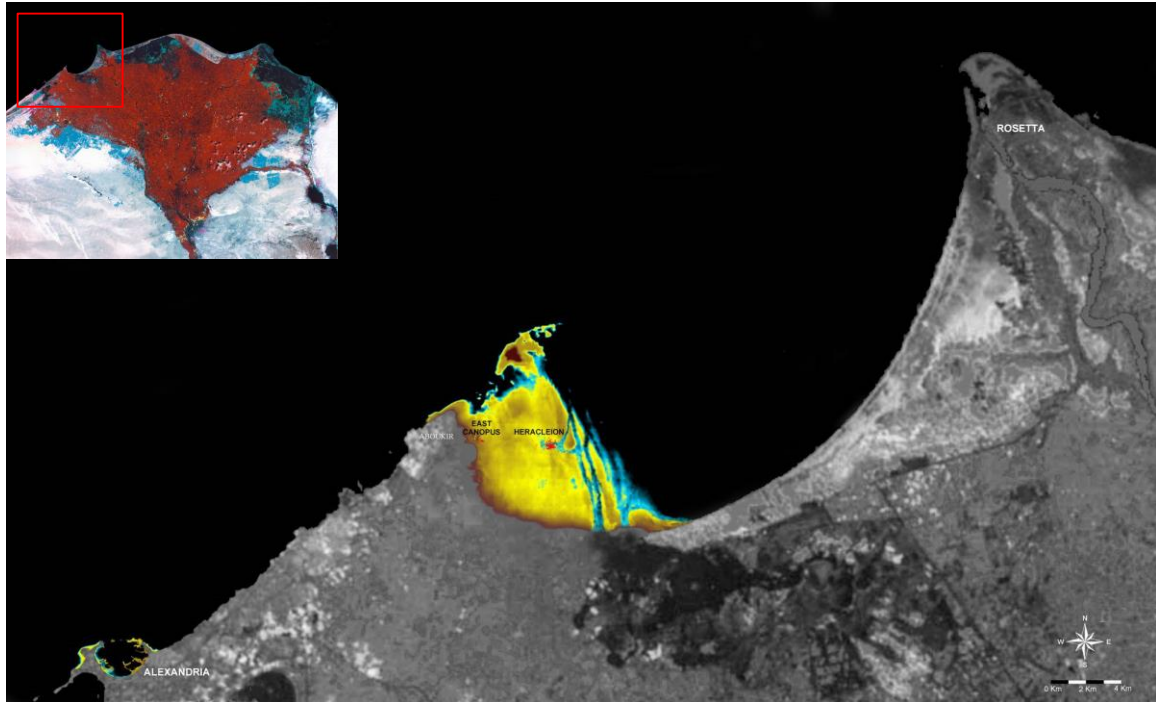
Figure 1: The Bay of Aboukir and the location of Thonis-Heracleion. Image IEASM © Franck Goddio / Hilti Foundation.
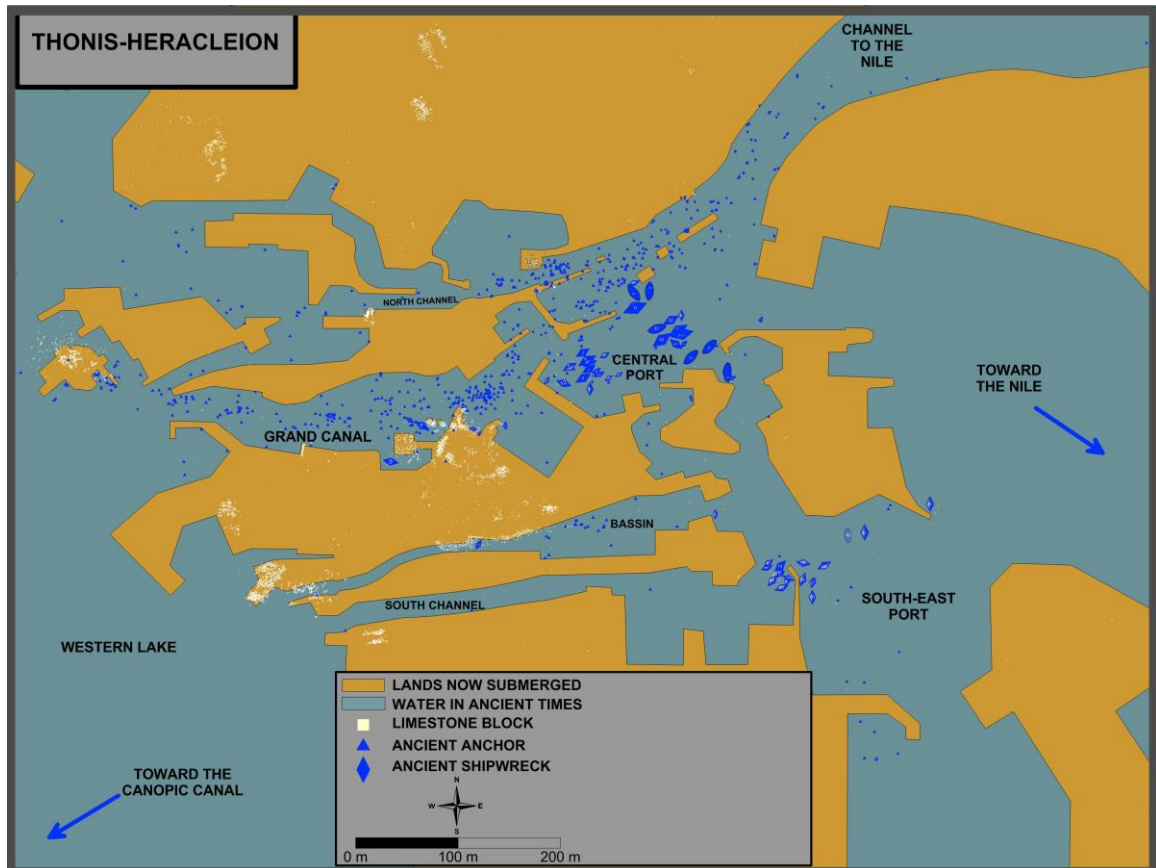


Figure 2: The topography of Thonis-Heracleion. Image IEASM © Franck Goddio / Hilti Foundation.

Figure 3: Finds of Greek military equipment from Thonis-Heracleion (spear butts, sling bullets and a Chalcidian helmet[122]). Photographs C. Gerigk © Franck Goddio / Hilti Foundation.

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[122] Sekunda 2008, 336 cat no. 307; 337 cat nos. 311-313; 342 cat no. 356.

Figure 4: The Thonis-Heracleion Stele. Photograph C. Gerigk © Franck Goddio / Hilti Foundation.

**Mediterranean Byzantine ports and harbours in the complex interplay between environment and society**
**Spatial, socio-economic and cultural considerations based on archaeological evidence from Greece, Cyprus and Asia Minor**

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Throughout the history of Byzantium, ports and harbours provided a frontline service in the administrative, military and economic chain which linked the different parts of the empire as well as linking the empire with the rest of the known world. Whether for levying taxes, military dispatches, private and official state correspondence or staple commodities, the most efficient form of long-distance communication – from as far back as antiquity − involved passage through coastal gateways. It is therefore surprising that Byzantine Archaeology has long been facing a serious problem in tracing the actual material remains of these ports and harbours. Given the volume of maritime trade in Byzantium from the fourth to the fifteenth century, the archaeological evidence of harbour construction and refurbishments during this period is relatively scarce.[123]

In this study I intend to show that this problem has two dimensions: one real and one circumstantial. The reality of the problem has been revealed beyond any doubt by the recent unearthing of the Theodosius harbour of Constantinople at Yenikapi. This accidental discovery made clear the size of the environmental transformation on the coastline of the Eastern Mediterranean, especially around river deltas, as well as how much archaeological effort is required in order to locate and investigate Byzantine harbours.[124] As Robert Vann has shown:

> "harbors, by necessity at the edge of land and water, suffer the depredations of both environments. Continuous winter storms batter the breakwaters and associated structures at the same time that basins and channels become clogged with silt. Thus the south breakwater at Korykos port, that is thought to have once joined the mainland and the Sea Castle, is gone and the harbour at Sebaste is now landlocked. Second is the nature of construction. Many breakwaters built of rubble are poorly preserved and while large portions of concrete breakwaters such as that at Pompeiopolis might remain, other harbor structures on land have disappeared because their building materials were convenient to reuse. Third, several of these harbors will be difficult to investigate in the future because they continue to be used as anchorages today. In some instances, such as at Antalya (Coraceseum) and Aydmiak (Celenderis), new breakwaters have been built on or near the old ones. Finally, even where large excavations have been in the field, such as at Anemourion, an elusive harbor might be an expensive objective when so many other priorities exist."[125]

On the other hand, a great help in our search for Byzantine ports is just knowing their place-names from Byzantine texts; this should normally facilitate archaeological

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[123] Much of the available evidence will be discussed further in this study. For late antique sites see the brief account by Kingsley 2001; for Byzantine sites see Vann 1998. Some of the ancient Greek harbours surveyed by researchers of the National Technical University of Athens have been also found to have remained in use in late antiquity and the early middle ages (Memos et al. 2014). The European Project NAVIS II also provides some sporadic information about harbours in late antiquity and the middle ages (Navis II).
[124] Pulak 2010.
[125] Vann 1998, 80-81.

research. Indeed, the sources have provided us with a great number of Byzantine names for places which are defined by the authors as λιμήν, ἐπίνειον or κατάβολος, ἐμπόριον, ὅρμος, σκάλα, ἀρσανάς.[126]  At this point the second, circumstantial dimension of the problem of 'missing' ports arises. Tasha Voderstrasse has recently discussed the challenges faced by historical archaeology in related issues: the texts can be both helpful and misleading, since they can affect the archaeological tasks of find-interpretation and site-reconstruction.[127] The Byzantine texts do indeed provide us with more or less detailed representations of the natural and built environments in the aforementioned ports, harbours and anchorage sites.[128] However, as Sean Kingsley has argued, "a fundamental reason for the absence of late-antique (and Byzantine) harbour installations, which seems surprising to the modern mind, is the disparity between modern and ancient definitions of a port. Contemporary definitions emphasize the indispensable requirement for artificial installations, which ease the movement of cargoes onto shore within a calm body of sheltered water. (...) Such definitions [or rather representations] have been applied inappropriately to ancient ports."[129] Kingsley cites a first-century nautical guide in order to demonstrate that a Roman port is defined as loosely as a maritime settlement where merchandise is traded, and a harbour appears simply as a geographical point where a ship can anchor.[130] Indeed, neither of the aforementioned terms found in Byzantine texts was specifically synonymous with artificial maritime structures which would provide striking archaeological finds. The λιμήν would mean a port; the ἐπίνειον or κατάβολος a satellite harbour or town; ἐμπόριον a commercial centre; ὅρμος (ὀρμίσκος) would mean a bay or natural harbour, defined either as a natural embayment suitable for mooring or a cove enclosed by headlands, or as the internal basin of a harbour; σκάλα stood for an anchorage and ἀρσανάς for a small anchorage.[131]

Given the aforementioned diversity of Byzantine anchorage sites and regardless of the existence or the nature of accompanying settlement, I will investigate the notions of ports and harbours in Byzantium by examining the history of such sites within the context of the complex interplay between environment and society. Aspects of this investigation refer, for example, to the criteria used by the Byzantines for the selection of ports' and harbours' locations, their construction and maintenance practices, as well as the meaning of different components and features of ports and harbours in different periods. The investigation is based on a discussion of several features of archaeological sites at Byzantine ports and harbours in the Eastern Mediterranean, dated to between the fourth and ninth centuries and located in modern Greece and Turkey (the locations of all the archaeological sites mentioned in the text are shown in **Fig. 6**). This discussion has three aspects as follows. First of all, my main aim is to define the ways in which specific physical and social features of these sites determined – and emerged from – their role in land and maritime networks. Secondly, in a similar vein, I focus on three multidisciplinary factors that are not only interrelated in the development of ports and harbours but also fundamental in shaping their history: geomorphology, geography, and human geography. Last but not least, I comment on the physical, economic, political

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[126] For an account of ports and harbours known from Byzantine texts see: Koder 2005, 104-5; Gkagktsis / Leontsini / Panopoulou 1993; Koder 1993; Malamut 1988, 536-561; Avramea 2002, 77-88; Gerolymatou 2008, 90-183, 272-278.
[127] Voderstrasse 2010, 15-26.
[128] Maria Gerolymatou (2008, 272-278) provides an ample account.
[129] Kingsley 2001, 85.
[130] Ibidem
[131] Kingsley 2001, 85; Gerolymatou 2008, 272-278; Koder 2005, 103-4.

and cultural conditions which add up to the analytical categories of the medieval Mediterranean port and harbour, putting on the table a few ideas about the way these sites performed as Byzantine "gateway communities", fostering social contact and cross-cultural exchanges.

### <H1> Byzantine ports and harbours: ancient and newer

Elements of the antique way of life were inherited and adjusted to late antique and medieval conditions in the eastern Mediterranean and ports are no exception to this. By the mid-fifth century a large number of coastal cities operated within a dense network of Byzantine civic settlements. The former would have been the late antique ports with built harbours equipped with appropriate amenities to host the subjects and products involved in maritime trade. Some built harbours of older Roman ports are indeed known to have been refurbished during the first centuries of Byzantium. One example from Greece is the great port of Neapolis and later Chrysoupolis (modern Kavala, in Greece) which gained importance due to its proximity to the Via Egnatia.  Some repairs dated to between the third and the sixth century have been observed at the gate leading from the harbour to the settlement through the sea walls and along them.[132] Other port constructions dated somewhat later (sixth–seventh century) are known from Anthedon in Central Greece, as well as from sites in Byzantine provinces not included in this study.[133]

Apart, however, from the antique ports, which continued to be used in similar ways after antiquity, the emergence of a number of other coastal sites indicates what seems to be a pattern of natural, economic, political and cultural conditions which add up to the analytical categories of Byzantine port and harbour within the medieval eastern Mediterranean. I will now discuss some of the principal traits of these patterns which are related to the three aforementioned, interrelated factors in the development and history of ports and harbours, i.e. geomorphology, geography, and human geography.[134]

### <H1> Interrelated factors in the development and history of ports and harbours

#### <H2> Geomorphology

Geomorphology is the first of the factors related to the development and history of ports and harbours. It involves the natural aspect of the port and its physical setting. It had the greatest impact on the foundation and evolution of a port because the limited technological resources of the time were insufficient to offset or modify natural settings to any great extent. Consequently, sites that offered favourable natural conditions seem to have been preferred to others. The geomorphological characteristics that turn out to have been necessary for the successful development of a port can be summarized as:

1) presence of a sandy beach for loading, unloading, and dockyard activities;

2) protection offered by a promontory or rocky area, including protection from marine currents and coastal winds, but also as a defence from enemy attack, because a

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[132] Dakari / Bakirtzis / Karabasis 2008, 13.
[133] Blackman / Schäfer / Schläger 1967, 12-17; Blackman / Schäfer / Schläger 1968; Theodoulou 2014a. For the evidence of Early Byzantine repairs to the harbours of Caesaria Maritima and Dor, Sarepta in Lebanon and Marea in Egypt see the brief account by Kingsley 2001, 81 (litterature); Vann 1998; Hohlfelder 2000.
[134] Orvientani Busch 2001, 255.

hilly promontory was suitable for fortification and provided a lookout (**figs. 4, 5.a-d**); and

3) the mouth of a river or smaller watercourse to provide fresh water for the settlement and sailors and to serve as an easy route for communication with the interior (**figs. 1-3, 5.a-d, 6**).[135]

Most Byzantine ports shared all these geomorphological features. They were certainly located on sandy beaches rather than a rocky seabed. Whenever possible and in order to ensure maximal protection from bad weather conditions, they comprised double bays (i.e. two anchorages at either side of an isthmus) (**fig. 4**),[136] or complexes of bays and nearby islets to serve as breakwaters (**fig. 5.d**).[137] For the same purpose it was also common for several other auxiliary points of anchorage (sometimes even on rock) to be used in addition to the main port, depending on weather conditions (**figs. 2, 5.a-d**).[138] Last but not least, some Byzantine harbours were noted for their sweet and healthy drinking water.[139]

A fourth condition was also often present, sometimes connected to a major river or at other times substituting for it: coastal wetlands and lagoons that could be used as docking basins and fisheries and serve as connections to the sea,[140] as in the cases of settlements on Strymon, Louros and Arachthos Rivers (**fig. 1**) as well as Miletus (**fig.**

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[135] Orvientani Busch 2001, 255.

[136] Double-bay complexes are found for example in Dor (Kingsley 2001, 71-75), in Salamis-Constantia (Raban 1995; Karageorghis 1969; Flemming 1974), Amastris (Crow / Hill 1995, 256); Aphrodisias (Vann 1998, 83), Mytilene in Lesbos (Kourtzelis / Theodoulou 2014) and Monemvasia (Kalligas 2002, 879-880). In this case, either one of the bays served as the main basin and the other as an anchorage (e.g. Monemvasia, fig. 4) or both bays might be used simultaneously for different purposes (e.g. one for the navy and the other for merchants, as at Amastris) or each bay was used at different periods according to the problems created by silting (e.g. in Salamis-Constantia). See also n. 16 below on the port of Thessaloniki.

[137] This pattern is found in the combination of Dolichiste (mod. Kekova) with the gulf of Tristomo in Lycia (Foss 1994, 18-21), at the coastal settlement with two islets at Göl, Halicarnassus peninsula (Foss 1988, 171 f.), at Fygela, Caria (Foss 1979, 123), at Agios Georgios near Pegeia, Cyprus, discussed in detail below (fig. 5.d.) as well as at Dor (Kingsley 2001, 73-74).

[138] Apart from the multiple harbours and anchorages known from Byzantine texts to have been offered by the Byzantine capital Constantinople (Magdalino 2007; Gerolymatou 2008, passim), this is also known in the cases of the ports of Monemvasia (fig. 4) (Kalligas 2002, 879-880) and Amathous, where the nearby anchorage at Maroni-Vrysoudhia seems to have served mostly for the distribution of produce from the countryside (Rautman 2004, 198; Rautman 200, 325) and Thessaloniki. The latter, in particular, being located on the coast of the extensive Thermaic Gulf, had the advantage of having in fact three different ports and several anchorages within the same gulf (fig. 2) (Bakirtzis 2007, 95) 'of which the main was created by Constantine the Great in the south-west corner of the city (Bakirtzis 1975, 315-320; Bakirtzi 2007, 94). The harbour facilities comprised a dockyard, the state granaries and the custom services supervised by the *kommerkiarioi* or *avydikoi* (Bakirtzis 2007, 94-95). This main harbour also served as a naval port and for that reason it was closed to some categories of ships and was surrounded by fortifications preventing free circulation (Bakirtzis 2007, 95). However, there were another two harbours called *Ekklesiastiki Skala* and *Kellarion* respectively (fig. 2) (Ibidem; Bakirtzis 1997). The first was in the most southerly corner of the city, on the site of the Roman harbour that had served as the palace of Galerius and the fact that it was termed ecclesiastical and differentiated from the main harbour suggests that it was used exclusively by the Church of Thessalonike and probably exempt from the normal customs procedures (ibid.). On this side the Thermaic Gulf formed a number of coves suitable for landing-stages for sailors and passengers for short-distance trade within the Gulf, fishing anchorages and market-places (ibid.).

[139] This seems to be the case of the natural harbour of Strobilos in Lycia, mentioned in the Middle-Byzantine and later sources, which Clive Foss has identified with Aspat Castle (Foss 1988, esp. 176).

[140] Orvientani Busch 2001, 255.

**3.a.).**[141] In these cases, there were no built harbours but just *skalai*, whose Byzantine connotations did not include permanent infrastructure – rafts solved the problem of communications with the interior, as on all the great rivers of the southern Balkans.[142]

Unfortunately, most places that offered all four of the characteristics mentioned above were, for the same reasons, locked into a delicate geomorphological balance. In other words, the harbour and nearby land or wetlands were subject to the damaging effects of siltation due to the same natural forces that had created some of the favourable conditions in the first place.[143] Countermeasures involved either:

a) controlling the water level by efforts to remove alluvial deposits so as to artificially prevent the harbour from silting-up, as for example in Nafpaktos,[144] or

b) moving port activities to a more recently exploited part of the coastline like in Constantinople and Ephesos, for example, where different harbours succeeded one another at different times,[145] or

c) relocating the settlements to adjust to changes of the riverbed such as to the east and west river-channels of the River Strymon in the case of settlements around Amphipolis and Chryssoupolis[146] and perhaps also in the case of Eressos on Lesvos,[147] or

d) eventually abandoning the settlements all together, as in the case of Salamis-Constantia in Cyprus and Herakleia at Latmos in Asia Minor,[148] or

e) controlling the wetlands by creating artificial drainage channels and diverting the course of the river (as in the cases of Rogoi on Louros (**fig. 1**), and also of Strymon and Demetrias)[149] so as to create access to the old silted harbours like in Ephesos (**fig. 3.b.**) and perhaps Latros.[150]

Nevertheless, it seems that the Byzantines may have been cautious not to overdo it. In his description of the harbour settlement of Demetrias Kekaumenos described how the wetlands around the city served as a major protection for the inhabitants, equal to the sea.[151] Aggradation is a great constant of Mediterranean life; but, as Horden and Purcell suggested in their cutting-edge work *The Corrupting Sea,* "this cluster of processes must be seen in perspective: we must pursue 'mutual-caused processes of co-evolution of people and their landscapes' and 'recognize the futility of one-sided deterministic approaches in which certain factors are singled out as the sole explanation of complex, closely interwoven physical, biological and cultural processes.'"[152]

And there were, of course, exceptions to the rule of selecting port locations fulfilling the aforementioned four geomorphological criteria. Some strategically-selected port locations, albeit in geographically disadvantageous situations (such as standing at the head of bays exposed to the sea and isolated by rugged mountains from

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[141] Herda / Brückner / Müllenhoff 2009; Ragia 2009, 173-176 (lit.). The site of Βίγλα/Vigla or Φανάρι/ Phanari must have been one example of a secure, fortified embayment providing side anchorage to Byzantine Miletus (Ragia 2009, 144).
[142] Dunn 2009, 19.
[143] See discussion by Horden / Purcell 2000, 312-328.
[144] Veikou 2012, 36-37.
[145] Müller-Wiener 1961, 24, note 39; Foss 1979, 185-187; Ladstätter 2011, 11-12; Knoob / Pfarr / Grellert 2011, 245, fig. 5., Gerolymatou 2008, 129; Ragia 2009, 152.
[146] Dunn 2009.
[147] Schaus 1996; see also Kourtzelis / Theodoulou 2014.
[148] Raban 1995; Karageorghis 1969*;* Flemming 1974; Ragia 2009, 152.
[149] Jing / Rapp 2003, 182, 192, 198; Veikou 2012, 31-32, 477; Dunn 2009; Karagiorgou 2001, 197f.
[150] Ladstätter 2011, 11-12; Knoob, Pfarr, Grellert 2011; Bokotopoulos 1966/67, 73.
[151] Karagiorgou 2001, 210.
[152] Horden / Purcell 2000, 327.

easy access to the interior), were developed for economic reasons.[153] Other similarly apparently "uncomfortable" port locations were stopovers on important long-distance maritime routes along the Eastern Aegean and South-eastern Mediterranean, established for economic and military purposes (**fig. 6**).[154] In a few striking cases of such ports − like the long-lived Byzantine port of Monemvasia (**fig. 4**) − there was not even fresh water.

## <H2> Geography

In the Mediterranean the fragility of the port environment and the vulnerability of port settlements due to deltaic phenomena involving estuaries are an inevitable side-effect of their privileged geomorphology which allows them economic autarchy and surplus due to the presence of fertile estuarine plains. However, the aforementioned exceptions to the rule introduce us to the second factor in the development of a port: geography, meaning the relative geographical position of the harbour within the surrounding region. In his work "La Méditerranée et le monde méditerranéen à l'époque de Philippe II" Fernand Braudel described a common attribute of all Mediterranean ports: being located at the crossing of land- and sea-routes.[155] In fact, the strategic location of Byzantine ports (such as those of Constantinople, Thessaloniki (**fig. 2**), Durrës, Corinth, Platamon, Thessalian Thebes and Demetrias, Amastris, Ephesos (**fig. 3.b.**), Miletus (**fig. 3.a**), Myra, Limyra and many others) along not just sea routes but also inland and river routes connecting the ports with fertile hinterlands (**fig. 6**) is crucial, because it indicates both the area of production of goods exported by these ports and, conversely, the most distant markets reached by the merchandise arriving in the ports themselves.[156] Indeed it seems that long-distance maritime routes along the

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[153] For example, the port of Aperlae in Lycia seems to have flourished thanks to the trade of *murex trunculus* used for the production of purple dye (Hohlfelder / Vann 1998), just like at Dor (Kingsley 2001, 71-72). Bays along the Northern coast of the Northern Gulf of Corinth in Boeotia are likewise known to have been used for the same purpose in the same period (Dunn 2006); these ports seem to have been functioning as stopovers for intraregional − not interregional or long-distance − trade (Vroom 2004).

[154] This seems likely to have been the case at Monemvasia (Kalligas 2002) and Emporio on Chios (Balance 1955, 7). On these routes see Gerolymatou 2008, 122-123; Malamut 1988, 547-9; Avramea 2002, 77-88.

[155] Braudel 1966, I, 291.

[156] Constantinople's strategic location on the routes from East to West and North to South has already been discussed in various instances. The port of Thessaloniki was located in the deltaic area of four rivers (fig. 2), the Vardar (ancient Axios) and Gallikos (ancient Echedoros), extending as far as the Loudias lagoon and the River Loudias while Aliakmon River lay a little further to the west; it enjoyed the geopolitical advantages conferred by its position as a Balkan port communicating via the Aegean with the Black Sea and the Levant (Dimitriadis 1990; Bakirtzis 2007, 94). The port of Durrës linked the Adriatic Sea with the East via the Via Egnatia (Gerolymatou 2008, 141). The ports of Arta and Rogoi were located in the deltaic areas of two major river-routes to the Epirote hinterland, along the rivers of Louros and Arachthos (fig. 1). Corinth had two ports, Lechaion on the Northern Gulf of Corinth (for a summary of the available evidence see Theodoulou 2014b) and Kenchreai on the Saronic Gulf (Rife et al. 2007) allowing a settlement to operate at the junction of two major maritime routes linking the West with the East. The (as yet unidentified) port of the Byzantine settlement by the Castle of Platamon, which was eventually silted up by alluvial deposits, was also located in a strategic position, controlling the exit from the Tempe valley (connecting Macedonia with Thessaly and southern Greece) to the Aegean (Loverdou-Tsigarida et al. 2001; Loverdou-Tsigarida 2006). At Demetrias the Xerias River likewise linked the port with the fertile hinterland of Thessaly (Karagiorgou 2001, 184). The port of Limyra, Phoenix, was situated at the junction of two land routes running along river valleys to the hinterland (Foss 1994, 37); Joanita Vroom (2004) has shown that it definitely involved large-scale, long-distance trade, as demonstrated by the amounts of pottery imports from Cyprus, Egypt, SE Turkey and the Near East. The port of Myra, Andriace, was located near the delta of the Myros River connecting it with a

Eastern Aegean and South-eastern Mediterranean remained entirely or partly open during the Byzantine Period, as confirmed by both written sources and archaeological evidence such as the distribution of ceramics in that period, for instance.[157]

All of this defines the extent of the port's foreland, i.e. the overall maritime area served by the port. For instance, the professions mentioned in the 456 fifth- and sixth-century funerary inscriptions of Korykos, the main port in Cilicia, Asia Minor, allow for a reconstruction of everyday economic and social life in a Byzantine port whose prosperity is not related to a specific activity.[158] The individuals mentioned worked in two main fields of social life: a) as public and ecclesiastical officials and b) in maritime occupations. No merchants are mentioned with the exception of wine-importers, while a large number of industrial workshops reveal the dynamics of the local economy; a significant part of the population was also involved in food storage, preparation and sales. In fact the evidence reflects a combination of economic strategies, including the cultivation of grains, grapes, and olives, as well as horticulture, and the herding of sheep and goats, whose wool and skin were processed in Isaurian-Cilician cities and harbour settlements. The productivity of the port's immediate hinterland and the area's ease of communication with the harbour itself were fundamental elements in the port's initial establishment as well as its further development into a major port-city.[159]

## <H2> Human agency

In fact, ports and other harbours or anchorages qualify as "complex systems" as described in the introduction to this volume,[160] because they represent the process of constant adjustment of – maritime and fluvial − water-trade routes to environmental and social (political, economic, and cultural) conditions, as is evident in the ports of Leucas and Chrysoupolis in Greece and possibly also in Butrint. In the case of Leucas, the selection of the inner or outer maritime route depended equally on environmental and social conditions, i.e. the accessibility of the Dioryctos Channel depending on tidal phenomena but also the security of Ionian waters and the ship's final destination.[161] Similar tidal phenomena resulted in the profound transformation of settlement around Butrint; rearrangements of the settlement's access to the sea could perhaps even have caused the ninth-century relocation of the administrative centre from the fortified nucleus to Vrina Plain.[162] According to Archie Dunn, in this process "individual *loci* of maritime traffic were shifting in response to environmental change, but also gaining or losing in importance in response also to politico-administrative and economic changes."[163] This brings us to the third factor in the development of ports, i.e. to human geography. While geomorphology and geography allow humans to act, it is human agency that really profits (or not) from the opportunities offered by nature. Differences in the fate of Byzantine harbour settlements, then, can also be an outcome of their inhabitants' agency, which needs to be acknowledged as a cultural trait. A good example is that alongside surviving late antique port-cities, which – as such – were inevitably also centres of central administration, some anchorages (σκάλαι) with non-

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fertile hinterland (Foss 1994, 21). Miletus lay in the deltaic area of the Meander River and Ephesos in that of the Kaystros River, both connecting the Aegean coast with the fertile plains of the Anatolian hinterland and highways to the east (Ragia 2009, 173; Foss 1979, 3).

[157] Gerolymatou 2008, 123; Francois 2012.
[158] Iacomi 2010; Varinlioğlu 2011, 173f.
[159] Varinlioğlu 2011, 187.
[160] Preiser-Kapeller, Introduction to this volume.
[161] Veikou 2012, 37.
[162] Hodges et al. 1997, 211-212; Greenslade / Hodges 2013, 3.
[163] Dunn 2009, 19.

built harbours also developed into intra-regional and even inter-regional trade centres, as discussed below in some detail.

It seems that the role of ports was of vital importance to the settlements. The loss of that role due to environmental or political change proved fatal for some settlements, such as for Agios Georgios near Pegeia and Itanos in Crete, discussed below. In other cases, related phenomena reveal a very complex interplay between environment and society. For example, in Olympia, although the major alluvial crises in the area of the Slavic cemetery have been dated by Eric Fouache to after the seventh century, environmental change due to the alluvial processes linked to the River Alpheius must have been under way for quite a while.[164] Alluvial processes may well have caused a gradual change of land use from agricultural to pastoral perhaps even before the seventh century. This is implied by the differences in pattern between the two phases of Byzantine habitation, but should also be considered within the context of the rapidly changing demographic and political conditions in the area from the sixth century onwards. Similarly, in the case of the relocation of the lowland harbour settlement of Demetrias to the hilltop site of Iolkos, environmental change due to the silting up of the harbour cannot be ignored or underestimated by comparison with the defensive needs of the seventh-century bishopric considered by Olga Karagiorgou to have been the main cause of relocation.[165]

In other instances, people might well devote considerable resources and energy to maintaining and refurbishing harbours through the construction of more or less sophisticated installations, which archaeologists can usually now trace in ports where sedimentation is absent. First of all, stabilization works have been observed in the harbour of Aperlae in Lycia.[166] Harbour installations might range from modest constructions (like the simple, plain jetties identified in Aperlae and Leucas,[167] the plain stone docks at the promontory of Sıralık, by the Halicarnassos peninsula,[168] or the wooden ones in the main (northern) port of Monemvasia (**fig. 4**)[169] or even a mere handful of rubble walls and a pavement in Emporio on Chios (**fig. 5.a**) )[170] to sophisticated buildings (like the sixth-century granary at Andriace , the harbour of Myra[171] or the lighthouse which functioned at least until the thirteenth century in Monemvasia (**fig. 4**) ).[172]

Furthermore, the construction of breakwaters, in cases where natural ones (e.g. islets or promontories) were absent, seems to have been a primary concern. They were made of stone like those located in the Mikron Emvolon in Thessaloniki (identified by Charalambos Bakirtzis with the *Kellarion* anchorage, **fig. 2**),[173] or of wood as in Sebastos in Caesarea Maritima;[174] alternatively older Roman concrete constructions might have been still in use as in Korykos.[175] The extensive artificial stone ridges, discovered along the Thermaic Gulf in Thessaloniki,[176] probably served not only as

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[164] Fouache 1999, 115-130.
[165] Karagiorgou 2001, 209f.
[166] Hohlfelder /Vann 1998, 32.
[167] Bakirtzis 1997.
[168] Foss 1988, 169-171.
[169] Kalligas 2002, 879.
[170] Balance 1955, 47-49.
[171] Foss 1994, 29-30.
[172] Kalligas 2002, 879-880.
[173] Bakirtzis 1997, 306-307.
[174] Kingsley 2001, 77, fig. 7.
[175] Vann 1993, 32.
[176] Bakirtzis 1997, 306-307.

breakwaters for all three known ports and anchorages but they might also have been meant to produce a channel which would prevent the bay silting up too quickly and obstructing the harbour area, as happened also in other cases such as the port of Dor.[177] Last but not least, fortifications were essential for important harbours that were expected to host naval forces, especially when it came to Early Byzantine imperial works and provincial sites of the seventh, eighth and twelfth centuries. Several examples are known from insular and continental ports in both Greece and Asia Minor (e.g. in sites in Lycia and Caria, Chios, Corinth, Nafpaktos, Butrint, Leucas, Vonitsa, Rogoi, Iolkos, Thessaloniki etc.).[178] In fact, ports from the seventh century onwards seem to have followed the prevailing patterns of dispersed overall settlement (small fortified stations) with the exception of big cities.

# <H1> The significance of settlements' specific roles within maritime networks

The last point to be explained is that specific physical, social and cultural features of these sites determined – and emerged from – their role within land and maritime networks. I intend to demonstrate this first of all by commenting on the ways some Byzantine harbours are seen to perform as "gateway communities" of social contact and cross-cultural exchange, although they do not seem to have shared other characteristics of contemporary port-cities.[179] Secondly, I will comment on certain spatial and social traits of ports and harbours, identified from textual evidence, which define such sites as culturally distinct places among Byzantine settlements.

## <H2> Byzantine harbours as 'gateway communities'

It seems only reasonable that in Late Antiquity the great ancient port-cities should have remained administrative centres charged with conducting and controlling maritime inter-regional commerce. Moreover, the situation seems to have changed between the fifth and seventh centuries. More specifically, in that period a new form of coastal settlement seems to have appeared in coastal areas and especially along the coastline of the islands. The reason for its appearance seems to be associated with the fact that coastal areas in general, and especially those of the islands, presented extensive possibilities for trade, whereas inland areas had a more limited field of communication.[180] This difference between coast and hinterland is certainly of crucial importance in all periods, but even more so in the context of the fifth to seventh centuries for reasons which will be explained below.

This new settlement formation dating from the fifth to the seventh century is perhaps most aptly termed an *emporion*.[181] Several coastal sites of this period can be categorized as this type of settlement. In this study I shall consider the cases of Chrysoupolis at Strymon, Emporio on Chios, settlements at Kalymnos and the Telendos strait in the Dodecanese, Itanos on Crete, Koutsopetria and Agios Georgios at Pegeia in Cyprus, although I will discuss them all in detail. Of the aforementioned settlements, half were located on strategically located islands, such as Emporio at Chios, the settlement at the Kalymnos-Telendos strait, Itanos, the settlement at

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[177] Kingsley 2001, 74.

[178] Foss 1988, esp. 159 ff; Foss 1994, 32, 36; Balance 1955; Veikou 2012, 448f., 476f., 513f.; Karagiorgou 2001, 210; Bakirtzis 2007, 95.

[179] On the term 'gateway communities' coined by a prehistoric archaeologist and relating to the interregional movement of goods and people, see Hirth 1978.

[180] Haldon 2013, 104.

[181] Veikou 2013, 129.

Koutsopetria and Agios Georgios at Pegeia (**fig. 6**). Almost half of them emerged very close to a still thriving late antique city. For example, Chrysopolis on the Strymon was located next to Christoupolis (modern Kavala), the site of Koutsopetria was located in the immediate vicinity of Kition while Agios Georgios at Pegeia was located near Paphos (**fig. 6**). Last but not least, all aforementioned sites seem to have been orientated towards the sea and not facing inland, by contrast with other contemporaneous settlements in the same region, like in the examples from Cyprus. According to Tassos Papacostas this must indicate that their inhabitants' main interest was trade and the redistribution and exchange of any surplus they might have produced.[182]

To briefly explain the precise features shared by these sites, I will discuss a few examples based on the best-investigated sites. So, the site of Koutsopetria, first of all, is located on Larnaka Bay, 10 km east of ancient Kition and has recently been investigated by David Pettegrew, William Caraher and R. Scott-Moore.[183] The site consists of a broad scatter of cultural material on the narrow coastal plain at the base of a continuous ridge (**fig. 5.c.**). The investigated area covers some 40 hectares and has produced a large number of features and artefacts especially of Roman and Late Roman date. The features include a church, architectural sculptures and a lot of Cypriot roof tiles, cisterns, evidence of olive processing and limestone quarries; predominant among the artefacts are examples of Late Roman pottery, especially LR1 amphoras and fine wares such as Cypriot Red Slip, African Red Slip and Phocean Ware. This would be consistent with the site's *floruit* being attributed to the fifth and sixth centuries when it was part of a broad regional system of exchange. The site's southern boundary is the sea and some low-lying sandy soils; based on the finds distribution the investigators think that this lowland to the east of Koutsopetria marks an embayment that is now infilled but functioned as a natural harbour throughout antiquity and probably as late as the medieval era.[184] They also think that the harbour would certainly have been well situated to take advantage of several ancient roads through this area, one running toward the Mesaoria and one probably turning towards Salamis-Constantia. Why did the site of Koutsopetria flourish in the immediate vicinity of Kition? Some scholars have suggested that Kition suffered earthquakes in the fourth century and as a result of tectonic uplift the harbour gradually silted up.[185] The growth of Koutsopetria and other neighbouring small sites might have been encouraged by the city's decline due to that.[186] However, it has been suggested that the town's silted harbour might have been refurbished during Late Antiquity or that maritime activity in Kition during this period might have shifted further west from its ancient location at Bamboula towards the central area of the medieval city near the church of Ayios Lazaros.[187] Therefore it may very well be that Kition and Koutsopetria flourished concurrently.[188]

It would seem that there was contemporaneous flourishing of an ancient city and a mid-size settlement nearby on the western coast of the island too: Agios Georgios near Pegeia at Cape Drepanon (**fig. 5.d.**) grew into a flourishing and wealthy, important centre of inter-regional exchange just 21 km north of the port-city of Paphos, the former capital of Cyprus. The settlement covered 16 hectares and the site has produced burial chambers, agricultural implements, a bath complex and three large, luxuriously

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[182] Papacostas 2001, 120-121.
[183] Caraher / Pettegrew / Scott Moore forthcoming.
[184] Caraher / Pettegrew / Scott Moore forthcoming, Chapter 7, 1.
[185] Ibidem.
[186] Ibidem, Chapter 7, 32-33.
[187] Caraher / Pettegrew / Scott Moore forthcoming, Chapter 7, 33.
[188] Ibidem, Chapter 7, 34.

furnished, basilica churches.[189] The fact that this site appears to have been more dependent on the sea and contacts beyond the shores of Cyprus, turning its back on the hinterland, led Charalambos Bakirtzis to argue that it grew not as a result of its proximity to Paphos, but on account of its orientation towards the sea, serving as a stopover for Egyptian grain ships bound for Constantinople.[190] However, the settlement can equally be very plausibly explained as a thriving *emporion* of the time, due to its strategic location on the *annona* road.

Finally, thorough investigation of the site of Itanos in Crete **(fig. 5.b.)** has confirmed the same pattern by means of more precise dating of buildings and pottery.[191] Indeed pottery finds from Itanos have confirmed a *floruit* of the settlement between the fifth and the seventh centuries and they have indicated not only the existence of trade and contacts with North Africa, Asia Minor and Cyprus but also a large amount of locally produced vessels serving agricultural purposes, especially during the sixth and seventh centuries.[192]

Indeed, for island coastal settlements in particular, Late Antiquity was a time of economic and demographic growth as a result of the integration of the local population into a system of interregional shipping routes and trade in the fifth and sixth centuries.[193] On the southern coast of Attica, for example, Piraeus also appears to have overshadowed other coastal settlements during the period from the fourth to the seventh century.[194] Having been structurally integrated into an expanding network of long-distance exchange, *emporia* flourished until at least the mid-sixth century. But human activity at all of these coastal sites seems to have contracted dramatically after the mid-seventh century with slight regional, chronological variations.[195] During this last period of their life (seventh and eighth centuries) these coastal settlements functioned within networks of regional communication.[196] The pottery finds from Itanos, among which there are a great many objects from Asia Minor, strongly support this idea.[197] What was once considered an apparently drastic decline in maritime trade between the sixth and the tenth century, which could also have caused the subsequent decline of coastal settlements, tends now to be viewed more circumspectly.[198]

However, it was during the sixth and seventh century that coastal areas seem to have faced the biggest changes.[199] In Itanos not only were large amounts of local pottery being produced for agricultural purposes in that period, but also locally made amphorae survive in greater quantities.[200] In fact, excavations of the site indicate that the settlement died out in the seventh century due to the decline of the long-distance maritime trade and the Arab raids. There was no trace of violent raids or destruction of parts of the settlement; only shrinkage, decline, and final abandonment.[201] The same pattern is seen in the Byzantine port-settlements at Koutsopetria, Agios Georgios near

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[189] Bakirtzis 2001.
[190] Bakirtzis 1995.
[191] Tsigonaki 2009, 159-174.
[192] Xanthopoulou 2004, 1014.
[193] Deligiannakis 2008, 209-234.
[194] Tzavella 2013.
[195] While, for example, the turning point for such settlements in the Dodecanese occurred during the mid-sixth century, the one in Itanos, Crete (like Pyla in Cyprus) continued until the mid-seventh century.
[196] Haldon 2013, 100-101.
[197] Xanthopoulou 2004, 1016.
[198] Pieri 2013, 39.
[199] Curta 2001, 200ff.
[200] Xanthopoulou 2004, 1016, 1022.
[201] *Ibidem*, 1027; Tsigonaki 2009, 159-174.

Pegeia, possibly a number of other sites in Cyprus,[202] Telendos,[203] and Emporio on Chios.[204]

As for the interpretation of these sites, Archie Dunn has referred to them as '*loci of maritime traffic*' while Cecile Morrisson and Jean-Pierre Sodini term them Byzantine *emporia* and 'secondary towns'.[205] Whatever their status, the emergence of these sites seems to be linked to their inhabitants grabbing the opportunity for economic growth by simply taking advantage of the sites' privileged locations astride major maritime trade routes of the period. George Deligiannakis proposed a definition for this type of site in the Dodecanese, calling them 'secondary' or 'satellite towns' after Morrisson and Sodini.[206] According to him, "the evidence from these coastal settlements indicates a relatively socially homogeneous population, which lived primarily on the land as small-holders or tenant farmers, but also engaged in maritime activities as traders and fishermen, as well as in various kinds of craftsmanship; there is clear evidence for commercial contacts with regions far beyond their shores. At a local level, these settlements usually functioned as centers of local markets, artisanal production and trade, and hardly differed from small cities; agricultural surplus would have fuelled the growing economy of these market towns and supported an island-wide project of church building. A network of wealthy agrarian villages was connected with these large settlements, which possibly functioned as upper-tier collection points for local agricultural products and major distribution centres for bigger markets; these large, prosperous coastal villages probably offered a partial substitute for urban centres in the regional economy, even though they did not carry the traditional urban apparatus and culture".[207]

David Pettegrew, William Caraher and R. Scott-Moore have discussed the 'urban or rural character' of these sites. According to them:

"What we have in all these cases are a number of mid-sized coastal sites which are neither wholly urban nor wholly rural space. They possess religious architecture, obvious wealth, some civic amenities and connections to the broader world, yet lack the full range of civic features. They are rural spaces which gained independence from their strategic and favorable positions. While undoubtedly interacting closely with nearby cities, they also developed and flourished in respect to their connectedness to networks beyond the city. (...) It is clear that these settlements, centered at crossroads, would have been places of cultural exchange and frequent interaction with a broader Late Antique world. Just as scholars recognize that pottery sherds are the most visible physical traces of a vibrant economic exchange system that included a much wider range of material goods, so they must also represent a broad array of exchanges of ideas and culture that are now invisible to us. The merchants putting into port at Koutsopetria, for example, may have gone on to either Salamis or Kition, and from there, to the coastal towns of northern Palestine and Syria, just as those from Korykos did. The inhabitants of these sites presumably interacted with neighboring large coastal sites and also with inland populations who provided the agricultural surplus for exchange. The routes themselves fostered relationships between coastal town and inland villages and farms, various urban and civic centres as well as other

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[202] Pettegrew / Caraher / Scott Moore forthcoming.
[203] Deligiannakis 2007, 256.
[204] Balance 1955.
[205] Dunn 2006; Morrisson / Sodini 2012, 179-180.
[206] Morrisson / Sodini 2012, 179-181.
[207] Deligiannakis 2008, 211-212.

provinces and places. Large crossroads settlements like them, then, were not just economic entities, but places of cultural contact and accommodation between groups originating from very different social and geographic spheres. The distinct and heterogeneous archaeological assemblages suggest that these places could produce independent self-expressions within larger relational networks. (...) These originally rural places were not static places standing outside of history and defined exclusively by an economic relationship to culture-producing urban zones, but constituted places capable of producing and transmitting culture in and of themselves."[208]

Under these conditions, it may well be suggested that these sites functioned as 'gateway communities', a concept applied mostly to settlements which control the point of contact between two quite strongly contrasting economic and social systems or, according to Horden and Purcell, between two settlements with heterogeneity in their value-systems, which promotes inter-cultural exchange.[209]

I shall finish this brief overview of Early Byzantine *emporia* by pointing out ways in which specific physical and social features of harbours determined – and, at the same time, emerged from – their role in land and maritime networks. An important common physical attribute shared by all the aforementioned *emporia* seems to emerge at this point. While the existence of a built harbour in all these sites is more or less assumed or taken for granted by their investigators, no built harbour has so far been discovered in any of these coastal settlements nor does any mention of them as ports exist in the late antique textual sources **(fig. 5.a-d)**. In the cases of sites located in alluvial plains it has been assumed, for example, that built harbours are hidden somewhere under the layers of alluvial deposits which gradually filled in the embayments. However, in the case of Agios Georgios near Pegeia **(fig. 5.d.)**, for example, there is no river and alluvial plain, yet no harbour installations have been identified along the coast below the settlement. Nevertheless, an underwater survey carried out along 13 km of coastline to the north and south of Cape Drepanon revealed several sites with Late Antique material including sixth- and seventh-century amphorae.[210] The site is still equipped with a natural anchorage hosting shipyards to this day **(fig. 5.d.)**.

What could be the significance of seafront settlements without built harbours and lacking port facilities developing into intra-regional and inter-regional trade centres after the fifth century? Was there indeed a correlation between the preference for one of the known ports and anchorages of that time over another and the nature – rather than range and scale – of redistribution and exchange of products in the area. A plausible reason for such choices, in my opinion, is that some people may have preferred to use side anchorages rather than big city-ports (with built harbours) in this period in order to avoid the official port taxation. Sean Kingsley was possibly hinting at this in his work about some late antique ports in Palestine.[211] Basing herself on the interpretation of sixth- to ninth-century ceramic evidence from the Adriatic, Joanita Vroom has stressed the great variety of agendas of different social groups involved in maritime trade.[212] She also suggested the existence, during this period, of a number of overlapping networks of production, distribution and redistribution which was essentially centred on the Aegean but stretched well beyond this area to the central and eastern Mediterranean, i.e. from Constantinople and the Black Sea to the South coast

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[208] Pettegrew / Caraher / Scott Moore forthcoming.
[209] Horden / Purcell 2000, 393.
[210] Bakirtzis 2001, 156, n. 6.
[211] Kingsley 2001, 84.
[212] Vroom 2012, 389f.

of Turkey, Cyprus, Egypt, Crete, Greece and the southern Adriatic.[213]   Could the flourishing of a black economy have been a cultural trait of this type of settlement? In my opinion the fact that such anchorages developed, during the fifth-to-sixth-century economic boom, in the vicinity of large contemporary ports, indicates that our assumption may be correct, because there had to be *some* reason why merchants would avoid using the nearby existing ports with their built-harbour facilities. And there is no reason why there could not have been alternative economic and distribution networks in the Byzantine provinces, operating alongside the official ones but seeking to escape state control.

If the development of ports with activities that were 'invisible' to the civic administration, using natural harbours only for tax-evasion purposes, would be a reasonable explanation for the flourishing of 'gateway communities' in Byzantium before the seventh century, it seems not to have been the case thereafter. From around the seventh century onwards, Byzantine neglect in maintaining the artificial Roman harbours is noticeable;[214] even in the port of the thriving Middle-Byzantine settlement of Corinth, Lechaion, no artificial harbour repairs have been dated later than 335 A.D.[215] This might be explained by various developments, the most important of which must have been the new technologies used in ship-building, which seem to have begun in earlier centuries but were developed and gradually introduced all over the Mediterranean from the early Middle Ages onwards.[216] These technologies probably produced smaller ships with shallow draught that eventually led to increased confidence in navigation skills.[217] Indeed, a Byzantine text referring to historical events of the year 866 in the port of Ephesos (ships sailing from there to Constantinople)[218] refers to bays (*ormous*), i.e. natural anchorages − not to harbours − and notes that the ships had low tonnage.[219]

## <H2> Ports and harbours as destinations and windows on the world

My final point involves another important cultural dimension of life in Byzantine ports, unconnected with administrative or construction issues, which must be acknowledged. Whether they were artificial harbours in big port-cities or natural harbours and simple anchorages near small settlements, harbours were above all destinations on unpredictably long and quite often dangerous voyages. This is evident from information about voyages and travelling found in various Byzantine texts and more specifically from the limited number of travellers' accounts at our disposal.[220] It is also made very clear in these texts that harbours meant both the end of the danger and discomfort of a voyage and a successful outcome (i.e. the survival of the travellers and their eventual arrival at their destination and return home). They were, therefore, associated with feelings of relief, the availability of commodities designed to satisfy the travellers' and crews' primary needs and other comforting services.

Furthermore, as Theoni Bazaiou-Barabas has shown through her study of literary texts, although no Byzantines would ever travel just for pleasure, the sea had by no means solely negative connotations. Though on the one hand it was perceived as an

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[213] Ibidem.
[214] Hohlfelder 2000; Kingsley 2001.
[215] Theodoulou 2014b.
[216] Makris 2002, 98; Rieth / Kahanov / Pomey 2012.
[217] Vann 1998, 81; McCormick 2013, 91.
[218] Ignatios Diakonos, § 17.10-14.
[219] Gerolymatou 2008, 129 and note 89.
[220] Gkagktsis / Leontsini / Panopoulou 1993; Karpozilos 1993.

unpredictable and dangerous way to travel, on the other it was an opportunity to open new routes of communication, ensure the proper functioning of state machinery and facilitate the everyday survival of the common people.[221] This has, I think, been confirmed by the examination of Early Byzantine emporia in the sense of "gateway communities" in this study.

Therefore ports and harbours also had distinct cultural connotations in Byzantine society, as both links and areas of transition between the safe but limited, 'ordinary', everyday life and the risky condition of travelling. Indeed life on board ship may well be considered one of Foucault's *heterotopias*, where space and time are experienced in different ways from normal.[222] This characteristic gives ports and harbours a particularly special place in Byzantine settlement and may ultimately stimulate more flexible and imaginative interpretations of material remains from relevant archaeological sites, their surroundings and their connection-points around their inhabitants' known world.

### <H1> Conclusions

In concluding this study, four ideas emerge as potentially fruitful paradoxes. In my opinion, these four paradoxical circumstances are the result of the liminal vicinity of water and land and the best reflection of the fragile balance of Byzantine ports and other harbour settlements.

So, first of all, as everybody knows: water is man's best friend and worst enemy. Exploiting it has been a constant struggle for man and not just for those on the medieval waterfront. In many cases changing physical conditions can be shown to have influenced the movement and number of the deltaic loci of maritime traffic and of administrative centres in the vicinity. Evidently contemporary technology allowed people to manage small-scale environmental change but, when large-scale physical phenomena – such as alluvial crises – radically altered the geomorphology of the wider area, the inhabitants either could not or did not find it worthwhile to struggle to 'rehabilitate' the disaster area and re-establish the former conditions. Adjusting to the new conditions by introducing changes in land use no doubt seemed preferable and a more natural development.

The second paradox, when it comes to ports and harbours, concerns the concept of contact. The harbour settlements function as gateways between the Aegean and the rest of the Mediterranean and the Balkan or Anatolian hinterlands, which were traditionally rich in agricultural resources, wetlands, agriculture and mining activities and gave them the inevitable advantages and disadvantages of close social contact.[223] Prosperity and the availability of commodities must have also gone hand in hand with cultural exchange but also with disease, invasions and raids.

The third idea concerns the correlation between the size of ports and the level of trade. During the Byzantine period, there seems to be no correlation between extensive commercial activity and the use of ports with built harbours. In the case of Strymon, Pegeia, Pyla and Itanos we have established that significant economic activity persisted for centuries in the absence of built harbours.[224] By contrast, it remains a moot point as to whether there was indeed a correlation between a preference for one port or anchorage over another and the *nature* – rather than range and scale – of trade and distribution networks.

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[221] Bazaiou-Barabas 1993, 443.
[222] Kokot 2008; Foucault 1967.
[223] Dunn 2009, 19.
[224] Dunn 2009, 20.

Finally, the last paradox I have come across during this investigation is that the more or less homogeneous patterns in settlement evolution, found in other categories of Byzantine settlements, are lacking in the case of ports. Obviously a complex interplay of different factors, as outlined by Johannes Preiser-Kapeller, is indeed very relevant in this case. The concept of connectivity has already been identified by Horden and Purcell as a key element in the interpretation of settlement in the Mediterranean, because it contextualizes urban centres as simply the largest nodes within a broad matrix of exchange and elevates the smaller links of the chain; villas, villages and small towns may have lacked urban status but they still produced surpluses, participated in trans-regional exchange and functioned with varying degrees of economic autonomy.[225] Caraher, Scott-Moore and Pettegrew also discussed this concept in relation to late antique Cyprus, and the site of Koutsopetria in particular.[226] They argued that this small island was never a central place in the Roman economy *per se* but it did sit astride major maritime trade routes linking Egypt, the Aegean and the Levant, and was, consequently, directly connected to the wider Mediterranean matrix. However, though connectivity offers potential and opportunity, it does not determine or presuppose the nature of relationships between inhabitants; this is a cultural aspect which also has to be taken into consideration. Therefore, it would be a good idea to broaden out our view of settlement around the late antique and medieval Mediterranean by bearing in mind that, apart from the strategic and economic potential of any site, which 'invites' human agency, the dynamic picture of settlement and the connectedness of different sites were also the result of a constant re-negotiation of human relations − both within the microcosm of a region and with the rest of the known world.

### ACKNOWLEDGEMENTS

**Bibliography**

Ignatios Diakonos: Ignatios Diakonos und die Vita des H. Gregorios Dekapolites, ed. G. Makris, trans. M. Chronz, Byzantinisches Archiv 17 (Stuttgart, Leipzig 1997).

Avramea 2002: A. Avramea, Land and Sea Communications, Fourth-Fifteenth Centuries. In: A. Laiou (ed.), The Economic History of Byzantium from the seventh through the Fifteenth Century, Dumbarton Oaks Studies 39 (Washington D.C. 2002), vol. 1, 56-90.

Bakirtzis 1975: Ch. Bakirtzis, Η θαλάσσια οχύρωση της Θεσσαλονίκης. Παρατηρήσεις και προβλήματα, Byzantina 7, 1975, 165-180.

Bakirtzis 1995: Ch. Bakirtzis, The Role of Cyprus in the Grain Supply of Constantinople in the Early Christian Period. In: V. Karageorghis / D.

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[225] Horden / Purcell 2000, 123-172.
[226] Caraher / Scott-Moore / Pettegrew forthcoming.

Michaelides (eds.), Proceedings of the International Symposium Cyprus and the Sea, Nicosia 25-26 September 1993 (University of Cyprus 1995) 247-253.

Bakirtzis 1997: Ch. Bakirtzis, Το Κελλάριον της Θεσσαλονίκης, Αφιέρωμα στον N.G.L. Hammond, Παράρτημα Μακεδονικών 7 (Thessaloniki 1997) 305-308.

Bakirtzis 2001: Ch. Bakirtzis, Αποτελέσματα ανασκαφών στον Άγιο Γεώργιο Πέγειας (ακρωτήριον Δρέπανον), 1991-1995. In: A. Papageorgiou (ed.), Πρακτικά του Τρίτου Διεθνούς Κυπρολογικού Συνεδρίου (Λευκωσία, 16-20 Απριλίου 1996) (Nicosia 2001), vol. II, 155-169.

Bakirtzis 2007: Ch. Bakirtzis, Imports, exports and autarchy in Byzantine Thessalonike from the seventh to the tenth century. In: J. Henning (ed.), Post-Roman Towns, Trade and Settlement in Europe and Byzantium (Berlin, New York 2007), Vol. 2, 89-118.

Balance 1955: M. Balance (ed.), Excavations in Chios, 1952-1955: Byzantine Emporio (Athens 1955).

Bazaiou-Barabas, 1993: Th. Bazaiou-Barabas, Θαλάσσιοι δρόμοι: δυνατότητες και δυσκολίες της θαλάσσιας επικοινωνίας σε βυζαντινά λόγια κείμενα. In: N. Moschonas (ed.), Η επικοινωνία στο Βυζάντιο, Κέντρο Βυζαντινών Ερευνών / Ε.Ι.Ε. (Athens 1993), 435-443.

Blackman / Schäfer / Schläger 1967: D. Blackman / J. Schäfer / H. Schläger, Un port de l'époque romaine en Grèce centrale, Archéologia 17, 1967, 12-17.

Blackman / Schäfer / Schläger 1968: D. Blackman / J. Schäfer / H. Schläger, Der Hafen von Anthedon mit Beiträgen zur Topographie und Geschichte der Stadt, Archäologischer Anzeiger 1968, 21-98.

Bokotopoulos 1966/67: P: Bokotopoulos, Λάτρος, Ἐπετηρὶς Ἑταιρείας Βυζαντινῶν Σπουδῶν 35, 1966/67, 73.

Braudel 1966: F. Braudel, La Méditerranée et le monde méditerranéen à l'époque de Philippe II, 2 vols. (Paris [2]1966)

Caraher / Scott-Moore / Pettegrew forthcoming: W.R. Caraher / D.K. Pettegrew / R.S. Scott Moore, Pyla-Koutsopetria: Archaeological Survey of an Ancient Coastal Town, American Schools of Oriental Research, Archaeological Report Series 21 (forthcoming).

Crow / Hill 1995: J. Crow / S. Hill, The Byzantine Fortifications of Amastris in Paphlagonia, Anatolian Studies 45, 1995, 251-265.

Curta 2001: F. Curta, Peasants as Makeshift Soldiers for the Occasion: Sixth-Century Settlement Patterns in the Balkans. In: T.S. Burns / J.W. Eadie (eds.), Urban Centers and Rural Contexts in Late Antiquity (East Lansing 2001) 199-218.

Dakari / Bakirtzis / Karabasis 2008: K. Dakari / A. Bakirtzis / G. Karabasis, Το παράλιο τείχος της Καβάλας, 12th Ephoreia of Byzantine Antiquities, Greek Ministry of Culture (Kavala 2008).

Deligiannakis 2007: G. Deligiannakis, The history and archaeology of the Aegean Islands in Late Antiquity, AD 300-700, The case of the Dodecanese, PhD Thesis, (University of Oxford 2007)

Deligiannakis 2008: G. Deligiannakis, The economy of the Dodecanese in late antiquity. In: Ch. Papageorgiadou-Banis / A. Giannikouri (eds.), Sailing in the Aegean. Readings on the economy and trade routes, Meletemata 53 (Athens 2008) 209-234.

Dimitriadis 1990: E. Dimitriadis, The Harbour of Thessaloniki: Balkan Hinterland and Historical Development. In: Αρμός, Τιμητικός τόμος στον καθηγητή Ν. Μουτσόπουλο (Thessaloniki 1990) 541-561.

Dunn 2006: A. Dunn, The Rise and Fall of Towns, Ports, and Silk-production in Western Boeotia: the Problem of Thisvi-Kastorion. In: E. Jeffreys (ed.), Byzantine Style, Religion and Civilization. In honour of Sir Steven Runciman (Cambridge 2006) 38-71.

Dunn 2009: A. Dunn, Byzantine and Ottoman Maritime Traffic in the Estuary of Strymon: Between Environment, State, and Market. In: J. Bintliff / H. Stöger (eds.), Medieval and Post-Medieval Greece: The Corfu Papers, BAR International Series S2023 (Oxford 2009) 15-31.

Flemming 1974: N.C. Flemming, Report of Preliminary Underwater Investigations at Salamis Cyprus, Report of the Department of Antiquities of Cyprus (Nicosia 1974) 163-174.

Foss 1979: C. Foss, Ephesus After Antiquity: A Late Antique, Byzantine, and Turkish City (Cambridge 1979).

Foss 1988: C. Foss, Strobilos and Related Sites, Anatolian Studies 38, 1988, 147-174.

Foss 1994: C. Foss, The Lycian Coast in the Byzantine Age, Dumbarton Oaks Papers 48, 1994, 1-52.

Fouache 1999: E. Fouache, L'alluvionnement historique en Grèce occidentale et au Péloponnèse, BCH Suppl. 35 (Paris 1999).

Foucault 1967: M. Foucault, Of Other Spaces: Utopias and Heterotopias (1967). In: N. Leach (ed.), Rethinking Architecture: A Reader in Cultural Theory (New York 1997) 330-336.

Francois 2012: V. Francois, Représenter le commerce de la poterie à Byzance. In: E. Malamut / M. Ouerfelli (eds.), Les échanges en Méditerranée médiévale. Marqueurs, réseaux, circulations, contacts (Aix-Marseille 2012) 33-55.

Gerolymatou 2008: M. Gerolymatou, Αγορές, έμποροι και εμπόριο στο Βυζάντιο (9ος-12ος αι.), Institute of Byzantine Research Monographs 9 (Athens 2008).

Gkagktsis / Leontsini / Panopoulou 1993: D. Gkagktsis / M. Leontsini / A. Panopoulou, Πελοπόννησος και Νότια Ιταλία: σταθμοί επικοινωνίας στη Μέση Βυζαντινή περίοδο. In: N.G. Moschonas (ed.), Η Επικοινωνία στο Βυζάντιο, Πρακτικά του Β΄ Διεθνούς Συμποσίου, Κέντρο Βυζαντινών Ερρευνών /E.I.E. (Athens 1993) 469-486.

Greenslade / Hodges 2013: S. Greenslade / R. Hodges, The aristocratic oikos on the Vrina Plain, Butrint c. AD 830−1200, Byzantine and Modern Greek Studies 37:1, 2013, 1-19.

Haldon 2013: J. F. Haldon, Commerce and Exchange in the Seventh and Eighth centuries. Regional Trade and the Movement of Goods. In: C. Morrisson (ed.), Trade and Markets in Byzantium, Dumbarton Oaks Byzantine Symposia and Colloquia (Washington D.C. 2013) 99-124.

Herda / Brückner / Müllenhoff 2009: A. Herda / H. Brückner / M. Müllenhoff, Auf Meersand gebaut – Landschaftswandel in Milet im Spiegel geoarchäologischer Zeugnisse. In: O. Dally / M. Maischberger / P. Schneider / A. Scholl (eds.), 'ZeitRäume' – Milet in Kaiserzeit und Spätantike, Exhibition catalogue Pergamon Museum Berlin (Regensburg 2009) 18-23.

Hirth 1978: K.G. Hirth, Interregional Trade and the Formation of Prehistoric Gateway Communities, American Antiquity 43:1, 1978, 35-45.

Hodges et al. 1997: R. Hodges / G. Saraçi / W. Bowden, Late Antique and Byzantine Butrint: the port and its hinterland, Journal of Roman Archaeology 10, 1997, 207-234.

Hohlfelder 2000: R.L. Hohlfelder, Anastasius I, Mud, and Foraminifera: Conflicting Views of Caesarea Maritima's Harbor in Late Antiquity, Bulletin of the American Schools of Oriental Researc 317, 2000, 41-62.

Hohlfelder / Vann 1998: R.L. Hohlfelder / R.L. Vann, Uncovering the Maritime Secrets of Aperlae, a Coastal Settlement of Ancient Lycia, Near Eastern Archaeology 61:1, 1998, 26-37.

Horden / Purcell 2000: P. Horden / N. Purcell, The Corrupting Sea (Oxford 2000).

Iacomi, Oil and Wine Production: V. Iacomi, Some Notes on Late-Antique Oil and Wine Production in Rough Cilicia (Isauria) in the Light of Epigraphic Sources: Funerary Inscriptions from Korykos, LR 1 Amphorae Production in Elaiussa Sebaste and the Abydos Tariff. In: Ü. Aydinoğlu / A. K. Şenol (eds.), Olive Oil and Wine Production in Anatolia during Antiquity, Symposium Proceedings, 06-08 November 2008, Mersin, Turkey (Research Center of Cilician Archaeology 2010)

Jing / Rapp 2003: Z. Jing / G.R. Rapp, The coastal evolution of the Ambracian embayment and its relationship to archaeological settings. In: J. Wiseman / K. Zachos (eds.), Landscape Archaeology in Southern Epirus, Greece, I, Hesperia Supplement 32 (Princeton NJ 2003) 157-198.

Kalligas 2002: H. Kalligas, Monemvasia, Seventh-Fifteenth Century. In: A. Laiou (ed.), The Economic History of Byzantium from the Seventh through the Fifteenth Century, Dumbarton Oaks Studies 39 (Washington D.C. 2002), vol. 2, 879-897.

Karageorghis 1969: V. Karageorghis, Salamis in Cyprus. Homeric Hellenistic and Roman (London 1969).

Karagiorgou 2001: O. Karagiorgou, Demetrias and Thebes: the fortunes and misfortunes of two Thessalian port cities in late antiquity, Journal of Roman Archaeology 42, 2001, 182-215.

Karpozilos 1993: A. Καρπόζηλος, Ταξιδιωτικές περιγραφές και εντυπώσεις σε επιστολογραφικά κείμενα. In: N. Moschonas (ed.), Η επικοινωνία στο Βυζάντιο, Κέντρο Βυζαντινών Ερευνών / Ε.Ι.Ε. (Athens 1993) 511-541.

Kingsley 2001: S. Kingsley, 'Decline' in the ports of Palestine in late antiquity. In: L. Lavan (ed.), Recent Research in Late Antique Urbanism, JRA Supplement 42 (Portsmouth 2001  69-88.

Knoob / Pfarr / Grellert 2011; M. Knoob / M. Pfarr / M. Grellert, Ephesos - byzantinisches Erbe des Abendlandes. Digitale Rekonstruktion und Simulation der Stadt Ephesos im 6. Jahrhundert. In: F. Daim / S. Ladstätter (eds.), Ephesos in Byzantinischer Zeit, Monographien des RGZM Band 84, 2, 2 (Mainz 2011) 241-254.

Koder 1993: J. Koder, Νησιωτική επικοινωνία στο Αιγαίο κατά το μεσαίωνα. In: N.G. Moschonas (ed.), Η Επικοινωνία στο Βυζάντιο, Πρακτικά του Β΄ Διεθνούς Συμποσίου, Κέντρο Βυζαντινών Ερρευνών /Ε.Ι.Ε. (Athens 1993), 445-455.

Koder 2005: J. Koder, Το Βυζάντιο ως χώρος. Εισαγωγή στην Ιστορική Γεωγραφία της Ανατολικής Μεσογείου στη Βυζαντινή Εποχή (Thessaloniki 2005).

Kokot 2008: W. Kokot, Port Cities as Areas of Transition. Ethnographic Perspectives. In:  W. Kokot / M. Gandelsman-Trier / K. Wildner (eds.), Port Cities as Areas of Transition. Ethnographic Perspectives (Bielefeld 2008) 7-23.

Kourtzelis / Theodoulou 2014: G. Kourtzelis / Th. Theodoulou, Lesvos - Eressos. In: C. Memos et al. (eds.), The Limenoscope Project of Ancient Hellenic Ports, School of Civil Engineering of the National Technical University of Athens and the Ephorate of Underwater Antiquities (NTUA 2014): http://www.limenoscope.ntua.gr/ show_port.cgi?lan=en&id=87

Ladstätter 2011: S. Ladstätter, Ephesos in byzantinischer Zeit. Das letzte Kapitel der Geschichte einer antiken Stadt. Überblick. In: F. Daim / S. Ladstätter (eds.),

Ephesos in Byzantinischer Zeit, Monographien des RGZM Band 84, 2, 2 (Mainz 2011) 3-29.

Loverdou-Tsigarida 2006: Κ. Λοβέρδου-Τσιγαρίδα, Το Κάστρο του Πλαταμώνα (Athens 2006).

Loverdou-Tsigarida et al. 2001: K. Loverdou-Tsigarida / B. Xanthos/ A. Tokmakidou / P. Photiades, Έρευνες στο Κάστρο του Πλαταμώνα, Archaeologiko Ergo Makedonias Thrakis 15, 2001, 401–414.

Magdalino 2007: P. Magdalino, Studies on the History and Topography of Byzantine Constantinople (Aldershot 2007).

Makris 2002: G.E. Makris, Ships. In: A. Laiou (ed.), The Economic History of Byzantium from the seventh through the Fifteenth Century, Dumbarton Oaks Studies 39 (Washington D.C. 2002), vol. 1, 91-99.

Malamut 1988: E. Malamut, Les îles de l'Empire byzantin: VIIIe-XIIe siècles (Paris 1988)

McCormick 2013: M. McCormick, Movements and Markets in the First Millenium. Information, Containers, and Shipwrecks. In: C. Morrisson (ed.), Trade and Markets in Byzantium, Dumbarton Oaks Byzantine Symposia and Colloquia, (Washington D.C. 2013) 51-98.

Memos et al. 2014: C. Memos et al. (eds.), The Limenoscope Project of Ancient Hellenic Ports, School of Civil Engineering of the National Technical University of Athens and the Ephorate of Underwater Antiquities (NTUA 2014): http://www.limenoscope.ntua.gr/show_port.cgi?lan=en&id=36)

Morrisson / Sodini 2002: C. Morrisson / J.-P. Sodini, The Sixth-century Economy. In: A. E. Laiou (ed.), The Economic History of Byzantium from the Seventh through the Fifteenth century (Washington D.C. 2002) 171-220.

Müller-Wiener 1961: W. Müller-Wiener, Mittelalterliche Befestigungen im südlichen Jonien, Instanbuler Mitteilungen 11, 1961, 89-112.

Navis II: The NAVIS II Project Database, European Commission Directorate General Information, Communication, Culture, Audiovisual Culture and Audiovisual Policy, (Brussels 2014): http://www2.rgzm.de/Navis2/Home/Frames.htm.

Orvietani Busch 2001: S. Orvietani Busch, Medieval Mediterranean Ports: The Catalan and Tuscan Coasts, 1100-1235, The Medieval Mediterranean 32 (Leiden-Boston 2001).

Papacostas 2001: T. Papacostas, The Economy of Late Antique Cyprus. In: S. Kingsley / M. Decker (eds.), Economy and Exchange in the Eastern Mediterranean during Late Antiquity (Oxford 2001) 107-128.

Pettegrew / Caraher / Scott Moore 2006: D.K. Pettegrew / W. Caraher / R. Scott Moore, Between City and Country: Settlement on the Fringe in Late Roman Cyprus, Paper Presented on November 16, 2006 at the Annual Meeting of the American Schools of Oriental Research, Washington, D.C: http://www.pkap.org/publications/ASOR%202006.htm)

Pieri 2013: D. Pieri, Regional and Interregional Exchanges in the Eastern Mediterranean during the Early Byzantine period. The Evidence of Amphorae. In: C. Morrisson (ed.), Trade and Markets in Byzantium, Dumbarton Oaks Byzantine Symposia and Colloquia (Washington D.C. 2013) 27-50.

Pulak 2010: C. Pulak, Yenikapi Byzantine Shipwrecks. In: Istanbul: 8000 Years Brought to Daylight, Marmaray, Metro, Sultanahmet Excavations (Istanbul 2010) 202-215.

Raban 1995: A. Raban, The Heritage of Ancient Harbour Engineering in Cyprus and the Levant. In: V. Karageorgis / D. Michaelides (eds.), Proceedings of the International Symposium Cyprus and the Sea (Nicosia 1995) 162-163.

Ragia 2009: E. Ragia, Η κοιλάδα του κάτω Μαιάνδρου ca 600-1300. Γεωγραφία και Ιστορία (Thessalonike 2009).

Rautman 2000: M. Rautman, The Busy countryside of Late Roman Cyprus, Report of the Department of Antiquities of Cyprus 2000, 317-331.

Rautman 2004: M. Rautman, Valley and Village in Late Roman Cyprus. In: W. Bowden / L. Lavan / C. Machado (eds.), Recent Research on the Late Antique Countryside, LAA 2 (Leiden-Boston 2004) 189-218.

Rieth / Kahanov / Pomey 2012: E. Rieth, Y. Kahanov, P. Pomey, Transition from Shell to Skeleton in Ancient Mediterranean Ship-Construction: analysis, problems, and future research. The International Journal of Nautical Archaeology 41.2, 2012, 235–314.

Rife et al. 2007: J. Rife / M. Morison / A. Barbet / R. K. Dunn / D. H. Ubelaker / F. Monier, Life and death at a port in Roman Greece: The Kenchreai Cemetery Project 2002-2006, Hesperia 76, 2007, 143-181.

Schaus 1996: G. Schaus, An Archaeological Field Survey at Eresos, Lesbos, Echos du monde classique/Classical Views 15, 1996, 27-74.

Theodoulou 2014a: Th. Theodoulou, Anthedon. In: C. Memos et al. (eds.), The Limenoscope Project of Ancient Hellenic Ports, School of Civil Engineering of the National Technical University of Athens and the Ephorate of Underwater Antiquities (NTUA 2014): http://www.limenoscope.ntua.gr/show_port.cgi?lan=en&id=36

Theodoulou 2014a: Th. Theodoulou, Corinth - Lechaeon. In: C. Memos et al. (eds.), The Limenoscope Project of Ancient Hellenic Ports, School of Civil Engineering of the National Technical University of Athens and the Ephorate of Underwater

Antiquities (NTUA 2014): http://www.limenoscope.ntua.gr/show_port.cgi?lan=en&id=60

Tsigonaki 2009: Ch. Tsigonaki, Ίτανος. Ιστορία και τοπογραφία μιας παράκτιας θέσης της ανατολικής Κρήτης κατά την πρωτοβυζαντινή περίοδο. In: O. Gratziou / Ch. Loukos (eds.), Ψηφίδες, Μελέτες Ιστορίας, Αρχαιολογίας και Τέχνης στη μνήμη της Στέλλας Παπαδάκη-Oekland (Herakleio 2009) 159-174.

Tzavella 2013: E. Tzavella, Urban and Rural Landscape in Attica in the Early and Middle Byzantine period (4th-12th c.), PhD Thesis (University of Birmingham 2013).

Vann 1993: R. Vann, A Survey of Harbors in Rough Cilicia: the 1991 Preliminary Survey, X Araştırma Sonuçları Toplantısı 1993, 29-40.

Vann 1998: R.L. Vann, Some Observations on Byzantine Harbors in Isauria, zantijskij Vremennik 55, 1998, 78-85.

Varinlioğlu 2011: G. Varinlioğlu, Trades, Crafts and Agricultural Production in Town and Countryside in Southeastern Isauria. In: O. Dally / C. Ratté (eds.), Archaeology and the cities of Asia Minor in Late Antiquity, Kelsey Museum Publication 6 (Ann Arbor 2011) 173-187.

Vorderstrasse 2010: T. Vorderstrasse, A Port without a Harbour: Reconstructing Medieval al-Mina. In: J.G. Schryver (ed.), Studies in the Archaeology of the Medieval Mediterranean, The Medieval Mediterranean 86 (Leiden-Boston 2010) 15-40.

Veikou 2012: M. Veikou, Byzantine Epirus: A topography of transformation. Settlements from the 7th to the 12th centuries (Leiden-Boston 2012).

Veikou 2013: M. Veikou, Settlements in the Greek Countryside from the 4th to the 9th centuries: forms and patterns, Antiquité tardive 21, 2013, 125-133.

Vroom 2012: J. Vroom, From One Coast to Another: early medieval ceramics in the southern Adriatic region. In: S. Gelichi / R. Hodges (eds.), Da un mare all'altro. Luoghi di scambio nell' Alto Medioevo Europeo e Mediterraneo / From One Sea to Another. Trade Centres in the European and Mediterranean Middle Ages (Turnhout 2012) 353-392, 540-542.

Vroom 2004: J. Vroom, Late Antique Pottery, Settlement and Trade in the Eastern Mediterranean: a preliminary comparison of ceramics from Limyra (Lycia) and Boeotia. In: W. Bowden / L. Lavan / C. Machado (eds.), Recent Research in Late Antique Countryside, LAA 2 (Leiden-Boston 2004) 281-331.

Xanthopoulou 2004: M. Xanthopoulou, Παλαιοχριστιανική κεραμική της αρχαίας Ιτάνου. In: M. Livadiotti / I. Simiakaki (eds.), Creta Romana e Protobizantina (Atti del Convegno Internazionale, Iraklion, 23-30 settembre 2000, Scuola Archeologica Italiana di Atene) (Torino, Padova 2004), vol. III/1, 1013-1028.

**Figures to: Mediterranean Byzantine ports and harbours in the complex interplay between environment and society. Spatial, socio-economic and cultural considerations based on archaeological evidence from Greece, Cyprus and Asia Minor**
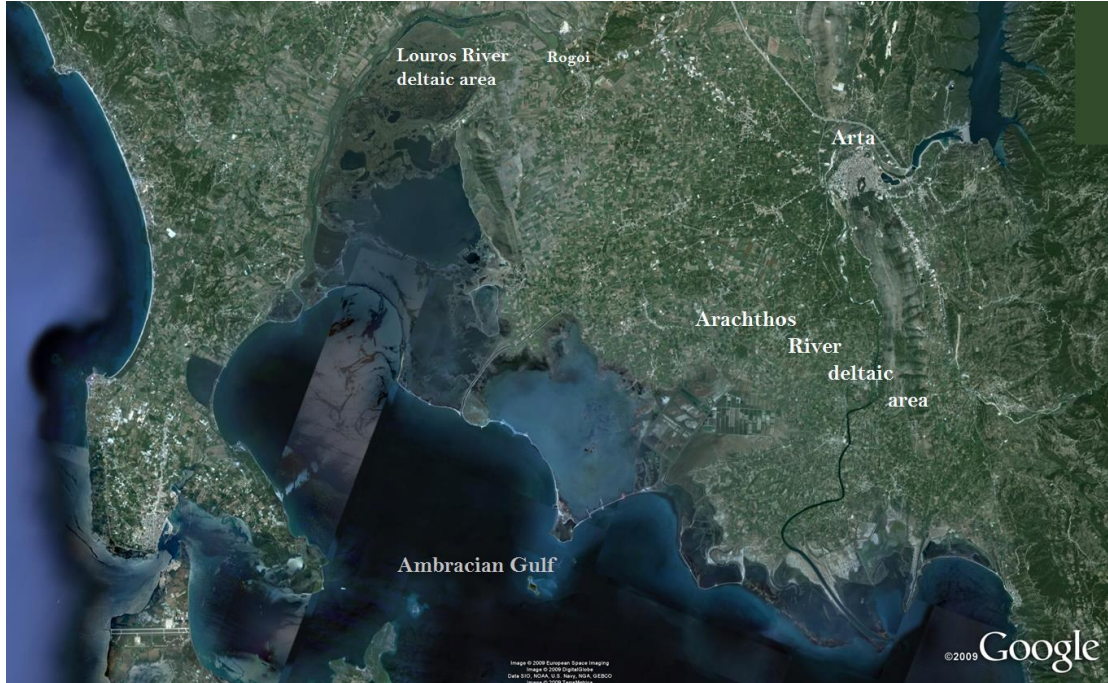


1. Satellite image depicting the geomorphology and Byzantine ports in the area of the Ambracian Gulf in Epirus, Greece (the background is courtesy of Google Earth).
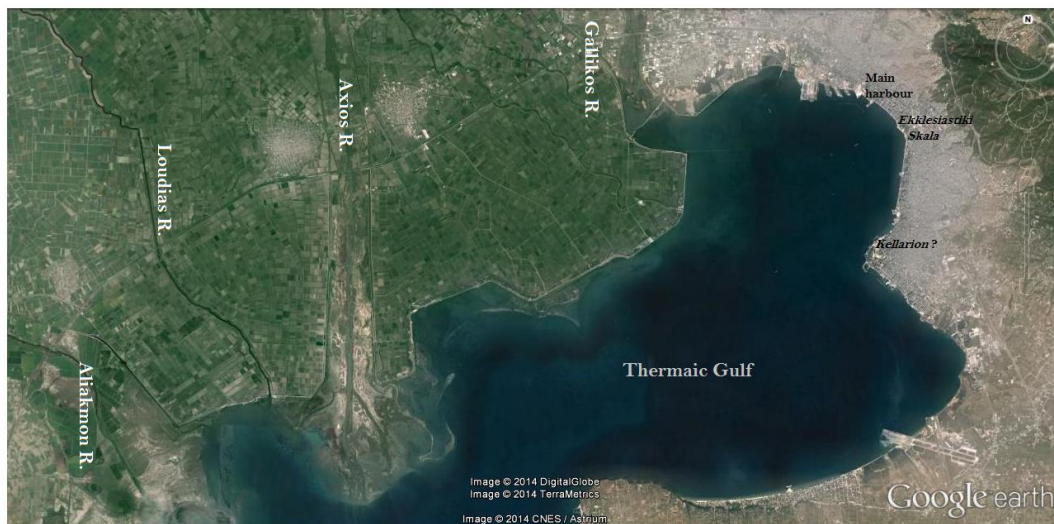


2. Satellite image depicting the geomorphology and Byzantine ports in the area of the Thermaic Gulf near Thessaloniki, Greece (the background is courtesy of Google Earth).

3. Satellite image depicting the geomorphology and Byzantine ports in the area near Ephesos in Asia Minor (the background is courtesy of Google Earth).

4. Satellite image depicting the geomorphology in the area of the Monemvasia Peninsula in the Peloponnese, Greece (courtesy of Google Earth).



5. Satellite images of harbour areas of: a. Emporio in Chios (Greece), b. Itanos in Crete (Greece), c. Pyla-Koutsopetria near Larnaca (Cyprus), d. Agios Georgios near Pegeia (Cyprus). (The background is courtesy of Google Earth).
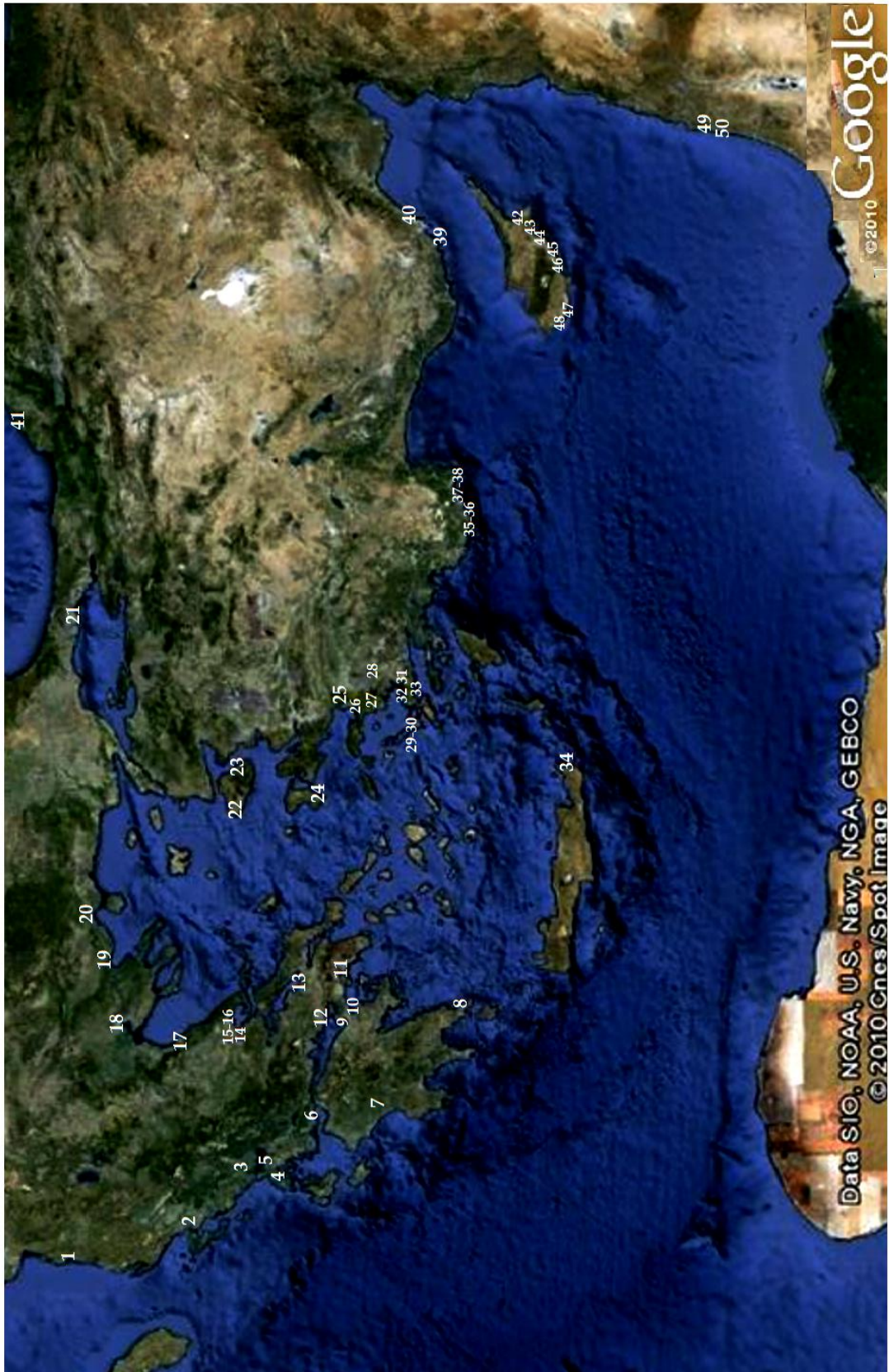
6. Map of known sites of Byzantine ports and harbours, in the Eastern Mediterranean, mentioned in the text  (the background is courtesy of Google Earth):

1. Dyrrachion, anc. (mod. Durrës)
2. Bouthroton, anc. (mod. Butrint)
3. Rogoi, anc. (mod. Kastro Rogon)
4. Leucas, anc. (mod. Karyotes)
5. Vonitsa, anc.
6. Nafpaktos, anc.
7. Olympia, anc.
8. Monemvasia, anc.
9. Lechaeon / Corinth, anc.
10. Kenchreai / Corinth, anc.
11. Piraeus, anc.
12. Thisvi basin, Boeotia
13. Anthedon, anc.
14. Thessalian Thebes, anc. (mod. Nea Anchialos)
15. Demetrias, anc.
16. Iolkos, anc.
17. Platamon, anc. (mod. Kastro Platamona)
18. Thessaloniki, anc.
19. Strymon R. delta
20. Neapolis - Chrysoupolis, anc. (mod. Kavala)
21. Constantinople, anc. (mod. Istambul)
22. Lesbos, Eressos, anc.
23. Lesbos, Mytilene
24. Chios, Emporio (mod. Emborios)
25. Ephesos, anc.
26. Fygela, anc. (mod. Kuşadacı)
27. Miletus, anc.
28. Herakleia, Mount Latmos, anc.
29. Telendos
30. Kalymnos
31. Sıralık
32. Caryanda, anc. (mod. Göl)
33. Strobilos, anc. (mod. Aspat)
34. Itanos, anc. (mod. Erimopolis)
35. Aperlae, anc.
36. Dolichiste, anc. (mod. Kekova) - Tristomo Gulf
37. Andriace / Myra, anc.
38. Limyra, anc.
39. Aphrodisias, anc.
40. Korykos, anc.
41. Amastris, anc. (mod. Amasra)
42. Salamis-Constantia, anc.
43. Koutsopetria
44. Kition, anc. (mod. Larnaca)
45. Maroni-Vrysoudhia
46. Amathous, anc.
47. Paphos, anc.
48. Agios Georgios, Pegeia
49. Dor, anc.
50. Sebastos / Caesaria Maritima, anc.

**The interplay between actors and decision-makers for the selection, organisation, utilisation and maintenance of ports under the Roman Empire**

Pascal Arnaud

When the editors of this meeting proposed me to present a paper about "The interplay between actors and decision-makers for the selection, organisation, utilisation and maintenance of harbours", my first reaction was that first-hand available evidence relating to these topics, as well as scholarly literature were definitely too scarce to allow for any serious attempt to propose any reconstruction of a patterns of interplay on a firm ground. But the question posed to me was so stimulating, that it seemed interesting at least to place these issues in the context of the current state of historiography, and to speed-up research about topics that are analysed within the framework of the ERC funded programme "Rome's Mediterranean Ports" (RoMP) directed by Simon Keay.

Any attempt to understand the interplay between performers and decision-makers must necessarily rely on a previous understanding of the structure of ports administration, and that of ports funding. Available evidence about these topics is unfortunately very scarce. It was actually so rare when I started paying attention to these issues that I had once thought to entitle this paper "the sound of silence". Even less rare now than at the times when Rougé was writing, evidence remains rare, and one has to think about the reasons why inscriptions relating to port administration are but exceptional. Thence we can reach one of the following two conclusions, or some mixture of both: either we are looking for functions that actually did not exist, or social conventions that ruled the display of public inscriptions left little or no space for the holders of these positions.

This situation may explain why little attention has been paid to port administration by modern historiography in the last fifty years. Rougé's pages on these topics are unfortunately the most out-dated part of his work, from both the point of view of the historical background and that of the evidence gathered. The most relevant article about our topic has been published in 1980 by G.W. Houston. He had rightly pointed out how little we know about the administration of Portus and why that little could not be applied to other ports. We eventually still know little about Portus, where many issues still are under discussion, and almost nothing about Italy[227]. No special attention has been paid so far to port administration outside Italy. For that reason, we shall provide here the preliminary results of our quest for new evidence from the provinces, and try to illustrate the new light it brings to the issue of ports administration.

The historiography of Roman harbours, however, is still dominated by the perspective of imperial administration and centralism. But it is probably too restrictive to focus only on the port administration as part of imperial administration and from the sole point of view of imperial centralism. The latter may well have been one of the layers of port administration in the Roman imperial Mediterranean, but it is possibly a misleading postulate to look primarily at it. If not entirely out-dated, Mommsen's Staatsrecht perspective has been widely challenged, and proved itself partly unsatisfactory to explain the complexity of the structure of the empire. It is also necessary to look at the empire through the lenses of other perspectives: that of the cities at one hand, that of political anthropology at the other hand. Since the early 1980's, the works of the late F. Jacques and others have led to a complete re-evaluation of the role and competences of cities in the Roman Empire[228]. The under-estimation of the municipal layer in understanding ports is precisely the cause of Rougé's misunderstanding of part of the preserved evidence. The sphere of municipal activity has provided me with significant pieces of evidence for the topics I had been asked to examine here.

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[227] Rougé 1966, 201-211; Houston 1980; Bruun 2002.
[228] Jacques 1984; Sartre 1991; Karwiese 1995.

Last, but not least, the social and political organization of the Roman Empire had at its top a divine autocrat. Its body used to be a pyramidal and clientelist organon based upon the dignity and social status of individuals, a strong hierarchy of persons within legible networks[229]. The originality of this social and political pattern does not allow to pose the problem only in terms of administrative organisation, and requires a larger focus. It will be necessary to replace the question of the decision-making processes in port building and maintenance in the complex context of the social relationships between the performers of that complex game, involving individuals, including the emperor, as well as groups, in highly codified interplays and networks.

## (H2) 1. The point of view of institutional authority: a complex situation.

A first key to understanding decision-making could be provided by port administration. Unfortunately, we know very little about how the administration of ports was actually organized.

### (H3) 1.1. Lost harbourmasters

Any attempt to find some Roman equivalent to the modern function of harbourmaster has failed so far, at Ostia as well as elsewhere. The discovery at Caesarea Maritima of an inscription mentioning a *κουράτορ πλοίων κολ(ωνίας) Καισαρείας* ("curator of the ships of the colony of Caesarea") has lead the editors of the text[230] to the idea that this would have been something like the local harbourmaster, but this interpretation seems rather unlikely, if not impossible. *Curatores navium marinarum* et *curatores navium amnalium* are well known at Ostia. They were numerous enough to form there two *corpora*[231], and this number seem to exclude that their function may have been that of harbourmaster. Furthermore another inscription from Ostia shows that at least some of them were in charge of the ships of their own city in a remote harbour, here Ostia. A man settled at Portus, but likely from Carthage, as suggested by his tribe, was *curator navium Karthaginiensum* (curator of the ships of Carthage) at Portus.[232] It seems then likely that Varius Seleukos, *κουράτορ πλοίων κολ(ωνίας) Καισαρείας*, was in charge of his mother-city's ships in some foreign port, likely *Portus*, rather than Caesarea's harbour master. What was the exact function of *curatores navium*, I shall not examine here, but it is almost certain that they were not harbour masters.

Only one possible extant witness of lower positions has been preserved. At Lilybaeum, a slave, who qualifies himself as *actor portus Lilybitani* had dedicated an *ex voto* after the safe return or trip of Plotinus and Rufa, maybe his masters, but it is not absolutely clear whether this slave, apparently not an imperial slave, was involved in port administration or in tax-collecting (if *portus* means *portoria*)[233]. He is likely to have been a slave of the tax-farmer in charge of the *statio* of Lilybaeum.

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[229] Alföldy 2014.

[230] Lehman / Holum 2000, n° 12, 47-48 = *ZPE* 99 (1993), 287, 291-292, 294-295.

[231] *CIL* XIV, 363 (add. p. 482, 615); *CIL* XIV, 364 (add. p 615); *CIL* XIV, 409 = Thylander, 1952, n° 339 = *D* 6146 = Meiggs 1960, 200; *CIL* XIV, 4142 = D 6140 (dated 173 CE, October 20th). The usual reconstruction of *CIL* XIV, 4549,42 (piazzale delle Corporazioni, locus nr 42): *[curatores(?) n]avium d[e suo(?)] | N[---* is very dubious.

[232] *CIL* XIV, 4626 = AE 1914, 275 : *L(ucius) Caelius L(uci) fil(ius) A[rn(ensi)] | Aprilis Valerian[us] | curator navium Kartha[g(iniensium)] | et Arellia Eleuthera eius | fecerunt sibi et | lib(ertis) libert(abusque) posteri(s)q(ue) eorum*: "Lucius Caelius Aprilis Valerianus, son of Lucius, inscribed in the Arnensis tribe, curator of the ships of Carthage and Arellia Eleuthera, his wife, have made (this grave) for themselves, for their freedmen of both sexes, and for their posterity".

[233] *CIL* X, 7225 = D 6769 (Marsala / Lilybaeum) : *Salvis Plotino et | Rufa E(u)logus ser(vus) | act(or) port(us) Lilybit(a)ni | hoc sacrarium | ex voto exornavi*. "Because Plotinus and Rufa are safe, I, Eulogus, slave, manager of the port (or "customs") of Lilybaeum, have adorned this sacred monument in fulfilment of his vow". We have followed Dessau's reading rather than Dressel's. There is no proof that Eulogus was an imperial slave.

The lack of evidence about ports administration is so impressive that there seem to be only two possible explanations for that state of things. Either there was no ancient equivalent for the modern harbourmaster, or the social legibility of the position and/or of the people appointed to it was not worth mentioning in public inscriptions.

### (H3) 1.2. The City and its officials

The foundation of the so-called *coloniae maritimae* by Rome during the 2nd-1st centuries BCE had placed most Italian harbours (in approximate chronological order: Antium, Tarracina, Ostia, Minturnae, Sinuessa, Sena Gallica, Castrum Novum, Pyrgi, Alsium, Fregenae, during the 3rd century BCe, and in the 2nd century BCE, Puteoli, Salernum, Volturnum, Liternum, Sipontum, Buxentum, Crotone, Tempsa) under the direct authority of Rome[234]. A confirmation of that situation is given by the fact that in 179 BCE, the moles of the port at Terracina had been funded by the Roman censors[235]. We also hear that by 166 BCE, Rhodes had apparently lost its authority over its own harbour[236]. It seems that at some time, things have changed. This may have been a slow process: in Italy, when *coloniae maritimae*, who were not cities, but groups of Roman citizens, turned into cities, and overseas, when integration did not justify any longer the direct authority of Rome upon foreign harbours.

Even indirect authority would have generated a heavy duty for the State, given the number of ports within the empire, and would have been a strange exception to the role played by the cities as the base of the imperial system. The works of the late François Jacques have brought a new light on this role and on the relationships between cities and imperial power. The authority of cities upon their harbours undoubtedly needs re-evaluation on that new ground, and brings significant change to the image of harbours placed under the direct authority of Rome which has been predominant in modern historiography.

Although available space does not allow me to give a full analysis here[237], there is enough reliable evidence to show that ports were normally placed under the authority of cities. A much quoted passage of the Diocletianic or Constantinian jurisconsult Aurelius Arcadius Charisius[238], known by the *Digest* as *magister libellorum* and the author of a boo *de muneribus civilis*, and a passage of Plutarch, never quoted before by modern scholarship[239], both list the

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[234] Salmon 1963; 1969, 70-81. The list of colonies is given by Livy, 37.38.4 and 36.3.6.

[235] Liv. 40.51: *Censores (…) opera ex pecunia attributa diuisaque inter se haec confecerunt. Lepidus molem ad Tarracinam, ingratum opus, quod praedia habebat ibi priuatamque publicae rei impensam inseruerat.* "The censors achieved the following works with the money they had received and divided between them: Lepidus, a mole at Tarracina. This did not please because he had estates in that city and had mixed a private expense with the State affairs".

[236] Polyb., 30.31.12

[237] This will be the topic of a Rome's Mediterranean Ports ERC program monography devoted to the administration of Roman ports.

[238] *Dig.* 50.4.18.10 = Arcadius Charisius *de muneribus ciuilibus*: *Hi quoque, qui custodes aedium uel archeotae, uel logographi, uel tabularii, uel xenoparochi (ut in quibusdam ciuitatibus) uel limenarchae uel curatores ad extruenda uel reficienda aedificia publica siue palatia siue naualia uel mansiones destinantur, si tamen pecuniam publicam in operis fabricam erogent, et qui faciendis vel reficiendis nauibus, ubi usus exigit, praeponuntur, muneribus personalibus adstringuntur.* "Also those who as guards of (public) buildings, or *archeotae* or *logographi*, or keepers of public archive, or xenoparochi (as in some cities), *limenarchae*, or curators, are in charge of the building or restoration of public buildings, palaces, naval infrastructure or post houses, even if they are spending public money for the purpose of the work's achievement; and also those in charge of building or restoring ships, where it is the use to impose it, are holding *munera personalia*".

[239] *An seni respublica gerenda sit* (19) : ἔστι δ' ὅπου καὶ τὸ φιλόνεικον καὶ παράβολον ὥραν ἔχει τινὰ καὶ χάριν ἐπιπρέπουσαν τοῖς τηλικούτοις ὁ πρεσβύτης δ' ἀνὴρ ἐν πολιτείᾳ διακονικὰς λειτουργίας ὑπομένων, οἷα τελῶν πράσεις καὶ λιμένων ἐπιμελείας καὶ ἀγορᾶς, ἔτι δὲ πρεσβείας καὶ ἀποδημίας πρὸς ἡγεμόνας καὶ δυνάστας ὑποτρέχων, ἐν αἷς ἀναγκαῖον οὐδὲν οὐδὲ σεμνὸν ἔνεστιν ἀλλὰ θεραπεία καὶ τὸ πρὸς χάριν, ἐμοὶ μὲν οἰκτρόν, ὦ φίλε, φαίνεται καὶ ἄζηλον, ἑτέροις δ' ἴσως καὶ ἐπαχθὲς φαίνεται καὶ φορτικόν. "But the old man in public life who undertakes subordinate services, such as the farming of taxes and the supervision of harbours and of the market-place, and who moreover works his way into embassies and trips abroad to visit the emperors and rulers, in which

function of port supervisor among municipal liturgies (or *civilia munera*), and show that this situation, already well established by the late 1$^{st}$ century CE has lasted down to the late Roman empire. In the text of Plutarch, the *λιμένων ἐπιμελεῖαι* (supervision of harbours) are listed among *τὰς ἐν πολιτείᾳ διακονικὰς λειτουργίας* altogether with *τελῶν πράσεις* (tax exactions), *ἀγορᾶς ἐπιμελεῖαι* (market surveillance, generally called *ἀγωρανομία*) and embassies to the emperors. They were, then, to be considered as *munera civilia publica*, the Latin expression of *τὰς ἐν πολιτείᾳ διακονικὰς λειτουργίας*. Plutarch gives the person in charge of the port the title of *epimeletes*, which is the Greek equivalent of the Latin *curator*. A port supervisor would then have been called in Latin *curator portus*.

According to Aurelius Arcadius Charisius these were called *limenarchae*[240]. He is confirmed by two inscriptions from Ephesus[241] where the function of *λιμενάρχης* is mentioned in lists of positions that include agoranomes, making it clearly a liturgy or *munius*, in accordance with both Plutarch and Aurelius Arcadius Charisius. They apparently wanted to point out that although these supervisors had the capacity of using public funds in the exercise of their office (*facultas erogandi pecuniam publicam*) they nevertheless were *munerarii* rather than magistrates. The distinction between *honores* and *munera* may have been tiny and sometimes unclear, as was the case of the *quaestura* considered in some cities as a magistracy (*honos*) and in other ones as a *munus*[242]. Two inscriptions who use the verb *limenarcheïn* at Arados in Syria[243] and at Kreusa[244] (the main harbour of Thespiae in Boeotia) seem to confirm that these were considered magistrates rather than *munerarii* in these two particular cities.

The silence of epigraphic evidence about that kind of function can be explained by the lack of social legibility, dignity, prestige and glory, attached to *munera* / liturgies, these being tasks performed by the effect of an order rather than by choice, placed under the command of magistrate, deprived of *potestas* or direct *facultas iubendi*, and that, contrary to euergetism, normally implied no personal expense[245]. This is why there was generally no reason to mention such offices in inscriptions displayed in public space, unless they had been managed in an exceptional way, or in cities such as Ephesus, where *munera* were mentioned together with *honores*.

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there is nothing indispensable or dignified, but which are merely services and seek of gratitude, seems to me, my friend, a pitiable and unenviable object, and to some people, perhaps, a burdensome and vulgar one" (transl. Goodwin).

[240] The word *limenarches* used by Charisius probably reflects the prevailing denomination. Plutarch's text is closer to the Greek tradition and describes rather than it names the function. Raschke 1978, n. 566 p. 778, had already noticed that the word *limenarches* had probably had several meanings. It is obvious that most all other occurrences, especially in *papyri*, refer to customs and tax-gathering (*portoria*) rather than to ports.

[241] *Inschr. v. Ephesos*, t. II n° 558.1, p. 229; t. III, n° 802, p. 148-149.

[242] Aurelius Arcadius Charisius (= *Dig*. 50.4.18.2): *Et quaestura in aliqua civitate inter honores non habetur, sed personale munus est*. "In some cities, even the *quaestura* is not listed among the magistracies, but is a personal *munus*."

[243] *IGLS* VII 4016 bis (Aradus, Syria, ca 207 CE)

[244] *IG* VII. 1826 (Kreusa, Beotia, on the harbour, 2$^{nd}$ cent CE?). Kreusis was the port of Thespiae, cf. Strab. 9.2.14; 25.

[245] Aurelius Arcadius Charisius (= *Dig*. 50. 4.18.10) explicitly mentions the use of public funds (*si tamen pecuniam publicam in operis fabricam erogent*) by these *munerarii*. The expression *limenarcha creato* in *Cod. Justin*. 7.16.38 (Dec. 294) in relationship with *res publica* leads us to the same sphere of municipal officials. Callistrate (*I Cognition.* = *Dig*. 50.4.14.1) gives a clear definition of the munus publicum: *Publicum munus dicitur, quod in administranda re publica cum sumptu sine titulo dignitatis subimus*. "We call public *munus* anything we undergo in the administration of the *res publica* with an expense and without any motive of dignity". About *munera* as the effect of an order or customary constraint, Marcian, *I publicorum iudiciorum* = *Dig*., 50.16.214 (*"Munus" proprie est, quod necessarie obimus lege more imperiove eius, qui iubendi habet potestatem*. "*Munus* is, properly speaking, any appointment we take on by an effect of Law or custom, or in execution of an order of those who have the power to give orders"); cf. also Paulus, *I responsorum* = *Dig*., 50.1.21. pr. Because *munera* were placed under the orders of others and bore no dignity to the munerarius, there was no reason to celebrate *munera* in inscriptions, unless in exceptional situations.

It is still uncertain whether the *epimeletaï/curatores* and *limenarchaï* were exactly what would be modern harbourmasters, or if they were rather in charge of the infrastructure, but it is quite certain that cities had, at least nominally, full authority over their harbours. Initiative and decision-making must then have been left to the city and to its institutions. We must imagine that in the West, this was the task of the *aediles*, and by delegation that of special curators. Decisions may have followed the usual decision-making process in cities, and were decrees created by the ad hoc assembly, the *ordo*, the *boulè*, or the *ekklèsia*, depending on the city's constitution. If the capitals found along the jetty at Gightis, in front of Girba in Lesser Syrtis, did actually belong to the jetty and have not been re-used, then this may have belonged to the same town planning initiative as the forum where exactly the same capitals were found[246]. We know that at Smyrna, the harbour – or part of the port – had been funded by a subscription[247].

### (H3) 1.3. The authority of the city challenged by imperial Governors?

This scenario fits well into the perspective we now have on the "privilège de liberté" of Roman imperial cities. But some scholars still are reluctant to give full space to this vision and insist on the idea that this would be mainly the case of *civitates liberae*. They often argue that the case of the harbour at Ephesus shows that this was not the case of civitates stipendiariae. Some have seen in the interference between the governor and the city a clue of the status of *civitas stipendiaria* of Ephesus, instead of that of *civitas libera*.[248]

A famous decree[249] of the proconsul L. Antonius Balbus, dated 147 CE, apparently gives the proconsul full authority upon the harbour. The severity and the apparent impoliteness of the general tonality is obvious and contrasts the usual deference of governors towards cities, even when these did not use to be *civitates liberae*. Albeit this, the governor is very careful, and is

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[246] Slim/Trousset/Paskoff/Oueslati 2004, 126-128, n° 61

[247] Petzl 1987, 191, n° 696

[248] Guerber 1995.

[249] *SEG* 19.684 = *AE* 1967. 480 = *IvE* 23 (AD 147) : [Ἀγαθῇ] · Τύχῃ· | Λ. Ἀντώνιος Ἄλβος ἀνθύπατος | λέγει· | Εἰ τ[ῇ μεγίσ]τῃ μήτροπόλει τῆς | Ἀσίας [καὶ] μόνον οὐχὶ καὶ τῷ κόσ|μῳ [ἀναγκ]αἰόν ἐστιν τὸν ἀποδεχό|μενον τοὺς πανταχ[όθ]εν εἰς αὐ|τὴν καταγομένους λιμέν<α>[249] μὴ | ἐνποδίζεσθαι, μαθῶν τίνα τρόπον | βλάπτ[ου]σι, ἀναγκαῖον ἡγησάμην | διατάγ[μ]ατι καὶ κῶλῦσαι καὶ κατὰ τῶν ἀπει|θούντων τ[ὴ]ν προσήκουσαν ζημίαν ὁρίσαι. |παραγγέλω [οὖ]ν καὶ τοῖς τὰ ξύλα καὶ τοῖς | τοὺς λίθους ἐνπορευομένοις μήτε τὰ ξύλα | παρὰ τῇ ὄχθῃ τιθέναι μήτε τοὺς λίθους | πρίζειν· οἱ μὲν γὰρ τὰς κατασκευασθείσας ἐπὶ | φυλακῇ τοῦ λιμένος πείλας[249] τ[ῷ] βάρει τῶν φορτίων | λυμαίνονται, οἱ δὲ ὑπὸ τῆς ἐνειεμ[έν]ης σμείρεως | [...]ερτης, ἐπεὶ εἰσφερομένη τὸ βάθος [συ]νχωννύντες | τὸν ῥοῦν ἀνείργουσιν, ἑκάτεροι δὲ ἀνόδευτον | τὴν ὄχθην ποιοῦσιν. ἐπεὶ οὖν ἐπιθεμέ[νο]υ μου | οὐκ ἐ[γενε]το ἱκανὸς Μάρκελλος ὁ γραμματεὺς | ἐπισχεῖν ἄν ὡς τὴν θρασύτητα, ἴστωσαν ὅτι | ἄν τις μὴ γνοὺς τὸ διάσταλμα καταλημφθῇ τῶν | ἀπειρημένων τι πράττων, ἐσοίσει | τῇ ἐπιφανεστάτῃ Ἐφεσίων πόλει καὶ οὐ|δὲν ἧττον αὐτὸς τῆς ἀπειθίας ἐμοὶ λόγον | ὑφέξει· τοῦ γὰρ μεγίστου αὐτοκράτορος περὶ | φυλακῆς τοῦ λιμένος πεφροντικότος | καὶ συνεχῶς περὶ τούτου ἐπεσταλκότος | τοὺς διαφθείροντας αὐτὸν οὔκ ἐστιν δί|καιον μόνον ἀργύριον καταβάλλοντας | ἀφεῖσθαι τῆς αἰτίας. προτεθήτω. | Γραμματεύοντος Τι. Κλ. Πο|λυδεύκου Μαρκέλλου Ἀσιάρχου. "To the Good Fortune. Words of L. Antonius Albus, proconsul: "If it is necessary not only to the greatest metropolis of Asia, but also to the Universe not to hinder the harbour that shelters those who come to it from everywhere, when I learnt that some had found a way to take rid of this, I thought it necessary to use constraint and to determine against the disobedient ones the convenient penalties. I therefore declare that it is forbidden to the timber- and stone-traders to place timber and to saw stone on the quay: these in fact cause damage to the *pilae* that have been set up for the protection of the harbour, the former because of the weight of the loads, the latter because of the reject of the waste pieces of stone, for they silt the depth of water with this deposit, and therefore prevent the water from flowing; the former as the latter equally make the quay inaccessible. Given that the Secretary (of the People) Marcellus that I had urged to enforce their offence, has proved to be unable to do so, let them understand that any one who, taking rid of the regulation, should be caught having done something in contradiction to these dispositions, will be tried by the tribunal of the most splendid city of the Ephesians and that he nevertheless will render account to me of his disobedience. For, as the greatest emperor has been preoccupied with the protection of the harbour and has continuously sent edicts on the matter, it would not be right that people who take rid of him, would only pay the fine and escape this accusation. Let (this decree) be displayed. Being Secretary (of the People) Tiberius Claudius Polydeucus, Asiarch." On this text see Hurlet 2007, 150-151, who insists on the excellent relationship between Ephesus and Antoninus (cf. also Halfmann 2004, 100 ss.) as cause for this edict.

fully conscious that he is interfering with the sphere of authority not only of this particular city, but also of his higher magistrate, who happened to be also an Asiarch. He therefore emphasises the reasons why he had to interfere through this decree. The harbour of Ephesus, he says, was not only Ephesus' matter. It also impacted the rest of the world. It is only because, despite a municipal decree, local institutions had failed to fix the problem that he had to intervene on behalf of larger, or even global, concerns, and on the ground of the special ties that existed between Antoninus Pius and Ephesus. These ties as well as the common interest of the empire had eventually made Antnoninus Pius the guardian of the port of Ephesus. His governor eventually was not stepping into the city of Ephesus' shoes. He came as support to the city, to increase the latter's efficiency. The municipal decrees remained valid, and offenders still were liable to the city. But the governor considered that these had also offended the emperor and were for that reason liable to him. The context makes Antonius Albus' edict very original, and in a way contradictory. At one hand the authority of the city over its harbour remained unchallenged; at the other hand, because the city could only impose fines, which were not sufficient to provide results, and since the interest of the rest of the empire was involved and more severe penalties were needed, the only competent tribunal was the governor's or the emperor's.

The situation of Ephesus was anyway specal. Under the Flavians, during more than ten years, the magistrates of the city had been replaced by an *episkopos*, appointed by the emperor[250]. Also, the port was under the permanent threat of silting. In any case, interventions of the governor had never abolished the authority of the city over its own harbour.

### (H3) 1.4. *Portus Augusti*: the emperor and his representatives in imperial ports

But a few harbours were probably placed under the direct authority of the emperor This was undoubtedly the case at *Portus Augusti*, and probably at *Centumcellae*[251] and *Portus Iulius*, as the name itself shows, and where no city had the authority over the harbour. The situation of Puteoli, where a *procurator portus Puteol(ani)*, who had its *origo* at Puteoli, may well have been a municipal *procurator* rather than an imperial one[252], is less clear.

Even in these cases, it is difficult to find an explicit authority over the harbour. Although our knowledge of port administration at Portus has been much improved thanks to G.W. Houston and C. Bruun[253], some essential points remain under discussion. Among these is the exact sphere of authority of the *procuratores portus Ostiensis* and later *procuratores portus utriusque*, which is far from being clear. The latter (who have apparently replaced the former after the building of Trajan's harbour) are likely to be the same as the *procuratores Augusti* whose names appear on at least 14 lead pipes at Portus and Ostia, and who were placed under the authority of the *a rationibus*. This is the opinion of Houston, following Pflaum, but this

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[250] Kirbihler 2005.

[251] Pliny the Younger, *Ep*. 6.31.7: *Habebit hic portus, et iam habet nomen* ("this harbour will bear and already bears the name of his founder") *CIL*, 6675,5 = *CIL* XV, 6: *Port(us) Trai(ani)*.

[252] *AE* 1972, 79 (Pozzuoli | Puteoli): *Sucessi || mirae prosapiae adque | nimiae integritatis | Iulio Sulpicio Sucesso v(iro) e(gregio) p|atrono c(oloniae) | procuratori portus Puteol(anorum) | ob meritis et adfectione | amoreque eius erga cives et patria(m) | ut ordo splendidissimus populusq(ue) | Puteolanus comprobavit | regio decatriae cultores dei patri | vexillari statuam ponendam | sollicite adcura(ve)runt || dedicata VI Idus Aug(ustas) | T(ito) Vitrasio Pollione II M(arco) Flavio Apro II co(n)s(ulibus)*. "Statue of Successus, to a man of astonishing origin and highest integrity. To Iulius Sulpicius Severus, *vir egregius*, patron of the colony, procurator of port of Puteoli, in reward of his merit, love and affection towards his fellow-citizens and homeland, the *regio decatriae*, the flag-bearer worshippers of the home-god, have attended with special attention to the provision of erecting the statue. Dedicated The 6th of the Ides of August, under the second joint consulate of Titus Vitrasius Pollio and Marcus Flavius Aper" The inscription has been engraved on a re-used pedestal, and is not clearly dated, for the date inscribed belongs to the first stage of the pedestal. Previous dating relies upon the postulate that the man is an equestrian imperial procurator, and that this is necessarily posterior to the one at Ostia. If the ducenarius at Ostia had soon been replaced by freedmen, the interpretation and dating of this inscription must be revisited.

[253] Houston 1980; Bruun 2002.

hypothesis has been rejected by C. Bruun, on the ground of what appear to be rather week arguments. My opinion is that the presence of the same name (*Agricola*, much rarer than argued by C. Bruun[254]), in the same reign, on a lead pipe[255] and on a public inscription left by a *procurator portus utriusque*[256] leaves little space for doubt. If so, the *procuratores portus utriusque* were placed under the authority of the *a rationibus*, and were in charge of imperial estates. They were usually freedmen, and only in one occasion was the position opened for people of higher status, in that case a ducenarius knight[257]. Evidence seems to contradict the idea that the equestrian *procuratela*, attested only once just before the *millenium urbis*, introduced a new sustainable status of the office[258]. The fact that these procuratores, placed under the authority of the rationalis, intervene in the water supply of Tor Boacciana[259], the lighthouse at the mouth of the Tiber, as well as in other sectors at Ostia, and at Portus seem to indicate that their authority extended to any imperial estate or infrastructure, either at Ostia or portus. But these were clearly not harbourmasters *stricto sensu*.

Their authority could be challenged by higher authorities in the hierarchy of state apparatus. Officials of the Annona office could take decisions regarding the harbour at Portus. In 210 CE, the *Praefectus Annonae* could bound the area whence it was legal to extract sand for ballasting the ships[260]. A papyrus[261] confirms that ships sailing back from Ostia to Egypt were sailing with ballast. Ballasting empty ships without causing harm to the port of destination of Annona could naturally be considered as part of the power of the Praefectus. This does not mean that the *praefectus Annonae* was in charge of the port. His presence at Portus is as discrete as is that of his administration[262]. But his personal statute and place in the hierarchy of the State officials, as a *perfectissimus*, assisted by the dreadful *frumentarii* and under Constantine (or just

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[254] Although *Agricola* is rather common among citizens, I could find only one other occurrence of a slave or freedman bearing this name within the limits of the empire. This took place in the reign of Trajan at Rome, and the individual also belongs to the *familia Caesaris CIL* VI, 8533 (p. 3890).

[255] *CIL* XIV, 5309,22 = *AE* 1913, 82b.

[256] *CIL* XIV, 125 = *IPOstie-B*, 324 = *D* 2223 Ostia Antica (AD 224).

[257] *CIL* XIV, 170 = *CIL* VI, 1624 (p. 3811, 4721) = *IPOstie-B*, 338 = *D* 1433 = *Tyche*-2010-89 (Ostia Antica, 247 CE).

[258] A freedman *procurator* is mentioned again later on a lead-pipe under Trebonianus Gallus, *CIL* XIV, 5309,26 = *AE* 1913, 83.

[259] *CIL* XV, 7746-7747

[260] *AE* 1977, 171 (Portus) : *Sicut coram praecepit / v(ir) p(erfectissimus) Messius Extricatus / praef(ectus) ann(onae) titulus ponetur / qui demonstret ex quo loci / in quem locum saborrariis / saborram tollere liceat factum / autem opus est ut idem titulo / retro omnium praefectorum / litterae instruantur quibus / de podismo est statutum quibusque / suam auctoritatem idem v(ir) p(erfectissimus) / manere praecipit titulus / scri<p=B>tus per / Iulium Maternum / l(centurionem) fr(umentarium) XV Kal(endas) Octobr(es) / Faustino et Rufino co(n)s(ulibus) / cura(m) agente M(arco) Vargunteio / Victore*. "In accordance with the personal instructions of the perfectissimus Messius Extricatus, prefect of the Annona, let an inscription be placed to indicate from what to what place the saborrarii have the right to remove sand for ballasting (saborram); and that on the back of this inscription the letters of all the prefects taking decisions concerning the footage of this area and through which the *perfectisismus* had given orders to make his authority sustainably unchallenged. Written by Iulius Maternus, centurio frumentarius, The 15th of the Kalendae of October, under the consulate of Faustinus and Rufinus, under the supervision of Marcus Vargunteius Victor" (September 16th, 210 CE)

[261] PBingen 77.

[262] The *adiutor / praefecti annonae ad horrea Ostiensia et Portuensia* "assistant of the prefect of the *Annona*, in charge of the warehouses at Ostia and Portus" (*IDRE*-2, 435 = *AE* 1983, 976 = *AE* 1987, 1026, Maktar) is the same as the *adiu/tori Ulpii Saturnini praef(ecti) annon(ae) / ad oleum Afrum et Hispanum recen/sendum item solamina transfe/renda item vecturas nav{i}cula/riis exsolvendas* "assistant of Ulpius Saturninus, prefect of the *Annona*, in charge of inventory of the African and Spanish oil, of transportation of the surplus and to pay the transport to the *navicularii*"(*CIL* II, 1180 = *D* 1403 = *CILA*-2-1, 23 = *IDRE*-1, 179 = *AE* 1965, 237 = *AE* 1971, 171 = *AE* 1991, 993. Séville, à la base de la Giralda), and his office seems to have been exceptional, cf. Erkelenz 2007, 298 et n. 39. The activity of the *proc(urator) annonae Ostiae et in Portu*, known in the late years of Trajan's reign (*ILTun* 720 = *RHP* 171 = *IDRE*-02, 424 = *AE* 1939, 81a) has just left no trace at Portus itself…

after his death) granted the *ius gladii*[263] made him one the most powerful men of the empire. The inscription of 210 CE shows that, at the end of Severus' reign, the authority of the *Praefectus Annonae* upon the infrastructure at Portus was not as firm or accepted as it might have been, for he had to engrave the copy of the letters of his predecessors who had founded this self-proclaimed authority in order to provide his decision and the authority it was based with a sustainable existence.

As far as we know, the imperial administration of Portus looks much more like an administration at Portus than an administration of the harbour of Portus, properly speaking. It seem to be the result of a cloud of possibly conflicting authorities, whose hierarchy could be that of the chief officials, the *praefectus Annonae*, the *a rationibus*, etc. The increasing authority of the *praefectus Annonae* and of the *frumentarii* since the reign of Severus gave him a special importance in this game of influence, and probably not only at Portus. The latter may have played a great role in the circulation of information between the provinces and the emperor as well as the regional *procuratores Annonae*[264].

## (H2) 2. Funding building and maintenance: Protectors and Benifactors, the emperor and some others

Funding imperial harbours was by nature the emperor's affair. As far as Roman imperial cities were concerned, we know in general that their public incomes tended to be significantly inferior to the actual level of their expenses, and that funding monuments and infrastructure was made possible with the help of local euergetism or with that of the emperor, especially in the case when huge works were necessary. We therefore must check whether ports building and maintenance fitted within this general pattern of civic life under the Roman Empire.

### (H3) 2.1. The emperor and others

I have recently pointed out that all dedicatory inscriptions relating to maritime infrastructure building mention the emperor the performer of the celebrated achievement. This opinion must be nuanced. A couple of inscriptions actually mention port building activities which have no relationship with the emperor. Some, such as at Smyrna, were public subscriptions to collect money in order to achieve what is described as "building the port" (*kataskeueïn ton limena*)[265]. The same expression occurs in several inscriptions at Ephesus, where funding the "building of the port" appears to be rather common. The sums spent by a single person on such occasions vary, during the same reign of Trajan, from 2,500 to 75,000 *denarii*[266]. These amounts are relatively small in comparison with other known construction costs[267]. Both their rhythm and amounts exclude that these were more than limited refitting or

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[263] *CIL* VI. 1151 (p. 845, 3071, 3778, 4329, 4340) = *CIL* VI. 31248 = *D* 00707 (Rome); *CIL* VI. 41293 (Rome); *CIL* VIII. 5348 = *CIL* VIII, 17490 = *ILAlg* 1, 271 = *D* 01228 (Guelma / Calama) ; *CIL* X. 1700 = *D* 1231 (Pozzuoli / Puteoli) ; *CIL* XIV. 135 (p. 613) = *EE* 9, 334 (Ostia Antica); *CIL* XIV. 4449 = Thylander, *IPOstie* B, 336 (Ostia Antica). The inscriptions from Rome (*CIL* VI. 1151), Portus (*CIL* XIV. 4449) and Guelma, in Africa (*CIL* VIII. 5348 = *CIL* VIII, 17490), refer to the same L. Crepereius Madalianus (*PLRE* 1.530; Scharf 1994, 66-68). These are the oldest extant mention of a *Praefectus Anonae cum iure gladii*. He was *Praefectus* when the news of Constantine's death (May 27th, 337) reached Rome, and was already *vicarius Italiae* 341 CE (*Codex Theodosianus* 16.10.2).

[264] About the role of *frumentarii*, see Rankov 2006. For regional *procuratores Annonae*, see *CIL* XII, 672 (p 817) = *D* 1432 = *CAG*-13-05, p. 676 = *ZPE*-63-173 = *AE* 1981, 400 = *AE* 1984, 631 = *AE* 1986, 479 = *AE* 1987, 753 dedicated to a *procur(ator) Augustorum ad annonam provinciae Narbonensis et Liguriae*.

[265] Petzl 1987, n° 696, p. 191.

[266] *IvE* 2061.II, l. 13 ss. About these interventions at the port of Ephesus, see Kokkinia 2014.

[267] The highest amount is 75,000 *denarii* or 300,000 *sestertii*, but this amount reflects the particular situation of the benefactor, a Roman knight from another city, who had probably invested much more in the works at the theatre where he is celebrated, and that he is said to have erected (Halfmann 2004, 88). In the same reign in Bithynia, Pliny the Younger gives the cost of a first aqueduct at Nicomedia as 3,318,000 *sestertii* (equal to 830,000 *denarii*). The cost of the 38 km long aqueduct built at Ephesus by Aristio and his wife together with one

embellishment works. The amounts were not determined by the needs of the harbour but rather by the customary amounts that people reaching certain positions had to spend. 70,000-75,000 *denarii* were the customary amount expected of a High Priest's liberality[268]. This hardly could finance real port building, but maybe parts of it[269].

Some have supposed a similar process at Cartagena where an individual would have paid for the building of three *pilae* and *fundamenta*, but it has been recently argued with convincing arguments that these projects did not actually refer to the harbour[270]. It appears that in the inscriptions from Ephesus, "limèn" means the basins and their limits (piers, wharves, quays, breakwaters) but not other features (porticoes), in accordance with Opramoas of Rhodiapolis who is said to have spent 18,000 denarii for rebuilding the double portico of the harbour after an earthquake at Patara in Lycia[271], and calls it the portico "near the harbour", exactly as Vitruvius[272] speaks of porticoes "around the harbour", although these used to be located on the sea-front, along the quays.

Individuals funding "oversized" project would inevitably have been considered as challenging the emperor. This is in a way what happened to a certain T. Claudius Aristio who had built altogether with his wife Iulia Claudia Laterane, a 38 km long aqueduct, and relating monuments: a monumental fountain and two nymphaïa, whose total cost is not given but estimated to amount to several million *sestertii*[273]. As a result he was brought to the tribunal of the emperor by a *delator* at the initiative of his enemies, but eventually acquitted[274]. The highest known contribution to harbour building at Ephesus – 75,000 *denarii* – is roughly equal to the highest contribution to public buildings known from Pergamon[275] in the reign of the same emperor. Neither the size of these operation nor their conventional amount, nor even the

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monumental fountains and two *nympheïa*, including the one dedicated to Trajan, may have reached a couple million (Halfmann 2004, 89-91). The cost of the theatre at Nicaea had already reached the amount of 10 million *sestertii* (or 2.5 million *denarii*) when it was still not completed. The data gathered by Duncan-Jones 1974, 89 ss and 157 ss. indicate that this was the average price of municipal baths in medium or small towns of Italy during the 2nd century, and more or less the price of a quadrifontal arch at Teveste in Africa (214 CE) and half the price of a monumental fountain at Caputamsaga. The *proscaenium* and *frons scenae* of the theatre at Leptis Magna cost half a million *sestertii* in 157/8. Building harbours such as Ephesus' must have cost millions of *denarii*. We must probably think of smaller restorations or mere restyling.

[268] Karwiese 1995, 110; Engelmann 1996, 93.

[269] A mutilated and undated inscription found in Trajan's Nymphaeum at Ephesus (*IvE* 1391), nevertheless considers the harbour's building completed (this may well refer to some other Aristio's and wife's gift to the city); the exact meaning of this inscription is very unclear. Other two inscriptions refer to port building by individuals under Trajan (*IvE* 2061; 3066).

[270] *CIL* II, 3434 = *CIL* II, 5927 = *CIL* I, 2271 (p.1104) = *CartNova* 1 = *ILLRP* 778 = ELRH-C 10 = *HEp-18*, 257 (Cartagena / Carthago Nova). Gianfrotta 2009, 103-105 rightly rejects as parallel two coetaneous late republican inscriptions from Capua where similar liberalities including *pilae* cannot refer to parts of a port : *CIL* X, 3774 = *CIL* I, 673 (p. 930, 931) = *ILLRP* 706 and *CIL* I, 2944 (p. 930) = *AE* 1952, 55 = *ILLRP* 708 (Capua).

[271] *IGRP* III. 739 (Rhodiapolis, the inscription engraved in Opraomas' grave is a list of decrees and official documents with the never-ending list of his gifts to Lycian communities): XVII, ll. 68-70 ὑπέσχη]|το δὲ καὶ ἄλλα [εἰς κατασκευὴν τῆς] || πρὸς τῷ λιμένι στοᾶς αὐτῶν; XVIII. 85-90 τῇ μὲν || Π]αταρ[έ]ων πόλει πρότερον μὲν ἀργυ[ρίου δηνάρια | δισμύρια, πάλιν δὲ ἀλλα εἰς κατασκε[υὴ]ν | στοᾶς διπλῆς τῆς πρὸς τῷ λιμένι ἤδη δηνάρια [μ]ύ|ρια ὀκτακισχείλια ὑποσχόμενος καὶ ὅλον τὸ ἀνάλωμα πληρώσειν. To the city of Patara, he had first given 20,000 *denarii* in silver, after he had given already 18,000 denarii for the building of the double portico near the harbour

[272] *Arch*., 5.13

[273] *IvE* 234, 424, 424 A, 3217. For the entire affair and the estimation of the amount, see Halfmann 2004, 89-91.

[274] Pliny the Younger had been invited by the emperor to attend his council at Centumcellae when this affair was judged. He gives us the following account of the story (*Epist.*, 6.31.3): *Dixit causam Claudius Ariston princeps Ephesiorum, homo munificus et innoxie popularis; inde invidia et a dissimillimis delator immissus, itaque absolutus vindicatusque est*. "Claudius Ariston, who has the first rank among the Ephesians, made his plea. He is a man of great munificence and unambitious popularity, and for that reason had aroused the envy of persons his opposites in character, they had instigated a delator. For these reasons, he has been acquitted and restored to his honour".

[275] 70,000 *drachmaï* (= *denarii*) for the portico of the Gymnasium, cf. *IGRP* IV 501.

collective character of subscriptions could break the unwritten law that made port building a privilege of the emperor. Even governors could be subject to the same rule. In the reign of Nero, Q. Marcius Barea Soranus proconsul of Asia had built some infrastructure within the harbour (he had "opened" the harbour) [276], and faced the emperor's anger for having done what was considered by Nero his own privilege.

As usual in Roman imperial cities, infrastructure was essentially based upon euergetism - imperial euergetism when greater works were concerned, private initiative in the case of smaller projects. The building of infrastructure thereby was fragmented in micro-interventions whose purpose was symbolic rather than really pragmatic. Even the maintenance was the affair of euergetists. At Ephesus again, at some time after 212 CE, a High priest offered the city the dredging of the harbour on occasion of his new position[277]. The amounts and purposes of each liberality were highly conventional and had to contribute to the greatness of the city and to the welfare of its citizens. Members of the elite had to spend customary sums for the benefit and prestige of the city when they reached certain positions, but, at least to some extent, they were free to choose the purpose of their funding. Some chose the harbour. The reason may have been primarily symbolic. Their decision to fund works at the port rather than games or the Gymnasium or baths supposes that the port was in the communities' mind both in terms of its symbolic value for the city's greatness (especially when similar works may have been undertaken in a rival city, such as Smyrna) and of its wealth and in terms of preoccupation: at Ephesus these operations concentrate in Trajan's reign, just before Hadrian eventually diverted the river's course, and one century later, the level of silting of the harbour may have been troubling enough to justify the donator's choice. But eventually the reason for bringing money to the port's "building" or maintenance was basically the promotion of individuals to higher positions. These were close enough to their city and fellow-citizens to appreciate when it was appropriate to fund games, works at the port, at the Gymnasium or rather at the Baths. Here again the reasons may have been if not purely, at least highly symbolic, but we have found no trace of any project of great relevance in terms of amount.

Subscriptions may have allowed for more significant undertakings, although no amount is known so far; but when huge works were needed, the city had to turn to the emperor, for he not only had the wealth, but also the engineers and architects necessary to achieve larger projects involving diverting rivers, deep excavations or building moles in open water.

**(H3) 2.2. The emperor as protector and saviour of mankind: lighthouses and port building.**

The question of the conventions that framed dedicatory inscriptions of monuments on behalf of the emperor is a general one: it is not specific to port infrastructure, and has already been studied as a whole[278]. Ports are not that different from other projects as long as single buildings were concerned: moles, warehouses or porticoes were all features whose building was at hand of wealthy individuals[279]. Huge and extraordinary works, such as lighthouse or port building were different from smaller buildings, and pose the question of the difference of nature of infrastructure projects undertaken made by the emperor, Lord of the land and the sea, acting for the common good, and of gifts addressed to a special community, usually a city, that made the emperor but the wealthiest among other euergetists.

The first duty of the sovereign was the protection and welfare he owed to any of his subjects, without consideration of any special favour to individuals or groups. One of the main aspects of the Roman image of the sovereign (as well as, earlier, of that of the Ptolemies) is

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[276] Tac. *Ann*. 16.23. He was in charge before 63, maybe in AD 61, and was sued in AD 65 *quia portui Ephesiorum aperiendo curam insumpserat.* "because he had bestowed pains on opening the port of Ephesus".
[277] *IvE* 3071
[278] Horster 2001.
[279] Arnaud 2014.

based upon his *pronoïa*/*providentia*, whose instrument was *epimeleïa / cura* stronger than constraints of Nature (*physis*)[280]. This consists in challenging nature thanks to technical achievements made possible not only by the extraordinary wealth, but also by the over-human mind and divine nature of the emperor, in order to provide welfare, a better life and a higher level of security for mankind.

The lighthouse built on the island of Thasos by a certain Keratos was much older than Ptolemy II's famous lighthouse at Pharos. Both dedicatory inscriptions were referring to the "salvation[281]" (s) of sailors[282]. The proposed reconstruction of the dedicatory inscription of Caesarea Maritima's lighthouse is unfortunately too fragmentary and Alföldy's reconstruction too hazardous to give us sufficient ground for discussion[283], but very similar words are found in the dedicatory inscription on Nero's lighthouse at Patara, dated 64-65 CE[284]. This inscription sheds interesting light on lighthouse building, first because it has been the work of the emperor, although there is no direct relationship to the travels of the emperor. We have seen that Tacitus considers this the main reason why the proconsul of Asia undertook efficient works at the harbour of Ephesus. It was basically the emperor's duty – at least according to the point of view of some. But it is the governor who is much honoured. He had been involved not only in building Nero's lighthouse – not a very big one, actually – and the complementary lighthouse, called *antipharus*, but also in other more usual building activity. The latter qualified him for the

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[280] See, e.g. Strabo 16.1.11 ; 17.1.3 ; 17.1.42 and Arnaud 2008. *Providentia*, which is the expression of both human foresight and divine providence also occurs twice in relationship with huge work in Pliny the Younger's and Trajan's correspondence (*Epist*. 8.17.2; 10.62).

[281] Pliny the Younger (*Ep*. 6.31.7) tells of the port of Centumcellae: *hic portus (...) eritque vel maxime salutaris* "This port will also be essentially saving (people)".

[282] Thasos : *IG* XII, 8, 68 : [ ʼΑ]κηράτο ε[ἰ]μὶ μνῆμα | το Φ[ρασ]ιηρίδο, κειμαι δʼ ἐπ'[ἄ]κρο | Ναυσ[τ]ά[θ]μο σωτήριον νηυσίν | τε κα[ὶ] ναύτηισιν ἀλλὰ Χαίρετε "I am the memorial of Akeratos, son of Phrasierides, and I lie at the naval port's utmost point, salvation to ships and to sailors: so farewell!". According to Lucian (*Hist*. *conscr*. 62), the text of the dedicatory inscription of Pharus Lighthouse read as follows : Σώστρατος Δεξιφάνους Κνίδιος θεοῖς σωτῆρσιν ὑπὲρ τῶν πλοϊζομένων. "Sostratos son of Dexiphanes of Cnide, to the Saving Gods in favour for those who sail"; Strabo (17,1,6, C 791) gives another version of the same text: τοῦτον δʼἀνέθηκε Σώστρατος Κνίδιος, φίλος τῶν Βασιλέων, τῆς τῶν πλοϊζομένων σωτηρίας χάριν, ὥς φησιν ἡ ἐπιγραφή *"Sostratos of Cnide, a friend of the Kings, has built (this tower) for the salvation of those who sail*, says the inscription"

[283] *AE* 1999,1681 = 2000, 1518 = 2002, 1556 = Lehman / Holum 2000, nr 43 p. 67-70. The late G. Alföldy (Alföldy 1999; 2002) identified the *Tiberieum* dedicated by Pontius Pilatus with Josephus' *Druseum* (*BJ* 1.412 ; *AJ* 15.336), this being also the lighthouse of Carsarea Maritima's harbour, an interpretation eventually accepted by Grüll 2010, 152-153 who had once challenged it; more recently Alföldy (Alföldy 2012) proposed to identify the *Druseum* and the *Tibereum* with the two towers that formed the entrance of the harbour, each being a lighthouse. Although clever and seducing, this interpretation is a bit difficult, and contradicts the traditional location of the lighthouse of Caesarea. İşkan-Işik / Eck / Engelmann 2008, 100 have proposed to restore at the beginning of the inscription *[Nauti]s* which is not very convincing. Although lighthouses are dedicated to the security or salvation of sailors, no preserved inscription appears to have dedicated a lighthouse to sailors.

[284] İşkan-Işik/ Eck / Engelmann 2008, 93 : Dedication of the lighthouse (including the comments of Ch. P. Jones, The Neronian Inscription on the Lighthouse of Patara. Zeitschrift für Papyrologie und Epigraphik, 166, 2008, 153-154): Νέρων Κλαύδιος (...) [αὐτοκρ]άτω[ρ γ]ῆς καὶ θαλάσσης τὸ θ, ὁ πατὴρ πα[τρίδ]ος, τὸν φάρον κατεσκεύασεν πρὸ[ς ἀσ]φάλ[ει]αν [τῶ]ν πλοϊ[ζομένω]ν διὰ Σ[έ]ξτου Μαρκί[ου Πρείς]κου πρεσβ[ευτ]οῦ [καὶ] ἀντ[ιστ]ρατήγου [Καίσαρ]ος [κτι]σα[μένου τ]ὸ ἔργον. "Nero Claudius (…), Lord of the land and the sea for the (-) time, Father of the Fatherland, has built the lighthouse for the safety of those who are sailing, through Sextus Marcius Priscus, Caesar's *legatus pro praetore*, who has made the dedication of the work". Dedication to Sex. Marcius Priscus (*ibid*. p. 94): [Σέξτον Μάρκιον Πρεῖσκον, πρεσβευτὴν Αὐτοκράτορος Οὐεσπασιανοῦ Καίσα]ρος Σεβαστοῦ, ἀντιστράτηγον καὶ πάντων αὐτοκρα[τ]όρων ἀπὸ Τιβερίου Καίσαρος Παταρέων ἡ Βουλὴ καὶ ὁ δῆμος δικαιοδοτήσαντα τὸ ἔθνος ὀκτετίαν ἁγνῶς καὶ δικαί[ω]ς, κοσμήσαντα τὴν πόλιν ἔργοις περικαλλεστάτοις, κατασκευάσαντα δὲ φάρον καὶ ἀντίφαρον πρὸς ἀσφάλειαν τῶν πλοϊζομένων, τὸν σωτῆρα καὶ εὐεργέτην. "(in honour of) [Sextus Marcius Priscus, legate of the emperor Vespasian Caesar] Augustus, and propraetor of all emperors since Tiberius Caesar, the Council and the People of Patara, because he has rendered justice to the (Lycians) with kindness and justice, because he has embellished the city with the most beautiful works and because he has built the lighthouse and the «antipharus» for the safety of those who sail. In honour of their saviour and benefactor".

title of "Benifactor", the former for that of "Saviour". This stresses upon the fundamental distinction between euergetism (benefactor), devoted to a special community and *epimeleïa* for larger groups.

In the current state of epigraphic evidence, the dedicatory inscriptions of Claudius and Trajan found at Portus mention more the positive effect of the canals on the floods of the Tiber than the building of the Port itself. The reason is that these had "freed the City from the threat of floods"[285]. The emperor here again appeared to have played his role as a Saviour.

When Josephus relates the intervention of the emperor Gaius in improving or building harbours in the straits of Messina[286], he does not mention safety nor euergetism but utility (ὠφελεία) in the context of grain supply. According to Josephus, the emperor then paid no special interest for the harbours themselves but rather for the grain supply of Rome. And when Cassius Dio (60.11.1-5) describes Claudius building activity in Portus, he mentions the treatment of famine as the main cause for that decision, while the main reason for the size of the project was the dignity (φρόνημα) and greatness (μέγεθος) of Rome.

As far as we know, imperial attention focused on ports in Rome's supply networks (Portus Iulius, Portus, Cemtumcellae, Carthage, the strait of Messina), and to lesser extent to other harbours – in other words, onto Rome. This is explicit in a 4th century inscription from Rusicade[287], and underlies Antonius Albus' decree at Ephesus. When the latter is concerned, it is interesting that the emperor's and governor's intervention tends to concentrate on sites where the governor was present or involved, mainly in the province's capital or leading cities.

A common point between the decree of the governor L. Antonius Albus and the only dedicatory inscription left by Claudius at Portus is that they tend to give technical details and explanations about the intervention, and the kind of improvement it was supposed to provide. The way the emperor, as well as the elite in charge of the empire and of the cities within it, was able to understand and explain nature and to overwhelm it with science or technology was one of the main qualities that justified the exercise of power. Owning some of the technical curiosities described by Hero of Alexandria, and being able to explain their meaning was something like a justification for a natural aristocracy.

For that reason, neither in Pliny the Younger's Letters, nor in the description of the works of Claudius or Trajan do we find any mention of the decision-making process, nor of other people involved in the process.

Paying interest to technical challenges such as a channel between the sea and Nicomedia's lake was part of the leading class culture and a key for a good governance. Huge works were not only supposed to be useful. They also used to be part of the ideology of power

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[285] Claudius: *CIL* XIV, 85 = *IPOstie* B, 310 = *ELOstia* p. 145 = Horster 2001, p. 269 = D 207 = *Epigraphica* 2002, 140 : *Ti(berius) Claudius Drusi f(ilius) Caesar / Aug(ustus) Germanicus pontif(ex) max(imus) / trib(unicia) potest(ate) VI co(n)sul design(atus) IIII imp(erator) XII p(ater) p(atriae) / fossis ductis a Tiberi operis portu[s] / caus{s}a emissisque inmare urbem / inundationis periculo liberavit*; Trajan : *CIL* XIV, 88 = *CIL* VI, 00964 (p 3070, 4311, 4441) = *IPOstie* B, 312 = *ELOstia*, p .145 = Horster 2001, p. 271 = D 5797a = *Epigraphica* 2002,122 = *AE* 2002, 279 : *[Imp(erator) Caes(ar) divi] / Ne[rvae fil(ius) Nerva)] / Tra[ianus Aug(ustus) Ger(manicus)] / Dac[icus trib(unicia) pot(estate) 3] / im[p(erator) 3 co(n)s(ul) 3 p(ater) p(atriae)] / fossam [fecit] / [q]ua inun[dationes Tiberis] / [a]dsidue u[rbem vexantes] / [rivo] per<e=F>n[ne instituto arcerentur]*.

[286] Ios. *Ant. Iud.* 19,205: ἔργον δὲ μέγα ἢ βασίλειον οὐδὲν αὐτῷ πεπραγμένον εἴποι ἄν τις ἢ ἐπ᾽ ὠφελείᾳ τῶν συνόντων καὶ αὖθις ἀνθρώπων ἐσομένων, πλήν γε τοῦ περὶ Ῥήγιον καὶ Σικελίαν ἐπινοηθέντος ἐν ὑποδοχῇ τῶν ἀπ᾽ Αἰγύπτου σιτηγῶν πλοίων: [206] τοῦτο δὲ ὁμολογουμένως μέγιστόν τε καὶ ὠφελιμώτατον τοῖς πλέουσιν: οὐ μὴν ἐπὶ τέλος γε ἀφίκετο, ἀλλ᾽ ἡμίεργον ὑπὸ τοῦ ἀμβλυτέρως αὐτῷ ἐπιπονεῖν κατελείφθη. "And for any great or royal work that he ever did, which might be for the present and for future ages, nobody can name any such, but only the one that he made about Rhegium and Sicily, for the reception of the ships that brought corn from Egypt; which was indeed a work without dispute very great in itself, and of very great advantage to the navigation. Yet was not this work brought to perfection by him, but was the one half of it left imperfect, by reason of his want of application to it".

[287] *CIL* VIII, 7975 = *CIL* VIII, 19852 = *ILAlg* II.1, 379 = D 5910. *horrea / ad securitatem populi Romani / pariter ac provincialium con/structa*

and of its presentation[288]. The main patterns of the ideological framework of huge works, of which ports were just a part, is well summarized by Pliny the Younger: a providential foreseeing work "worth non only (Trajan's) eternity but also glory, that would be beautiful and of public utility", also a duty – therefore a sign – of the magnanimity of the emperor (*Epist*. 10. 41.1). He would prove himself superior to kings that had left similar works unfinished.

For that reason, elements of the decision-making process are usually not mentioned in order to stress upon the cleverness and divine character of the emperor

Who were the emperor's advisors? A complex cloud, in which "friends" (the so-called *cohors amicorum*), the officials (imperial freedmen, Annona and governors, at Rome and in the provinces) as well as technocrats, involved in the practical realization of projects, were all present. All these people in turn were embedded in networks of client networks, which were part of the social structure of the Roman empire.

Dio's text describing the process of decision making for Claudius' basin at Portus  is almost the only extant evidence for decision-making in harbour contexts. It shows architects and other people advising the emperor not to undertake such a huge work, and the emperor eventually deciding to undertake it. Quintilian suggests that there have been discussions and that the technical point of view of the architects was only part of what might have been a larger debate[289]. Here we encounter a very conventional *topos*: emperors had to undertake over-sized works, even if the risk was high that these would never be achieved. And eventually, the emperor took his decision against the views of his advisors.

The discussion between Trajan and Pliny about the making of a canal between the lake at Nicomedia and the sea (*Epist*. 10. 41; 42; 61; 62) illustrates both the consequences of the visit a governor to a city of his province (Nicomedia) and the steps of the decision-making process. The governor alone realizes how useful such a work would be –a king had started it a long time ago, but had failed to bring the project to its end. He then estimates whether enough inhabitants could be used on the work, this being the first step of the reflection about the feasibility of the work, and then only explores its technical feasibility, with the help and advice of local architects. Then he turns to the emperor for approval and further technical support in order to establish with certainty the feasibility of the work. The emperor alone would decide and become the only official performer of the project.

For the cultural reasons I have tried to underline above, we must not under-evaluate the actual interest and competence of emperors, governors and higher state officials, as well as of members of municipal elites, in engineering as wells technical and architectural issues. The density of official correspondence between the emperor and his governors or other representatives, such as freedmen or procurators, clearly exemplified by Pliny the Younger's Tenth Book of his *Epistles*, a selection of his correspondence with the emperor, established a strong connectivity between the centre of power and the provinces. The ties between governors and the province's capital probably were particularly strong, but visits of the governor to other cities (especially to those who used to be rival of the capital) within his province in turn allowed the emperor to have direct information about several cities, if not about all. This process is well exemplified again by Pliny's correspondence. Infrastructure issues involving bath, aqueducts or canal buildings at Apamea, Nicaea or Nicomedia discussed by Pliny and the emperor all had their origin in the governor's travels. Governors have been essential for the development of some ports like Ephesus and Patara. So have they probably also been for other harbours.

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[288] Leveau 1993.

[289] Quintilian, *Inst. or*. 2.21.18: *ergo cum de faciendo portu Ostiensi deliberatum est, non debuit sententiam dicere orator? atqui opus erat ratione architectorum*. The same author (*Inst. or*. 3.8.16) makes the debate about building Portus the paradigm of debates, altogether with cutting the isthmus at Corinth and draining the Pontine marshes.

The number of imperial *horrea* in several ports outside Rome could establish further connections between ports and the emperor. Such *horrea* existed at Cumae[290], at Luna[291] and outside Italy, at Carthage[292] and Hippo Regius[293], in Africa, at Rusicade[294] in Numidia, and in many other places. Their direct relationship with *annona* has recently been challenged by L. Cavalier.[295] This stimulating article invites us to reconsider the role of warehouses in general as C. Virlouvet did on the basis of the evidence of *Tabulae Sulpiciorum*.[296] This makes little difference for our purpose. Through the administration and administrators of these estates, the emperor had similar to other owners some information about their environment – in that case, the port where they were located.

**(H3) 2.3. Imperial euergetism: the expression of *amor* and *adfectio* towards a city**

When it was the emperor's intention not to serve the common interests of his subjects but to make a gift to a specific community, he moved to the sphere of euergetism. This had its own rules. Euergetism was an ostensible testimony of the personal affection and close relationship between the benefactor and a special group, here, a city. This *adfectio* relied on the personal history of the benefactor, of that of his (or her) family, and on possible common friends. The beloved group was also this, and not that, and the emperor could thus express his preference for a city with respect to another. This is not of secondary importance in a context where cities were friends or foes to each other, and could properly hate each other to such an extent that they could seize any opportunity to humiliate (or even annihilate) the other one (generally a neighbouring one), in the Latin West as well as in the Greek East. This could lead to outbreaks of incredible violence.

The story of the complex relationship between Smyrna, Ephesus and Emperor Hadrian provides a good example of the role of imperial euergetism in expressing the variable level and hierarchy of imperial love, and the emperor's preferences, who were a public humiliation for cities which received less than others or nothing. Smyrna and Ephesus were traditionally rival cities. During his voyage in 124 CE, Hadrian clearly decided to humiliate Ephesus. Although the province's capital, it happened that Ephesus was now ranked only at number three in terms of imperial neocorates, behind Pergamon and the hated Smyrna. The emperor then spent 10 million in favour of Smyrna, but his passage through Ephesus left no trace. He even refused to fund the channelling a small tributary of the river Caystrus and ordered the city to make the work at its own expense. During the second voyage in 129 CE, the Emperor was less rude towards the city. He seized this opportunity to divert the river Caystrus and thus "make the port navigable". It is interesting that even then he did not offer just a sum of money or monuments, but offerings to goddess Artemis and corn-supply. As a reward he was honoured as "founder and saviour" of the city rather as a benefactor. He had not embellished the city, nor had he granted it a second imperial neocorate. He had just saved it. He had not demonstrated any

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[290] *AE* 1912, 251: *Hor(r)ei(s) Mamercianis / Caesaris A(ugusti)*

[291] *CIL* XI, 1358: D*(is) M(anibus) / Cla[u]diaes(!) / Benedictaes(!) / Abascantus / Imperatorum / hor[r]earius / coniugibus si / fecit et cidit / [-------]*

[292] *CIL* VIII, 13190 = *ILTun* 916 : *Dis Man(ibus) sacr(um) / Chrestus Aug(usti) custos / Uti<c=K>a(e) horreorum / Augustae pius vixit / annis LXXX*

[293] *AE* 1924, 36: *Genio et / numini / horreorum / Sabinus / Augg(ustorum) lib(ertus) / c(ustos) s(acrorum) h(orreorum) Hipp(onensium) R(egiorum) / item cura / cancellorum*

[294] *CIL* VIII, 7975 = *CIL* VIII, 19852 = *ILAlg* II.1, 379 = *D* 5910 : *Pro magnificentia temporum / principum maximorum domi/norum orb[i]s Valentiniani et / Valenti[s] semper Augg(ustorum) horrea / ad securitatem populi Romani / pariter ac provincialium con/structa omni maturitate / dedicavit Publilius Caeionius / Caec[i]na Albinus v(ir) c(larissimus) cons(ularis) / sexf(ascalis) p(rovinciae) N(umidiae) Cons(tantinae)*

[295] Cavalier 2012.

[296] Virlouvet 2000.

special love for the city but had made his duty as an emperor saving it from starvation and isolation[297].

Similar huge projects could have a different meaning in other contexts. Vespasian had undertaken major works at the harbour of Seleucia, diverting the waters of the river from the harbour through a tunnel. The reason for this was that he had been supported by the city after the Eastern legions had proclaimed him emperor[298]. So did Severus at Leptis Magna because he was a native son of that city[299]. Similarly, Nero created a colony and built an expensive port at *Antium* because he was born in that very city[300]. Here the ties between these cities and the emperor or members of his family were the key for understanding the possible needs of these cities, but also for deciding the size of sums the emperor or member of his family would spend for them.

In a sense, ports were not very different – but (maybe) in terms of cost – from other monuments or infrastructure projects offered to a number of cities. Cassius Dio[301] mentions ports together with aqueducts, ports, corn supply, distributions in kind (known at Smyrna) and buildings. All these he considers "honours" (τιμαί) rather than infrastructure *stricto sensu*. Although we have noticed that the context for the works at Ephesus was everything but "honours", Dio's account reveal how euergetism was basically understood by his beneficiaries: a mark of honour, rather than utilities. It is worth underlining that this passage actually speaks of a previously unknown level of euergetism reached by one particular emperor: Hadrian. The alleged reason was this emperor's travels.

An inscription from Ephesus brings confirmation and some precision to the Severian historian's witness. Dated 129 CE, it commemorates corn supplies and huge works at the ports (the inscription uses the plural) at the occasion of the emperor's travel, including diverting the Kaystros river[302]. We have seen that the emperor had had a tough relationship with the city during his first voyage. It is clear that the second voyage of the emperor had been the starting point of a slow change made visible by the second imperial neocorate granted to the city in the year 131/132 CE. It also allowed the emperor to understand the difficult situation of a city whose port was a concern for the entire Mediterranean, as the edict of L. Antonius Albus later pointed out. Imperial travels undoubtedly had impact on the cities infrastructures exactly as the governor's visits to the cities of his provinces[303]. They generated building activity in order to celebrate the emperor or the governor. In return, these had to repay in a way the community for the *adfectio* it had demonstrated with stronger signs of *adfectio*. This was but a game of regulated mutual duties and honours. These travels were also an opportunity for the emperor to appreciate particular situations from a personal point of view. There is no doubt that the imperial *horrea* built by Hadrian at Patara and Andriake in Lycia are a direct consequence of the emperor's visit to these places. They were built at the time of his travels. But the inscriptions they bear show clearly that they were not considered as part of euergetism. They were just part of the emperor's personal interest. Imperial autopsy was also part of decision-making. This is

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[297] For more details, see Halmann 2004, 98-99. Gifts to Smyrna: Philostrate, Soph. 531; channelling the Caystrus' tributary: *AE* 1993. 1472; corn-supply and great works at the harbour in 129 : *IvE* 274.

[298] Erol / Pirazzoli 1992; Uggeri 2004.

[299] Bartoccini 1958 ; Laronde 1988; Laronde 1994; Beltrame 2012;

[300] Suet., *Ner*. 9: *Antium coloniam deduxit ascriptis ueteranis e praetorio additisque per domicilii translationem ditissimis primipilarium; ubi et portum operis sumptuosissimi fecit.*

[301] Dion Cassius 69.5.3 (= Xiph. 244, 1-245, 6 R. St., Exc. Val. 294 (p. 713), Suidas s.v. ᾽Αδριανὸς): πολλὰς μὲν γὰρ καὶ εἶδεν αὐτῶν, ὅσας οὐδεὶς ἄλλος αὐτοκράτωρ, πάσαις δὲ ὡς εἰπεῖν ἐπεκούρησε, ταῖς μὲν ὕδωρ ταῖς δὲ λιμένας σῖτόν τε καὶ ἔργα καὶ χρήματα καὶ τιμὰς ἄλλαις ἄλλα διδούς.

[302] *IvE*, n° 274, l. 12 sq. : (…) σειτοπομπή[ας δὲ] | ἀπ ᾽Αἰγύπτου παρέχοντα καὶ τοὺς λιμένας | πο[ιήσαν]τα πλωτούς, ἀποστρέψαντά τε | καὶ τὸν βλά[πτοντα τοὺς] λιμένας ποταμὸν | Κάϋστρον διὰ τὸ [- - - - ] "and he has sent corn from Egypt and made the ports navigable, and has even diverted the river Kaystros that caused damage to the ports"

[303] Christol 2012

a key for the decision of Hadrian to divert the Kaÿstros to save Ephesus' port from silting, as it was the key for other interventions by governors within the same harbour. In addition to governor's and other imperial officials' reports and travels, imperial travels may have been essential for the development of port infrastructure as well as infrastructure in general, because they allowed for a direct perception of actual needs.

Huge works, involving diverting rivers or huge moles were undoubtedly the affair of the emperor, not only because he alone, as a person or on behalf of the State, had both the wealth and the technical staff necessary for such achievements, but also for ideological reasons. The presence of the emperor or strong ties with a community were the background for his intervention as a person.

## (H2) 3. Social intermediation: *collegia*, patrons, imperial officials.

By tradition, since Mommsen, the Roman Empire has been perceived mainly as an administrative structure. Given the relatively small number of people actually involved in administration, it has become increasingly difficult to build a model of the management of the empire only on the basis of state administration.

We have seen that cities have been another essential level of decision-making. It is also necessary to place decision making and power-based relationship in their social contexts. Beyond administrative hierarchies, the dignity of individuals and personal networking were the main characteristics of a society entirely based upon patronage and clienteles. This was the case not only for people, but also for cities. As individuals, groups, including cities, were friends or foes to each other, rivals or partners, used to choose patrons and were part of a complex structure of networks. Lobbying was an essential part of any decision-making process. The status of someone and the networks he was part of were maybe more important than the position he had been appointed to, *stricto sensu…*

We cannot deny the existence nor the immense power conferred by legal authority and administrative positions, indeed, but we must be aware that besides these (and part of the appointment process as well) lobbies, networks and patronage could be absolutely essential in decision-making. We must take into account the levels of social intermediation and their structure to have a clearer idea of the interference between administration and structured, visible, personal relationship[304]. As we have seen, the relationship between the governor Antonius Albus and one of the highest magistrates at Ephesus, Ti. Claudius Marcellus, who was a Roman citizen and a member of Council of Asia, were both kind and close. The governor had kindly suggested him to take some decisions; and only when these had failed to reach the expected goals, he eventually decided to intervene within the limits of the full respect of both the man and the city he was ruling.

Two decades later, being asked to become the patron of Cirta, in Numidia, Fronto, the preceptor of M. Aurelius and Lucius Verus, and for that reason a man of high influence, did not accept the honour, but proposed other names. Some were personal relatives, some were not. All had in common to be skilled in pleading causes, and to be senators[305]. The first duty of a patron was to defend the city both at the tribunal and through lobbying. The same pattern applied to individuals belonging to the patron's clientela.

The last decade of scholarship has entirely revisited the importance and structure of *corpora*. Once thought to be simple professional guilds, these appear to have been intermediate

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[304] Verboven 2002 has analysed in detail the importance of *amicitia* and patronage in the structure of the late-republican economy. The increasing complexity of network structures during the imperial period does not challenge the validity of the pattern.

[305] Fronto, *Ad Amicos*, 2.7.

structure between the elite and the plebs, and places for social intermediation[306]. They were also something like clubs, whose members included not only people who had a profession in common, but also prominent people who were associated with the group on behalf of their social position.

Evidence from Ostia has provided the clearest instances of the role of *collegia* in social and administrative intermediation.

A certain Caius Granius Maturus illustrates the kind of networking that bridged the gap between the local practitioners of port activity and the higher administration of the empire[307]. As a reward of his gifts to the city he had been made *gratis* a decurion and, later, a duumvir at Ostia. He was a member of the *corpus mensorum Ostiensium* and of the *corpus curatorum navium marinarum*, and was also patron of the latter, together with other four *corpora* : the *corpus curatorum navium amnalium Ostiensium*, the *corpus dendrophorum Ostiens(ium)*, and other two, whose name is unfortunately too mutilated to allow for any convincing reconstruction. The same man was also a close relative of two prominent individuals: the Senator Marcus Lollius Paulinus, who calls him an *amicus*, and Maturus, himself dedicated in 149 CE a statue, whose dedicatory inscription to a previous prefect of Annona, now prefect of Egypt has been preserved. This prefect he calls *amicus* "friend".[308] Let us have in mind how large the horizon of possible lobbying was, unveiled by this friendship to the eyes of a community of people who had chosen to place themselves under his protection.

We can imagine that this intermediation allowed not only for lobbying, but also for bottom-up information processes between the practitioners of port activity and people whose administrative function was in direct relationship with the latter's activity while their position made them relatives of the emperor himself. A Roman knight C. Veturius Testius Amandus may be celebrated as *defensor* by the V *corpora lenunculariorum* as a *defensor*[309]. At some time the *codicarii* had joined them in honouring the man. The word *defensor* clearly means that he has defended their cause in justice, but in addition to this, it is said that he has always protected them in a more general sense. Close relationship between influent people and practitioners of port activity were undoubtedly numerous.

At the limits of the sphere of legal authority, the links that tied groups of practitioners of ports activity and officials of Annona or the hierarchy between imperial offices could interfere with the possible or supposed port administration. At *Portus*, in the reign of Philippus, the *codicarii*, *navicularii* and erected a statue in honour of the *ducenarius procurator portus*

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[306] Christol 2003; Tran 2006; 2014; Broekert 2011; Verboven 2011; on the relationship between individuals and state (cities as well as imperial state) through collegia in port-cities, see mainly Rohde 2012. De Salvo 1992 is now widely outdated.

[307] *CIL* XIV, 363; *CIL* XIV, 364 (add. p. 615); he is also mentioned by *CIL*, XIV, 362 (D., 6135); Tran 2006 has recognized him as the anonymous honoured by *AE*, 1988, 212.

[308] *CIL*, XIV, 4458.

[309] *CIL* XIV, 4144 = *D* 6173 = *AE* 1998, 876 (Ostia Antica), whose text actually should read as follows: *C(aio) Veturio C(ai) f(ilio) Testio / Amando / <<eq(uiti) R(omani) patron>>o et / defensori V corporum / lenunculariorum) Ostiens(ium) / universi navigiarii corpor(um) / quinque ob insignem eius / in d[efend]endis se et in tuendis / eximiam diligentiam dignissimo / [a]tque abstinentissimo viro / ob merita eius / [et patrono cor]poris splendedissimi codicar(iorum) / l(ocus) d(atus) d(ecreto) d(ecurionum) p(ublice)*. "To Caius Veturius testius Amandus, son of Caius, Roman knight, patron and defender of the *lencuncularii* of the Five *corpora* of Ostia, all the *navigiarii* of the Five corpora, as a reward of the exceptional diligence he has shown in their defence and protection. To a man of highest dignity and abstinence, as a reward of his merit and to the patron of the *codicarii*. Spot given in a public space by decree of the decurions". The words *<<eq(uiti) R(omani) patron>>* have been engraved at a second step on a erased text, and belong to a later state of the text. It is difficult to understand what may have been erased from the first version and why. Maybe he was not a Roman knight then. The second last line is also an addition to the original text. The missing letters are fourteen and cannot be read *[quin]q(ue) corporis splendedissimi codicar*, as suggested by Hirschfeld. We therefore suggest to read *[et patrono cor]poris splendedissimi codicar(iorum)*. On this inscription, see Tran 2014 (forthcoming, not read).

*utriusque* apparently before he had left his position[310]. Under Constantine, when the *codicarii* and *nabicularii infernates* of Ostia decided to honour the emperor, the prefect of the Annona himself erected the statue[311]. At Arles, two documents show direct relationships between *navicularii* and officials of Annona. One is a decision of the praefectus Annonae about internal affairs of the *navicularii* of Arles, as people involved in the service of Annona, with the declared intention to treat them in a respectful and protective way.[312] This mentions at some point a procurator who is ordered to submit himself to the decree of the *navicularii*. This may well be the *procurator Augustorum ad annonam / provinciae Narbonensis et Liguriae* known through another inscription from Arles[313]. In the first case, relationships were probably not good, but it is clear that the affair has been successfully transmitted to the prefect in person (undoubtedly at the *navicularii's* initiative –, probably following the complex itinerary of petitions) and that the prefect had chosen to support the claims of the local college. In the second case, the procurator (a very low-grade knight who had not yet reached his fourth *militia*) had been honoured by them and had become their patron, after or at his departure for his fourth *militia* (the prelude of a hopefully brilliant equestrian career).

The same kind of strong relationship had been established under the joint reign of Marcus Aurelius and Lucius Verus between Sextus Iulius Possessor, *procurator Augg(ustorum duorum) ad ripam Baetis* and the *scapharii Hispalenses*, who gave him a *satisfecit*, probably when he was leaving his function in Spain to be appointed *procurator Augusti Ostis ad annonam*[314]. Such ties show that relationships between officials and *corpora* were closer than one imagines, especially when these officials were younger ones.

There is no evidence so far that these patterns have been involved in any step of building, maintenance or decision-making, but there is no reason why there would be preserved evidence about it. This is not the kind of things that inscriptions or literature used to describe. But it was so essential to Roman society and politics that it is almost impossible to imagine that it wouldn't have strongly impacted any administrative process, exactly as corruption did, without leaving notable traces.

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[310] *CIL* XIV, 170 = *CIL* VI, 1624 (p. 3811, 4721) = *IPOstie*-B, 338 = *D* 1433 = Tyche-2010-89 = *AE* 2010, +239 (Ostia Antica, AD 247), quoted above in n. 30.

[311] *CIL* XIV, 131 = *D* 687.

[312] *CIL* III, 14165,8 (p. 2328,78) = *D* 6987 = *AE* 1899, 161 = *AE* 1900, 201 = *AE* 1905, 216 = *AE* 1998, 876 = *AE* 2006, 1580 (Beirut – Berytus). About this text, see Virlouvet 2004, who rightly thinks that it was originally displayed at Arles and was transferred to Beirut probably during the Crusades.

[313] *CIL* XII, 672 (p 817) = *D* 1432 = *CAG*-13-05, p. 676 = *ZPE*-63-173 = *AE* 1981, 400 = *AE* 1984, 631 = *AE* 1986, 479 = *AE* 1987, 753 (Arles | Arelate). On this inscription and the previous one, see also Christol 1982.

[314] *CIL* II, 1180 = *D* 1403 = *CILA*-2-1, 23 = *IDRE*-1, 179 = *AE* 1965, 237 = *AE* 1971, 171 = *AE* 1991, 993. Found at Seville, at the base of the Giralda together with other material from the house of the Guild of the *scapharii*: *Sex(to) Iulio Sex(ti) f(ilio) Quir(ina) Possessori / praef(ecto) coh(ortis) III Gallor(um) praeposito nume/ri Syror(um) sagittarior(um) item alae primae Hispa/norum curatori civitatis Romulensium Mal/vensium tribuno mi[l(itum) leg(ionis)] XII Fulminatae / curatori coloniae Arcensium adlecto / in decurias ab Optimis Maximisque / Imp(eratoribus) Antonino et Vero Augg(ustis) adiu/tori Ulpii Saturnini praef(ecti) annon(ae) / ad oleum Afrum et Hispanum recen/sendum item solamina transfe/renda item vecturas nav{i}cula/riis exsolvendas, proc(uratori) Augg(ustorum) ad / ripam Baetis scapharii Hispalen/ses ob innocentiam iustitiam/que eius singularem.* "To Sextus Julius Possessor, son of Sextus, inscribed in the Quirina tribe, prefect of the Third Cohort of the Gauls, *praepositus* of the unit of the Syrian archers, and of the first Wing of the Spanish, curator of city of Romula Malva, military tribune of Twelfth Legion Fulminata, curator of the colony of Arca, added to the *decuriae* by the Best and Greatest emperors Antoninus and Verus, assistant of Ulpius Saturninus, prefect of the *Annona*, in charge of inventory of the African and Spanish oil, of transportation of the surplus and to pay the transport to the *navicularii*, procurator of the two Augusts in charge of the banks of the Baetis, the *scapharii* of Hispalis, as a reward of his exceptional integrity and justice". Part of of his carreer, following his departure from Hispalis is known through an inscription from Mactaris, in Tunisia, where he had his origin (*IDRE* II, 435 = *AE* 1983, 976 = *AE* 1987, 1026). On that man, see Remesal Rodríguez 1991; Christol 2003b; Erkelenz 2007, 298 et n. 39

This short enquiry challenges the traditional top-down view of a port-system entirely dominated by the imperial will, but does not exclude him from the game. Not only has it lead us to re-evaluate the role – and difficulties – of cities in managing their own ports similar to the ways they managed (or tried to manage) their public building and supplies policies. It has also underlined the importance of personal patronage and social intermediation, in other words, of personal and civic networks, in the development of port-building policies. The identity of beneficiaries and benefactors was often more essential than the practical impact of the building projects. The emperor nevertheless remains the main, if not the sole, performer of huge works, including port building.

This conclusion is not so surprising. It fits within the general patterns of what scholarship now thinks the Roman Empire looked like and eventually just shows that ports were but a particular case of the more general pattern of a society based upon social dignity and clientelism, and ruled by a divine, but remote emperor. There is no trace of any sustainable maintenance process. This rather took the form of punctual, expansive, but more spectacular and legible interventions (dredging or "building"). These reflect the collective consciousness of needs in harbour building or maintenance, because some have decided to invest in that kind of gifts rather than in offering games or baths, with the certainty that it would please the beneficiaries, indeed. But the causes for interventions have their roots in less pragmatic intentions or conventions: staging of self-presentation, personal or collective status and relationships between individuals and groups.

**Bibliography**

Alföldy 1984: G. Alföldy, Römische Sozialgeschichte (Wiesbaden 1984)

Alföldy 1999: G. Alföldy, Pontius Pilatus und das Tiberieum von Caesarea Maritima. Scripta Classica Israelica 18, 1999, 85-108.

Alföldy 2002: G. Alföldy, Nochmals: Pontius Pilatus und das Tiberieum vom Caesarea Maritima. Scripta Classica Israelica 21, 2002, 133-148.

Alföldy 2012: G. Alföldy, L'iscrizione di Ponzio Pilato: una discussione senza fine?. In: Iudaea Socia – Iudaea Capta, Convegno Internazionale della Fondazione Canussio, Cividale del Friuli, 22-24 settembre 2011 (Pisa 2012) 137-150.

Arnaud 2008: P. Arnaud, Conscience de l'impact environnemental et choix d'aménagements concurrentiels des cours d'eau chez les auteurs anciens. In: E. Hermon (ed.) Vers une gestion intégrée de l'eau dans l'empire romain, Actes du Colloque international Université Laval, Québec, 27-30 octobre 2006, Atlante Tematico di Topografia antica, suppl. XVI (Rome 2008) 157-162.

Arnaud 2014: P. Arnaud, Maritime Infrastructure. Between Public and Private Initiative. In: A. Kolb (ed.), Infrastruktur und Herrschaftsorganisation im Imperium Romanum. Herrschaftsstrukturen und Herrschaftpraxis. III Akten der Tagung in Zürich 19.-20.10.2012 (Berlin 2014) 161-179.

Bartoccini 1958: R. Bartoccini, Il porto romano di Leptis Magna. Bollettino del Centro studi per la storia dell'architettura, suppl. 13 (Rome 1958).

Beltrame 2012: C. Beltrame, New Evidence for the Submerged Ancient Harbour Structures at Tolmetha and Leptis Magna, Libya. In: International Journal of Nautical Archaeology 41.2, 2012, 315-326.

Broekaert 2011: W. Broekaert, Partners in business: Roman merchants and the potential advantages of being a collegiatus. Ancient Society 41, 2011, 221-256.

Bruun 2002: C. Bruun, L'amministrazione imperiale di Ostia e Portus. In: C. Bruun / A.G. Zevi (eds.), Ostia e Portus nelle loro relazioni con Roma (Rome 2002) 161-192.

Cavalier 2007: L. Cavalier, *Horrea* d'Andriakè et Patara: Un nouveau type d'édifice fonctionnel en Lycie à l'époque impériale. Revue des Études Anciennes 109.1, 2007, 51-65.

Christol 1982: M. Christol, Les naviculaires d'Arles et les structures du grand commerce maritime sous l'Empire Romain. Provence Historique 32, 1982, 5-14.

Christol 2003: M. Christol, Activité économique, appartenance à l'élite et notabilité: les collèges dans la Gaule méridionale et la vallée du Rhône. In: M. Cébeillac-Gervasoni / L. Lamoine (eds.), Les élites et leurs facettes (Rome , Clermont-Ferrand 2003) 323-335.

Christol 2003b: M. Christol, L'Huile du prince. In: M. Garrido-Hory / A. Gonzalès (eds.), Histoire, Espaces et Marges de l'Antiquité. Hommages à Monique Clavel-Lévêque (Besançon 2003) 209-226.

Christol 2012: M. Christol, "Voyages organisés": les interventions des "autorités et la géographie administrative de la province d'Afrique. In: Comptes-Rendus de l'Académie des Inscriptions et Belles-Lettres (Paris), janvier-mars 2012, 653-678.

De Salvo 1992: L. De Salvo, Economia privata e pubblici servizi nell' impero romano. I corpora naviculariorum (Messina 1992).

Duncan-Jones 1974: R. Duncan-Jones, The Economy of the Roman Empire. Quantitatives Studies (Cambridge 1974)

Engelmann 1996: H. Engelmann, Eine *Victoria Caesaris* und das Parther Monument (*IvE* 721). Zeitschrift für Papyrologie und Epigraphik 113, 1996, 91–93.

Erkelenz 2007: D. Erkelenz, Die administrative Feuerwehr? Überlegungen zum Einsatz ritterlicher Offiziere in der Provinzialadministration. In: R. Haensch / J. Heinrichs (eds.), Herrschen und Verwalten. Der Alltag der römischen Administration in der Hohen Kaiserzeit (Cologne, Weimar, Vienna 2007) 289-305.

Erol / Pirazzoli 1992: O. Erol / P. Pirazzoli, Seleucia Pieria: an ancient harbour submitted to two successive uplifts. International Journal of Nautical Archaeology 21.4, 1992, 317-327.

Gianfrotta 2009: P.A. Gianfrotta, Questioni di *pilae* e di *pulvis puteolanus*. Rivista di Topografia antica / Journal of Ancient Topography 19, 2009, 101-120.

Grüll 2010: T. Grüll, The Legendary Fate of Pontius Pilate. Classica et Medievalia 61, 2010, 151-176.

Guerber 1995: E. Guerber, Cité libre ou stipendiaire ? À propos du statut juridique d'Éphèse à l'époque du Haut-Empire romain. Revue des Études Grecques 108, 1995, 388-409.

Halfmann 2004 : H. Halfmann, Ephèse et Pergame. Urbanisme et commanditaires en Asie Mineur romaine, Scripta Antiqua 11 (Bordeaux 2004) [= Städtebau und Bauherren im römischen Kleinasien. Ein Vergleich zwischen Pergamon und Ephesos. Beihefte der Istanbuler Mitteilungen 43 (Tübingen 2001)].

Horster 2001: M. Horster, Bauinschriften römischer Kaiser. Untersuchungen zu Inschriftenpraxis und Bautätigkeit in Städten des westlichen Imperium Romanum in der Zeit des Prinzipats (Stuttgart 2001).

Houston 1980: G.W. Houston, The administration of Italian Seaports during the first three centuries of the Roman Empire. In: J.H. D'Arms / C. Kopff (eds.), The seaborne commerce of ancient Rome: studies in archaeology and history (Rome 1980) 157-171.

Hurlet 2007: F. Hurlet, L'eau et le pouvoir. L'exemple de l'Empire romain (1er-III'e siècles ap. J.-C.). In: P. Le Louarn (ed.), L'eau: sous le regard des sciences humaines et sociales (Paris 2007) 137-155.

İşkan-Işik / Eck / Engelmann 2008: H. İşkan-Işik / W. Eck / H. Engelmann, Der Leuchtturm von Patara und Sex. Marcius Priscus als Statthalter der Provinz Lycia von Nero bis Vespasian. Zeitschrift für Papyrologie und Epigraphik 164, 2008, 91-121.

Jacques 1984: F. Jacques, Le privilège de liberté. Politique impériale et autonomie municipale dans les cités de l'Occident romain (161-244). Collection de l'Ecole Française de Rome Roma, 76 (Rome 1984).

Jones 2008: Ch. P. Jones, The Neronian Inscription on the Lighthouse of Patara. Zeitschrift für Papyrologie und Epigraphik 166, 2008, 153-154.

Karwiese 1995: St. Karwiese, Groß ist die Artemis von Ephesos. Die Geschichte einer der großen Städte der Antike (Wien 1995).

Kirbihler 2005: F. Kirbihler, L. Cusinius, *épiscopos* à Éphèse. Jahreshefte des Österreichischen Archäologischen Instituts in Wien 74, 2005, 151-174.

Kokkinia 2014: C. Kokkinia, Rome, Ephesos, and the Ephesos Harbor: a Case Study in Official Rhetoric. In: A. Kolb (ed.), Infrastruktur und Herrschaftsorganisation im Imperium Romanum. Herrschaftsstrukturen und Herrschaftpraxis. III Akten der Tagung in Zürich 19.-20.10.2012 (Berlin 2014) 180-196.

Laronde 1988: A. Laronde, Le port de Leptis Magna. Compte-rendus de l'Académie des Inscriptions et Belles-Lettres, 1988, 337-353.

Laronde 1994: A. Laronde, Nouvelles recherches archéologiques dans le port de Lepcis Magna. Comptes-rendus de l'Académie des Inscriptions et Belles-Lettres, 1994, 991-1006.

Lehman / Holum 2000: C.M. Lehman / K. G. Holum, The Greek and Latin inscriptions of Caesarea Maritima (Boston 2000).

Leveau 1993: Ph. Leveau, Mentalité économique et grands travaux hydrauliques: le drainage du lac Fucin aux origines d'un modèle. Annales. Économies, Sociétés, Civilisations 48.1, 1993, 3-16

Meiggs 1960: R. Meiggs, Roman Ostia (Oxford 1960).

Petzl 1987: G. Petzl, Die Inschriften von Smyrna, II.1 (Vienna 1987).

Rankov 2006: B. Rankov, Les *frumentarii* et la circulation de l'information entre les empereurs romains et les provinces. In: L. Capdetrey / J. Nelys-Clément (eds.), La circulation de l'information dans les états antiques (Bordeaux 2006) 129-140.

Raschke 1978: M.G. Raschke, New Studies in Roman Commerce with the East. In: H. Temporini (ed.), Aufstieg und Niedergang der Römischen Welt, Geschichte und Kultur Roms in der neueren Forschung, II. Principat 9.2 (Berlin 1978) 604-1361.

Remesal Rodríguez 1991: J. Remesal Rodríguez, Sextus Iulius Possessor en la Bética. In: Gerion. Homenaje al Dr. Michel Ponsich (Madrid 1991) 281-295.

Rohde 2012: D. Rohde, Zwischen Individuum und Stadtgemeinde: die Integration von "collegia" in Hafenstädten (Mainz 2012).

Sartre 1991: M. Sartre, L'Orient romain: provinces et sociétés provinciales en Méditerranée orientale d'Auguste aux Sévères (Paris 1991).

Slim / Trousset /Paskoff / Oueslati 2004: H. Slim / P. Trousset / R. Paskoff / A. Oueslati, Le littoral de la Tunisie. Étude géoarchéologique et historique (Paris 2004).

Salmon 1963: E. T. Salmon, The *Coloniae Maritimae*. Athenaeum 41, 1963, 3-33.

Salmon 1969: E. T. Salmon, Roman Colonization under the Republic (Ithaca, New York, London 1969).

Scharf 1994: R. Scharf, *Comites* und *comitiva primi ordinis* (Mainz 1994).

Thylander 1952: H. Thylander, Inscriptions du port d'Ostie (Lund 1952).

Tran 2006: N. Tran, Les membres des associations romaines: le rang social des collegiati en Italie et en Gaules sous le Haut-Empire (Rome 2006).

Tran 2014: N. Tran, C. Veturius Testius Amandus, les cinq corps de lénunculaires d'Ostie et la batellerie tibérine au début du IIIe siècle. Mélanges de l'École Française de Rome. Antiquité 126, 2014: http://mefra.revues.org/2043.

Uggeri 2006: G. Uggeri, Seleucia Pieria: il porto di Antiochia sull' Oronte. Journal of Ancient Topography 16, 2006, 143-176.

Verboven 2002: K. Verboven, The economy of friends. Economic aspects of amicitia and patronage in the Late Republic (Brussels 2002).

Verboven 2011: K. Verboven, Resident aliens and translocal merchant collegia in the Roman empire. In: O. Hekster / T. Kaizer (eds.), Frontiers in the Roman World: 9th Workshop of the International Network Impact of Empire (Leiden 2011) 335-348.

Virlouvet 2000: C. Virlouvet, Les denrées alimentaires dans les archives des Sulpicii de Pouzzoles. Cahiers du Centre Gustave Glotz 11, 2000, 131-149.

Virlouvet 2004: C. Virlouvet, Les naviculaires d'Arles à propos de l'inscription provenant de Beyrouth. Mélanges de l'Ecole Française de Rome - Antiquité 116.1, 2004, 327-370.

**Networks of Medieval City-Ports in the Black Sea (7th-15th C.).**
**The Archaeological Testimony**
Flora Karagianni

It is a well-known phenomenon in the history of the cities located around seas, that the maritime routes which secure their intra-communication not only function as links between them, but that provided infrastructure to establish various networks, cultural, social, religious and commercial as well[315]. In the medieval East, many of these networks developed in the very active and rich area of the Black Sea[316], where some very important city-ports emerged from the ancient times onward[317]. There is no doubt that from the 4th c. AD onwards and for more than ten centuries, the most important city of the area around the Black Sea was Constantinople, the capital of the Byzantine Empire. During the ages, it became the biggest commercial, economic, cultural and religious centre of the East, which kept constant communication with the city-ports of the Black Sea, establishing various networks with them.

As the history of the city indicates, very soon after its establishment as the capital of the empire, Constantinople experienced a remarkable growth and development. Coming to a peak of almost 400,000 inhabitants in the 6th c.[318] it reached its zenith in the age of Justinian as the imperial capital of the biggest empire of that era, which covered a territory covering almost the entire Mediterranean world apart from Gaul and Spain, as well as a big part of the Black Sea. Despite plagues and the spread of diseases, constant wars and the population losses due to thee frequent earthquakes in the area, Constantinople remained undoubtedly the largest city of the Empire, forming a city class of its own[319]. Situated at the edge of a peninsula between two continents, it was surrounded by strong defensive walls, which for almost 11 centuries (with the exception of 57 years between 1204 and 1261 when the city was under Latin occupation) protected the capital and offered security to its citizens[320] (fig.1).

Due to its strategic location, Constantinople became very quickly a major political, economic, commercial, spiritual and cultural centre between East and West. In its long lasting life there emerge more than six harbours[321] in the Golden Horn and at the Sea of Marmara, which served for centuries the maritime transportation as well as the trade activities between the capital and the main centres around the seas (Black Sea, Sea of Marmara, Aegean and Mediterranean). In all these places and in a variety of degrees, depending on the political and economic circumstances, a lot of networks developed via the various maritime routes.

The archaeological testimony indicates that for the biggest part of the area around the Black Sea, especially at its western-northern shores, the end of 6th -7th c. AD marked a period of decline of urban life in the already existing cities and the beginning of a new era. In many cases and for a variety of reasons such as natural factors (seismic activity, sea level oscillations, silting of bays), hostile invasions or demographic issues (reduction of the population due to plagues), many cities were destroyed or abandoned[322], whereas new ones emerged. The ones which survived continued being used as main ports of the Black Sea, and this characteristic became a significant factor for their economic survival, since the trade in their harbours secured a constant income to the inhabitants and prosperity to the city.

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[315] On this issue see: Ahrweiler 1966; Avramea 2001, 57-90; Laiou 2012, 125-146.
[316] Karagianni 2013, 23-46.
[317] Grammenos / Petropoulos 2003; Grammenos / Petropoulos 2007; Koromela 2001.
[318] Jacoby 2010, 92.
[319] Magdalino 1995, 35.
[320] On the walls of Constantinople see: Asutay-Effenberger 2007; Turnbull 2004; Janin 1964, 261-300; Müller-Wiener 1977, 286-323.
[321] Two harbours in the Golden Horn /Prosphorion and Neorion) and at least three (Boukoleon, Julian/Sophia and the Theodosius harbor) at the sea of Marmara. On the Constantinopolitan harbours see the recent papers: Magdalino 2007; Günsenin 2012, 99-105; Kocabaş / Türkmenoglu 2014, 115-130.
[322] Karagianni 2013, 28; Custurea / Nastasi 2013, 320-331.

Among the city-ports which survived until the medieval era and became important parts of the maritime networks of the Black Sea are Ahtopol, Sozopol (fig.2), Nessebar (fig.3), Odessos (mod. Varna)[323], Kranevo, Balchik[324], Constanta (fig.4)[325], Tauric Chersonesos (fig.5), Kaffa (Feodosiya), Bosporos (Kerch)[326], Trebizond (fig.6)[327], Samsun[328], Giresun[329] and Sinope[330]. They were all large fortified cities with one or – in some cases- two harbours[331]. Adjusted to the various landscapes and located at the rocky coastal line of the Black Sea, via their fortifications the cities controlled the approach of ships and offered security to the locals.

In all these cases, gradually from the early Christian era to the medieval period, the constant need for the supply of the population with goods and products led to an increase of trading activities among different parts of the Byzantine Empire as well as wuth areas outside of it. For example it is well known that Egypt supplied Constantinople with big quantities of grain[332]. When in 640 the Arabs conquered Egypt, they caused a significant blow to the capital which lost its main source of food. From that period onwards the maritime routes of trade that were in use for centuries in a way changed. During the Middle Ages, and mainly after the 9th c. AD, the the commercial map included routes of communication of the capital with many city-ports of the Black Sea, especially with its western shores, which became a significant source for many products[333]. At times and in varying degrees, Byzantine Constantinople depended on the areas north of the Bosporus for food supply. Within this context, it is well known from the sources that already from the 9th century onwards merchants travelled to the city-ports of Anchialos (Pomorie) and Messemvria (Nessebar) to import grain[334].

On the contrary, the northern shore of the Black Sea was a grain deficit area. The testimony of the exiled Pope Martin in 654-655 is very precious: he complained that grain was often mentioned but never seen in the Crimea, and it was only from the crews of Byzantine ships venturing in search of salt that he was able to buy his bread[335]. Constantine Porphyrogenitus comments that "if the Chersonites do not travel to Romania to sell the wax and hides that they get from the Pechenegs, they cannot live. And if grain does not pass from the Aminsos and Paphlagonia and from the Boukellarioi and the flanks of the Armeniakoi, the Chersonites cannot live"[336].

After the 9th c. up to the 13th c., the Black Sea area had become a strong commercial centre, in which many ports functioned as stations of transport and places of exchange of products. After the establishment of the Kievan State in the 9th c., Russian merchants from the north initiated direct commercial relationships with Constantinople. Their commercial fleet, consisting of monoxyla and sailing via the Dnieper, entered the Black Sea and included in its cargo furs, wax, honey and linen, which they exported to Constantinople. The supply of Constantinople was maintained in the 10th c. also by Bulgarian merchants who brought to the capital linen, honey, apparently slaves[337] as well as grain and oriental spices, aromatics and

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[323] On the history of Odessos (Varna) see: Minchev 2006, 181-187; Idem 2014, 214-235; Pletnyov 2006, 205-207.
[324] On the Bulgarian Black Sea city-ports see: Minchev 2014, 135-276.
[325] On Constanta see: Buzoianu / Bărbulescu 2006.
[326] On the Ukrainian city-ports see: Paradeisopoulos / Suntsov 2014, 329-390.
[327] Bryer / Winfield 1985, 178-250.
[328] Bryer / Winfield 1985, 92-95.
[329] Bryer / Winfield 1985, 126-134.
[330] Bryer / Winfield 1985, 69-88; Leaf 1916, 1-15.
[331] Karagianni 2013, 25-26.
[332] Magdalino 1995, 35-47.
[333] It is mentioned in the texts that ports such as Chersonesos and Bosporos in the Crimea were considered as sources of supplies of grain to Constantinople even from the end of the 4th c. AD onwards (Aibabin 2013, 57).
[334] Teall 1959, 117-118.
[335] Teall 1959, 118.
[336] Constantinus Porphyrogenitus, De administrando Imperio, ed. G. Moravcsik / R. J. H. Jenkins (Washington D. C. 1967) 286.
[337] Jacoby 2007, 688.

dyestuffs. After the 11th c. Italian merchants became very active in this maritime trade and gradually the biggest maritime power of the area[338].

In order to cover transportation needs, city-ports developed harbour facilities, in which storage places for vessels, anchors, amphorae, pottery were constructed. The most extensively excavated case up to now is the Theodosius harbour in Istanbul[339], which for centuries served as one of the main harbours in which food and products from the Mediterranean and Black Sea were arriving to the city as cargos of commercial ships. During the excavations, a lot of information was gained on the original design of the harbour, the piers at which the ships were tied, the ships themselves (36) (fig.7), the sea walls for the protection of the harbour and the animals used for the transportation of the products from or to the boats. Moreover, numerous artefacts coming from the cargo of the ships provide a lot of information on the origin of the products that were part of cargos. In the excavations of the several layers, there have been found plant remains, seeds and remnants of fruit plants and trees, such as figs, grapes, cherries, melon seeds, spices, olive pits, hazelnuts and pine nuts (fig.8) which were spread in the sea when a strong storm hit the port or were found within the amphorae, indicating that they were going to be either exported to other places or imported to the capital[340]. The identification of the origin of the amphorae is also very important, since they allow for reconstructions of the networks of the trade. For example, through the study of the amphorae we know that the wineries of Ganos and the Crimea supplied Constantinople with wine, since from these places are originated the amphorae found in the YK1 and YK12 shipwrecks[341] (fig.9).

Since 7th c. the Theodosius harbour ceased to be the main port of the capital for the ships which were arriving to Constantinople after a long trip from Egypt (which was lost to Arabs, see above). Hence, although it started losing its function, it seems that it continued being in use by smaller vessels until the 11th c. With the silting of the harbour caused by the Lykos stream, it was filled in the 12th c. and lost its maritime commercial function[342].

Regarding the trade routes, it is well known from the sources that during the middle Byzantine era a variety of products was brought to Constantinople from the Indian Ocean, the Far East, Egypt and Italy[343]. Especially the Italian merchants tried to bypass the City by conveying products from Black Sea directly to Genoa, but they were prevented to do so by the Byzantine emperors who were always trying to secure imperial revenue from the transit trade. The capital retained till the end its function as a major trans-shipment station.

The exchange of products between different places within the Byzantine Empire and outside of it included coastal navigation in the sea as well as numerous stops at many ports, in order to ensure fresh water supply as well as to enable commercial transaction along the way[344]. As a result, in many city-ports around the Black Sea coast one can find traces of objects of daily use, such as pottery, coins, seals and jewellery, but also liturgical and luxury objects, works of art etc., originating from the capital or other centres of the Black Sea.

Among the most common kind of objects found all around the Black Sea area is Byzantine pottery which came directly from Constantinople and was used by local households in a very extended area covering almost the entire Black Sea. The biggest concentration of such pottery is found in Bulgarian and Crimean coastal cities, which functioned as main stops in the commercial networks. During the medieval period, at the western shore of Pontos, Odessos (mod. Varna), Anchialos, Messemvria, and Sozopol maintained their position as prosperous

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[338] Nystazopoulou-Pélékidis 1970, 19-21; Jacoby 1997.
[339] For the Theodosius harbour see: Kızıltan 2010, 2-15; Kocabaş 2010, 23-33; Kocabaş 2012, 107-113; Kocabaş 2013, 401-413; Kocabaş /Türkmenoğlu 2014, 118-127.
[340] Asal 2007, 180-189.
[341] Asal 2013, 9.
[342] Kızıltan 2010, 2-4.
[343] Jacoby 2010, 96-97.
[344] Jacoby 2007, 681.

towns with busy harbours and wide trading contacts. In Anchialos (Pomorie) (fig.10), as well as in Varna there has been accumulated a significant quantity of middle byzantine ceramics consisting of glazed bowls decorated with several motives in various techniques: fine incised decoration, or slip painted ware, painted sgraffito ware, incised sgraffito ware, champlevé ware etc. This pottery is a clear indication of the constant trade contacts between the city-ports of the western Black Sea and Constantinople[345].

In Sozopol[346] and in Nessebar[347] (fig.11), there have also been found many pieces of Constantinopolitan glazed pottery which cover a quite extended period from the 9th-13th c. Moreover, the archaeological material from Odessos and its wider hinterland includes a variety of glazed plates, cups, bowls and jars, some of them made in Constantinople, whereas many of them consisted of production of local workshops which imitated the Constantinopolitan techniques, decorative motifs, types and forms of vessels[348]. During the entire Byzantine period, the area seems to have received a regular supply of glazed pottery which was the most common tableware. A few kilometres to the north in the Dobruja region, in the Cape Kalliakra Fortress[349], there has also been found glazed pottery of the same period, which indicates the connection of that city-port with the Constantinopolitan centre of production.

For the north-western side of the Black Sea, the study of archaeological material proves that the trade activity established land routes which started from the Black Sea and continued to the area of the Danube's mouth (fig.12). Within this framework can be interpreted the discovery of pottery dated to the 11th c. and originating from the Byzantine centres in settlements of the Lower Danube[350]. The number of settlements developed in a quite small distance from the coast in which contacts with the others medieval centres of the Black Sea can be traced, in combination with the variety of Byzantine pottery found there, testify active commercial exchanges between several centres of the Black Sea and reveal as well the role and impact of the maritime networks in the hinterland.

Among the main centres of the commercial sea routes of the Black Sea was the northern part of the Black Sea, mainly the Crimean Peninsula. In the biggest and most important medieval city-port of the Crimea, Tauric Chersonesos, there have been found large quantities of imported glazed pottery, representing the main categories of the Constantinopolitan tableware such as fine and incised sgraffito, "Zeuxippos", Slip-Painted, Glazed White and Polychrome sgraffito wares (fig.13). Pottery and coins found in the excavations of the late Byzantine layers of the city illustrate the connections that the Crimean city developed with the Byzantine world, the south-western Black Sea as well as with the Mediterranean[351]. But still, even if Chersonesos functioned as a large transit trade centre, Constantinople remained the main manufacturer and supplier of a variety of products, objects and works of art[352].

Besides Chersonesos, Byzantine glazed pottery was also found in Feodosiya (Kaffa), where some of the most important examples of the "Zeuxippus Class II" ware are considered to have been produced there. The city with its workshops is considered to have been one more centre for the production of that specific type of pottery, which draws its name from the Zeuxippus baths of Constantinople, since a large quantity of it was found there. It seems that through the various networks of communication this type of highly quality glazed table ware reached the distant Crimean city-port and initiated its imitation by the local workshops[353].

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[345] Manolova-Voykova 2013, 353-366.
[346] Dimitrov 2009, 220.
[347] Kiyashkina / Bozkova / Marvakov / Ushev / Delev 2012, 132-137.
[348] Cullin-Mingaud / Doncheva / Landers 2006, 231-235; Kuzev 2003, 79-80.
[349] Rousseva 2006, 99.
[350] Paraschiv-Talmaţchi / Talmaţchi 2013, 338; Kuzev 2003, 77-80.
[351] Rabinowitz / Sedikova / Henneberg 2010, 450; Zalesskaya 2011, 127.
[352] Sedikova 2013, 133.
[353] Megaw / Armstrong / Hatcher 2003, 95.

Apart from pottery, Byzantine lead seals are valuable witnesses of the various commercial activities between different parts of the empire as well. In Chersonesos, the large number of seals of kommerkiarioi (fig.14) indicates that there existed state control over the trade with articles of foreign merchants as early as the 7th c. Due to these seals, we know that the city kept close connections with many centres of the Balkans, Asia Minor and Black Sea regions: Constantinople, Hieron, Amastris, Abydos, Thessaloniki, Nikaia, Anchialos, etc.[354]. On the other hand, in Chersonesos there have also been found a lot of lead seals attributed to kommerkiarioi of Chersonos, identifying it as a flourishing city-port in the middle byzantine era[355], whereas more than 400 byzantine lead-seals, dated to the 10th-12[th]c., have been found to Soldaia as well[356]. Analogous lead seals of kommerkiarioi from Nessebar, dated between 7th-9th centuries, are considered as very important witnesses for the levy of customs in middle byzantine Messemvria[357].

Byzantine seals are also found in the eastern part of the Black Sea, in the fortified city-port of Petra (modern Tsikhisdziri), where some very important seals mentioning imperial officers (Protospatharios, Hypatos, imperial Notary of the Genikon, Ostiarios, Asekretis, Ptonotarios, Vestis, Taxiarchos) indicate the presence of Byzantine officers from the 6th -11th c.[358] (fig.15).

Seals and numerous Byzantine coins have been found in many city-ports of the Black Sea, in Bulgarian, Romanian, Crimean and Turkish territories. One should also underline that in the western areas, and mainly in the Dobruja region, from 9th-13th century, despite the unstable political situation and the long-lasting conflicts between Byzantines and Bulgarians, some very important hoards of gold, silver and bronze Byzantine coins have been found, indicating the ongoing connections between Byzantium and the locals[359]. The diffusion of artefacts in the territory confirms that the penetration of the Byzantine coinage between 9th-10th c. followed the existing channels of the city-ports of the Black Sea, through which byzantine coins reached the main centres such as Constanta, Mangalia and of course the Danubian cities of Silistra, Isaccea etc.[360] The concentration of findings in the seaside area indicates that the Byzantine coins were used also in the commercial transactions between Byzantine and local merchants[361] (fig.16).

The networks of the medieval ports of the Black Sea were not limited to the exchange of products, goods and food necessary for the everyday life. The archaeological material highlights also the constant circulation of luxury objects between Constantinople and the main urban coastal centres. To the north, Chersonesos -being among the richest and most important ports of the Black Sea-, preserves representative luxury objects originating from the capital, such as bronze, stone and ivory icons, jewellery, splendid steatite icons[362] and metal crosses (fig.17)[363].

More or less, on a bigger or smaller scale, similar works of art are found in the entire western, northern and eastern part of the Black Sea as a result of maritime transportation, navigation, trade activities and of course the transfer of people, merchants, pilgrims, soldiers, travellers or artists. A catalogue of artefacts made in Constantinople or even in local workshops which reproduced types and forms from the capital consists of numerous entries for many city-

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[354] Aleksenko 2005, 1592-1626; Sedikova 2013, 132.
[355] Alekseyenko 2007, 121-164.
[356] Balloni / Kukovalska 2009, 130; Aibabin 2013, 62.
[357] Stoycheva 2013, 103-105.
[358] Mikeladze 2013, 380-383.
[359] Custurea / Talmaţchi 2011, 109-117.
[360] Custurea / Matei 2007, 105-106.
[361] The coins could also be used as payment for Byzantine soldiers in the region or could be subsidies (Paraschiv-Talmaţchi / Talmaţchi 2013, 339).
[362] Mack / Coleman Carter 2001, 168-169.
[363] Mack / Coleman Carter 2001, 166-169; Zalesskaya 2011, 118-130.

ports all around the basin. As an example, one could mention the presence of encolpion crosses in Chersonesos[364], in Soldaia[365], Odessos (Varna), Kranevo and Kavarna[366], in Nessebar[367] and Sozopol[368], processional crosses from Varna[369], Tauric Chersonesos[370], glass medallions from Varna[371], Cape Kalliakra[372] and Kastritsi[373], steatite icons from Tauric Chersonesos etc.

One more very interesting aspect in the study of the networks of the Black Sea is the transportation of pilgrims from one place to another, using the existing marine routes and disembarking from ships to existing ports. Besides relevant references in the written sources[374], this phenomenon is also testified by the existence of various kinds of souvenirs which pilgrims brought with them after visiting "holy" places. These "holy" objects such as ampullae, encolpia, icons, crosses, lamps or vessels, coming from the big pilgrimage centres of Constantinople, Syria and Palestine, Egypt and Asia Minor are found for instance in Chersonesos, and are important indicators for the communication of the city with other areas of the Christian world[375]. Undoubtedly, travel by sea was preferable in many cases, since the main pilgrimage centres of the Byzantine Empire were very close or within city-ports. A very indicative example is the pilgrimage to Hagios Demetrios in Thessaloniki, famous during the whole Byzantine period[376]. It is well known both from the sources and mainly from archaeological material that during the 13th -14th c. pilgrims who visited the tomb of the saint in Thessaloniki upon their return to their homes took with them either lead ampullae, known as "koutrouvia" containing *myron* from the tomb of the saint[377], or bowls with the name of the saint in the interior, for "blessing"[378]. Such ampullae have been found in Varna and Baltchik (Fig.18)[379], whereas bowls with the monogram "Demetrios", some of them coming from the saint's tomb in Thessaloniki (fig.19), have been found in Odessos, Kastritsi and Messemvria[380]. Although we do not possess references in the sources for specific travels of Bulgarian pilgrims to Thessaloniki, the material itself provides us with a reliable evidence for the connection of the important Aegean city-port of Thessaloniki with the Thracian city-ports.

Navigation, transportation and exchanges among the city-ports were one aspect of the networking in the area. Another aspect was the emergence of networks through which architectural trends from Constantinople were spread across an extended area around the Black Sea. The still existing monuments of the middle and late Byzantine era in the coastal area unfortunately are not so many in order to allow us to make many remarks on the architectural trends spread outside the borders of the empire. To the north, we know in general the important monuments in the states of the Rus and their relations to Byzantine art and architecture[381]. Moreover we do know that to the east the architecture of Georgia was strongly influenced by

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[364] Mack, Coleman Carter 2001, 167.

[365] Balloni / Kukovalska 2009, 131.

[366] Cullin-Mingaud / Doncheva / Landers 2006, 237-239.

[367] Kiyashkina / Bozkova / Marvakov / Ushev / Delev 2012, 140-141.

[368] Dimitrov 2009, 198.

[369] Totev / Pletnyov 2011, 103-128

[370] Mack / Coleman Carter 2001,167.

[371] Totev / Pletnyov 2011, 79-85.

[372] Totev / Pletnyov 2011, 160-161.

[373] Totev / Pletnyov 2011, 162-164.

[374] For example, it is known that in the 8th-9th c. the monk Epiphanius traveled along the St. Andrews route to the Black Sea, using commercial ships which passed by (Albrecht 2013, 113-114; Chotzakoglou 2013, 94-100).

[375] Jašaeva 2010, 479-491.

[376] On the pilgrimage to Hagios Demetrios in Thessaloniki see: Bakirtzis 2002, 175-192, with the oldest bibliography, and most recently Alto Bauer 2013.

[377] Bakirtzis 2002, 183-184; Idem 1987, 205-209.

[378] On the bowls with the monogram of "Demetrios" see: Papanikola-Bakirtzis 1987, 203-204.

[379] Totev / Pletnyov 2011, 168-171; Totev 2011, 53-79.

[380] Totev / Pletnyov 2011, 99-101, 172-183.

[381] Lazarev 2000;

the Byzantine one[382]. It is interesting to note thoug that in several cases the medieval architecture of the city-ports around the Black Sea recalls morphological and typological characteristics of the Byzantine capital.

The relation of the ecclesiastical monuments of Messemvria with the architecture of Constantinople has been documented, for instance[383]. In a way, this could be expected since the Thracian coast so close to Constantinople has been considered as its "backyard". It is well known for instance, that many noblemen from the court of the capital some years after the Ottoman conquest in 1453 left Constantinople and settled here. Among them were numerous Byzantine high officials and members of the aristocratic families, who moved to the Bulgarian Black Sea coast[384]. So, due to the small distance, in Bulgarian city-ports, e.g. in Nessebar (fig.20) and in Sozopol, there have been erected ecclesiastical monuments which recall the architecture of the capital. The interesting thing though is that apart from Messemvria, the strong influence of the Constantinopolitan architecture is recognizable also in another monument preserved in far distant Bosporos (Kerch). The church of St. John[385] (fig.21) preserves many characteristics in the typology, building technique, and morphological details of the exterior which belong to the same architectural trends as the monuments of Nessebar and can be interpreted only through the communication with the Byzantine capital, or through the presence of architects, artisans and technicians who came from Constantinople and worked at the construction of the church.

Conclusively, the existing monuments and the archaeological material prove that from Constantinople to the most distant city-port in the North-Eastern part of the Black Sea, the maritime networks of city-ports provided for the diffusion of common characteristics and common trends in architecture and art. As the material reveals, medieval ships not only functioned as means of transportation on the sea routes of the Black Sea. In many different ways they became vehicles through which trends and cultural values were transmitted from one place to another. These "moving" trends were adopted by the locals and gradually influenced the architecture and art developed in the different polities around the Black Sea. Within this framework should be interpreted the similarities and common characteristics of medieval monuments of Bulgaria, Russia or Georgia and Byzantium.

The networks of the medieval city-ports were vivid, dynamic and under constant development through the ages, adjusting to the various historical, political and economic circumstances. The archaeological material proves that even when new polities emerged in the area (Bulgaria, Russia, Georgia), the already existing networks of communication continued connecting different cultures, kingdoms and cities, while also new ones appeared. In the beginning of the 13th century, the Latin occupation of Constantinople[386] and the growth of the Italian trade re-modified the balances of the networks. The Genoese became a major maritime power in the Mediterranean and Black Sea and established garrisons and built new fortresses or renovated old ones in areas of their interest, especially in the northern part of the Black Sea[387](fig.22). This development added new dimensions to the maritime networks between the city-ports of the 13th-14th c. In any case, archaeological surveys and discussions continue and the study of the medieval networks is an ongoing process.

**Bibliography**

Ahrweiler 1966: H. Ahrweiler, Byzance et la Mer. La Marine de Guerre, la politique et les institutions maritimes de Byzance aux VIIe-XVe siècles (Paris 1966).

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[382] Cowe 1997, 336-341.
[383] Vocotopoulos 2011, 25-39; Ćurčić 2010, 619-624; Rachenov 1932 (reprint 2006).
[384] Minchev 2014, 177.
[385] Paradeisopoulos / Sunchov 2014, 389.
[386] Jacoby 2001, 277-297;
[387] Jacoby 2007, 677-699; Papacostea 2006, 47-63; Balloni / Kukovalska 2009; Balard 1978; Ivanov 2013, 84-88.

Aibabin 2013: A. Aibabin, Written sources on Byzantine ports in the Crimea from the fourth to the seventh century. In: F. Karagianni (ed.), International Symposium: "Medieval Ports in North Aegean and the Black Sea. Links to the Maritime Routes of the East" (Thessalonike 2013) 57-65.

Albrecht 2013: St. Albrecht, Die Krim der Byzantiner. In: St. Albrecht / F Daim / M. Herdick (eds.), Die Höhensiedlungen im Bergland der Krim (Mainz 2013) 101-123.

Aleksenko 2005: N.A. Aleksenko, Tamozhnya I kommerkiarii Khersona. In: S.B. Sorochan (ed.),Vizantijskiy Kherson: Ocherki Istorii I Kultury, pt. 2 (2005) 1592-1626.

Alekseyenko 2007: M. Alekseyenko, La douane du thème de Cherson au IXe et au Xe siècle: les sceaux des commerciaires. In: A. Aibabin / H. Ivakin (eds), Ukrainian Papers at the XXe International Congress of Byzantine Studies: "Kiev – Cherson- Constantinople", (Paris, 19-25 August 2001) (Kiev, Simferopol, Paris 2007) 121-164.

Alto Bauer 2013: F. Alto Bauer, Eine Stadt und ihr Patron: Thessaloniki und der Heilige Demetrios (Regensburg 2013).

Avramea 2001: A. Avramea, Land and Sea Communications. Fourth-Fifteenth Centuries. In: A. Laiou (ed.), The Economic History of Byzantium from the Seventh to the Fifteenth Century, vol.1 (Washington D. C. 2001) 57-90.

Bakirtzis 1987: Ch. Bakirtzis, Ampules Byzantines de Thessalonique. In: Recueil des Rapports du IVe Colloque Serbo-Grec: L' Art de Thessalonique et des pays Balkaniques et les courants spirituels au XIVe siècle (Belgrade 1987) 205-209.

Bakirtzis 2002: Ch. Bakirtzis, Pilgrimage to Thessalonike: the tomb of St. Demetrios. Dumbarton Oaks Papers 56, 2002, 175-192.

Balloni / Kukovalska 2009: N.F.Balloni / N.Kukovalska, The Genoese in Crimea (Kiev 2009).

Balard 1978: M. Balard, La Romanie génoise, XIIe – début du XV siècle (Rome, Paris 1978).

Bryer / Winfield 1985: A. Bryer/ D. Winfield, The Byzantine Monuments and the Topography of Pontos (Washington D.C. 1985).

Buzoianu / Bărbulescu 2012: L. Buzoianu / M. Bărbulescu, Tomis. Historical and Archaeological Commentary (Constanta 2012).

Chotzakoglou 2013: Ch. Chotzakoglou, Harbors and sea-routes of the Black Sea according to Greek hagiographical texts. In: F. Karagianni (ed.), International Symposium: "Medieval Ports in  North Aegean and the Black Sea. Links to the Maritime Routes of the East" (Thessalonike 2013) 94-100.

Coleman Carter 2003: J. Coleman Carter (ed.), Crimean Chersonesos. City, Chora, Museum and Environs (Texas 2003).

Cowe 1997: S.P Cowe, The Georgians. In: H. C. Evans / W. D. Wixom (eds.), Catalogue of the exhibition: The Glory of Byzantium. Art and Culture of the Middle Byzantine Era A.D. 843-1261 (New York 1997) 336-341.

Cullin-Mingaud / Doncheva / Landers 2006: M. Cullin-Mingaud / M. Doncheva / Chr. Landers (eds.), Catalogue de l'exposition: Des Thraces aux Ottomans. La Bulgarie à travers les collections des musées de Varna (Montpellier Agglomération 2006).

Ćurčić 2010: S. Ćurčić, Architecture in the Balkans From Diocletian to Suleyman the Magnificent, c. 300-1550 (Yale 2010).

Custurea / Nastasi 2013: G. Custurea / I.Nastasi, The End of Urban Life on the Dobroudjan Shore of the Black Sea in the 7th century AD. In: F. Karagianni (ed.), International Symposium: "Medieval Ports in  North Aegean and the Black Sea. Links to the Maritime Routes of the East" (Thessalonike 2013) 320-331.

Custurea / Matei 2007: G. Custurea / I. Matei, A Coin Hoard found at Valul lui Traian (10th century). In: Coin Hoards of Dobrudja I (Constanţa 2007) 105-113.

Custurea / Talmaţchi 2011: G. Custurea / G. Talmaţchi, Repertoriul tezaurelor in monetare din Dobrogea (Constanţa 2011).

Dimitrov 2009: B. Dimitrov, Sozopol (Sofia 2009).

Ivanov 2013: O. Ivanov, Medieval Ports of the Southern Coast of the Crimean peninsula. Navigation and Urbanization In: F. Karagianni (ed.), International Symposium: "Medieval Ports in North Aegean and the Black Sea. Links to the Maritime Routes of the East" (Thessalonike 2013) 80-93.

Jacoby 1997: D. Jacoby, Trade, Commodities and Shipping in the Medieval Mediterranean (Aldershot 1997).

Jacoby 2001: D. Jacoby, The Urban Evolution of Latin Constantinople (1204-1261). In: N. Necipoğlu (ed.), Byzantine Constantinople: Monuments, Topography and Everyday Life (Leiden 2001) 277-297.

Jacoby 2007: D. Jacoby, Byzantium, the Italian Maritime Powers and the Black Sea before 1204. Byzantinische Zeitschrift 100, 2007, 677-699.

Jacoby 2010: D. Jacoby, The Economy of Byzantine Constantinople, ca. 850-1453. In: Catalogue of the Exhibition: From Byzantion to Istanbul. 8000 years of a Capital, Istanbul, Sakip Sabanci Museum, 5/6-4/9/2010 (Istanbul 2010) 92-101.

Janin 1964: R. Janin, Constantinople Byzantine (Paris 1964).

Jašaeva 2010: T. Jašaeva, Pilgerandenken im Byzantinischen Cherson. In: F. Daim / J. Drauschke (eds.), Byzanz- Das Römerreich im Mittelalter, t. 2,1 Schauplätze (Mainz 2010) 479-491.

Karagianni 2013: City-Ports from Aegean to the Black Sea. An Overview of their Early Christian and Medieval Past. In: F. Karagianni (ed.), International Symposium: "Medieval Ports in North Aegean and the Black Sea. Links to the Maritime Routes of the East" (Thessalonike 2013) 23-46.

Kiyashkina / Bozkova / Marvakov / Ushev / Delev 2012: P. Kiyashkina / A. Bozkova / T. Marvakov / D.Ushev / P. Delev, A Guide to the Collections of the Archaeological Museum of Nessebar (Nessebar 2012).

Kızıltan 2010: Z. Kızıltan, Excavations at Yenikapı, Sirkeci and Üsküdar within Marmaray and Metro Projects. In: Istanbul Archaeological Museums (ed.), Proceedings of the 1st Symposium on Marmaray-Metro Salvage Excavations, Istanbul, 5th-6th May 2008 (Istanbul 2010) 1-22.

Kocabaş 2012: U.Kocabaş, Byzantine Shipwrecks at Yenikapı. In: N. Günsenin (ed.), Proceedings of the Twelfth Symposium on Boat and Ship Archaeology, Istanbul 2009 (Istanbul 2012) 107-113.

Kocabaş / Türkmenoglu 2014: U. Kocabaş / E. Türkmenoglu, Istanbul. In: F. Karagianni (ed.), 40 Medieval City-Ports in North Aegean and the Black Sea. A Cultural Guide (Thessalonike 2014) 115-130.

Kuzev 2003: A. Kuzev, Byzantinische Keramik (11.-12.Jh) aus der Dobrudscha. In: Ch, Bakirtzis (ed.), VIIe Congrés International sur la Céramique Médiévale en Méditerranée, Thessaloniki, 11-16 Octobre 1999 (Athens 2003) 77-80.

Laiou 2012: A. Laiou, Regional Networks in the Balkans in the Middle and Late Byzantine Periods. In: C. Morisson (ed.), Trade and Markets in Byzantium (Washington D.C. 2012) 125-146.

Lazarev 2000: V. Nikitić Lazarev, Mosaïques et Fresques de l'Ancienne Russie (XIe-XVIe siècles) (Moscow 2000).

Leaf 1916: W. Leaf, The Commerce of Sinop Journal of Hellenic Studies 36, 1916, 1-15.

Mack / Coleman Carter 2001: G.R. Mack / J.Coleman Carter (eds.), Crimean Chersonesos. City, Chora, Museum, and Environs (Texas 2001).

Magdalino 1995: P. Magdalino, The grain supply of Constantinople, ninth-twelfth centuries. In: C. Mango / G. Dagron (eds.), Constantinople and its Hinterland (Aldershot 1995) 35-47.

Magdalino 2007: P. Magdalino, Studies on the History and Topography of Byzantine Constantinople (Aldershot 2007).

Manolova-Voykova 2013: M. Manolova-Voykova, Import of Middle Byzantine Glazed Pottery to the Western Black Sea Coast: The case of two cities: Varna and Anhialos. In: F. Karagianni (ed.), International Symposium: "Medieval Ports in North Aegean and the Black Sea. Links to the Maritime Routes of the East" (Thessalonike 2013) 353-366.

Megaw / Armstrong / Hatcher 2003: A.H.Megaw / P. Armstrong/ H. Hatcher, Zeuxippus Ware: An analytical approach to the question of Provenence. In: Ch, Bakirtzis (ed.), VIIe Congrés International sur la Céramique Médiévale en Méditerranée, Thessaloniki, 11-16 Octobre 1999 (Athens 2003) 91-100.

Mikeladze 2013: K. Mikeladze, Artifacts from Gonio and Tsikhisdziri. In: F. Karagianni (ed.), International Symposium: "Medieval Ports in North Aegean and the Black Sea. Links to the Maritime Routes of the East" (Thessalonike 2013) 377-388.

Minchev 2006: A. Minchev, Odessos et sa région dans l'Antiquité tardive (IVe–VIe siècle). In: M. Cullin-Mingaud / M.Doncheva / Chr.Landes / C. Huguenot (eds.), Des Thraces aux Ottomans. La Bulgarie à travers les collections des musées de Varna (Montpellier Agglomération 2006) 181-201.

Minchev 2014: A. Minchev, Bulgaria. In: F. Karagianni (ed.), 40 Medieval City-Ports in North Aegean and the Black Sea. A Cultural Guide (Thessalonike 2014) 135-276.

Müller-Wiener 1977: W. Müller-Wiener, Bildlexikon zur Topographie Istanbuls (Tübingen 1977).

Nystazopoulou-Pélékidis 1970: M. Nystazopoulou-Pélékidis, Venise et la Mer Noir du XIe au XVe siècle, Θησαυρίσματα 7, 1970, 15-51.

Papacostea 2006 : Ş. Papacostea, La Mer Noire carrefour des grandes routes intercontinentales 1204-1453 (Bucharest 2006).

Papanikola-Bakirtzis 1987: D. Papanikola-Bakirtzis, The Palaeologan Glazed Pottery of Thessaloniki. In: Recueil des Rapports du IVe Colloque Serbo-Grec: L' Art de Thessalonique et des pays Balkaniques et les courants spirituels au XIVe siècle (Belgrade 1987) 193-204.

Paradeisopoulos / Suntsov 2014, S. Paradeisopoulos/ V. Suntsov, Ukraine. In: F. Karagianni (ed.), 40 Medieval City-Ports in North Aegean and the Black Sea. A Cultural Guide (Thessalonike 2014) 329-390.

Paraschiv-Talmaţchi / Talmaţchi 2013: C. Paraschiv-Talmaţchi / G.Talmaţchi, Considerations regarding the commercial traffic through navigation in Danube's mouths area (10th-12th c). In: F. Karagianni (ed.), International Symposium: "Medieval Ports in North Aegean and the Black Sea. Links to the Maritime Routes of the East" (Thessalonike 2013) 332-350.

Pevny 1997: O. Pevny, Kievan Rus'. In: H. C. Evans / W. D. Wixom (eds.), Catalogue of the exhibition: The Glory of Byzantium. Art and Culture of the Middle Byzantine Era A.D. 843-1261 (New York 1997) 280-287.

Pletnyov 2014: V. Pletnyov, Varna au Moyen Âge (VIIe–XVIIIe siècle). In: M.Cullin-Mingaud / M.Doncheva / Chr.Landes / C. Huguenot (eds.), Des Thraces aux Ottomans. La Bulgarie à travers les collections des musées de Varna (Montpellier Agglomération 2006) 204-207.

Rabinowitz / Sedikova / Henneberg 2010: A.Rabinowitz / L. Sedikova / R.Henneberg, Daily Life in a Provincial Late Byzantine City: Recent Multidisciplinary Research in the South Region of Tauric Chersonesos (Cherson). In: Proceedings of the International Symposium: Byzanz- Das Römerreich im Mittelalter, Teil 2,1 Schauplätze (Mainz 2010) 425-478.

Rachenov 2006: A. Rachenov, Églises de Mésemvria (Sofia 1932, reprint Nessebar 2006).

Rousseva 2006: R. Rousseva (ed.), National Museum of History. Catalogue (Sofia 2006).

Sedikova 2013: Tauric Chersonesos. Medieval city-port. In: F. Karagianni (ed.), International Symposium: "Medieval Ports in North Aegean and the Black Sea. Links to the Maritime Routes of the East" (Thessalonike 2013) 131-138.

Stoycheva 2013: E. Stoycheva, Μεσημβρία/Nessebar: πόλη στα δυτικά παράλια του Ευξείνου Πόντου Λιμάνι-Σταθμός στους θαλάσσιους δρόμους της Ανατολής. In: F. Karagianni (ed.), International Symposium: "Medieval Ports in North Aegean and the Black Sea. Links to the Maritime Routes of the East" (Thessalonike 2013) 103-112.

Teall 1959: J.L.Teall, The Grain Supply of the Byzantine Empire, 330-1025, Dumbarton Oaks Papers 13, 1959, 87-139.

Totev 2011: K. Totev, Thessalonican Eulogia found in Bulgaria. Lead ampules, encolpia and icons from the 12th-15th centuries (Veliko Tirnovo 2011).

Totev / Pletnyov 2011: K. Totev / V. Pletnyov, Byzantine Art. Christian Relics from Varna Region, 11th–14th centuries (Varna 2011).

Vocotopoulos 2011: P. L. Vocotopoulos, Ecclesiastical Architecture on the Thracian Shores of the Black Sea. In: A. Tourta (ed.), Icons from the Thracian Coast of the Black Sea in Bulgaria (Athens 2011) 26-39.

**Figures for: Networks of Medieval City-Ports in the Black Sea (7th-15th C.). The Archaeological Testimony**



Fig.1.   Turkey, Istanbul. The land walls



Fig.2.   Bulgaria, Sozopol. General view of the walls

Fig.3.   Bulgaria, Nessebar. General view of the walls



Fig.4.   Romania, Constanta. General view of the walls

Fig.5.   Crimea, Chersonesos. General view of the walls
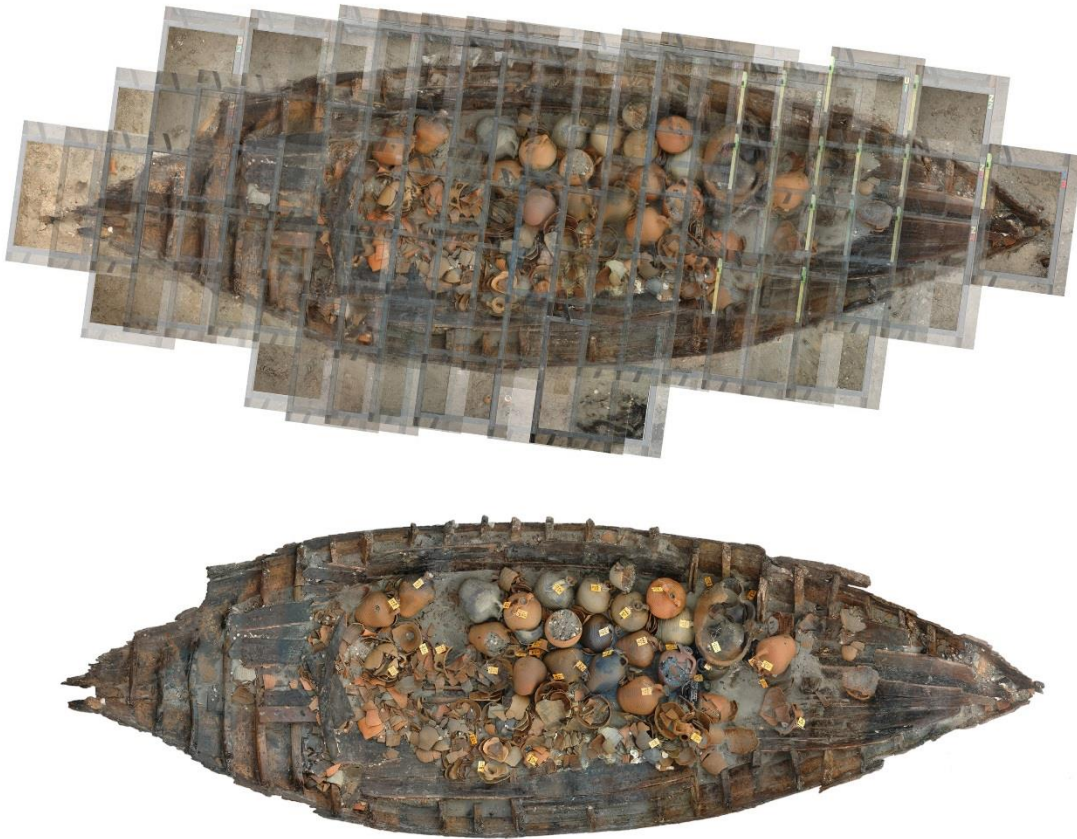


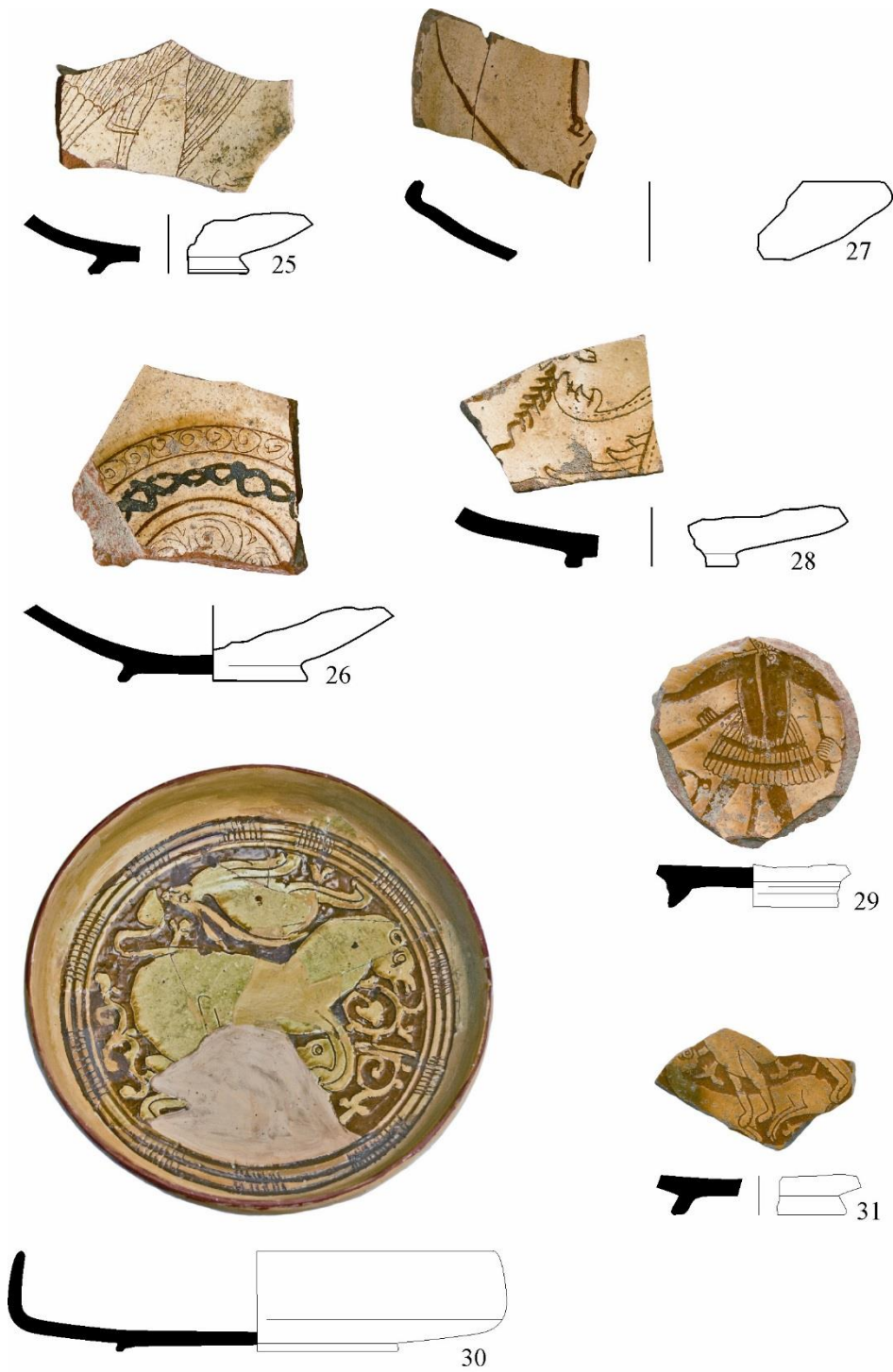Fig.6.   Turkey, Trebizond. General view of the walls

Fig.7. Istanbul, Theodosius Harbour. Shipwreck YK12 (Kocabaş 2013, 411, fig.8)



Fig.8. Istanbul, Theodosius Harbor. Products (plant remains, seeds and remnants of fruit plants and trees, spices, olive pits, hazelnuts and pine nuts) found in the shipwrecks

Fig 9. Istanbul, Theodosius Harbour. Shipwreck YK 12.

*Samples of Glazed Ware from Anhialo: 25 - Fine Sgraffito; 26 - Painted Fine Sgraffito; 27-29 - Incised Sgraffito; 30, 31 - Champleve Ware.*

Fig.10. Bulgaria, Pomorie (Anchialos). Imported glazed pottery (Manolova-Voykova 2013, 366, fig.7).

Fig.11.Bulgaria, Nessebar. Imported glazed pottery (Kiyashkina / Bozkova / Marvakov / Ushev / Delev 2012, 136-137).
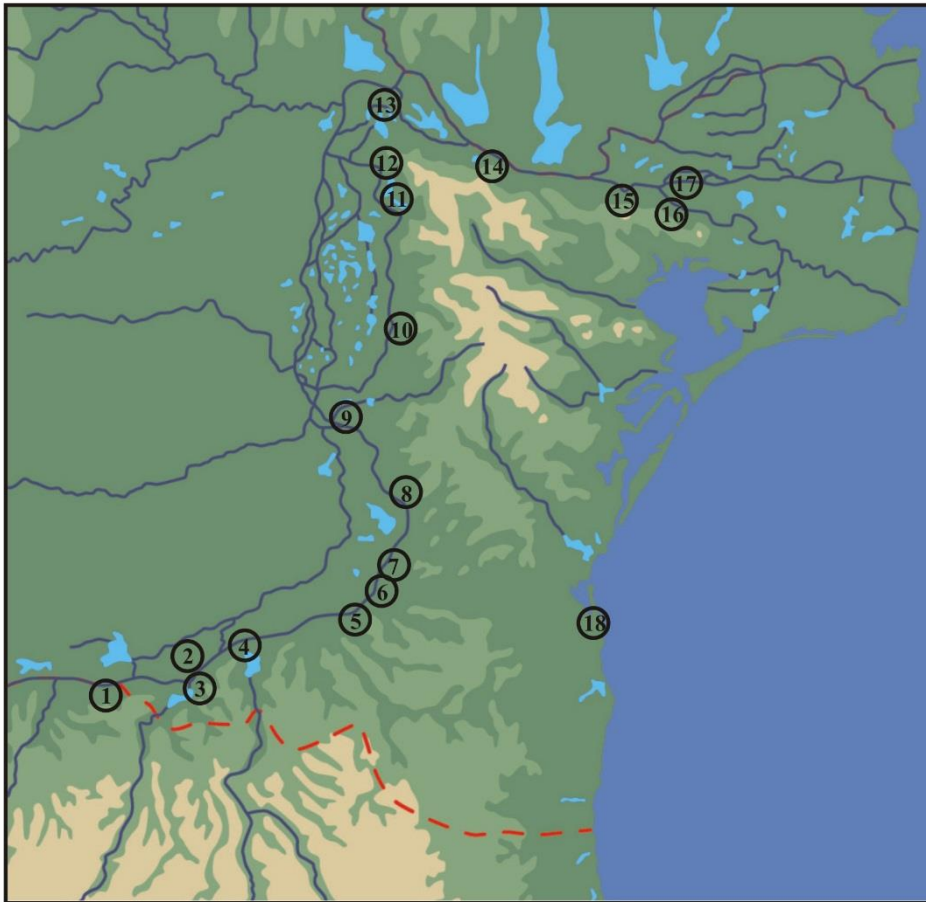
1. *Dorostolon*-Silistra; 2. Pacuiul lui Soare; 3. Dervent; 4. Oltina; 5. *Sacidava*-Rasova; 6. Cetatea Patulului; 7. *Axiopolis*-Cernavoda; 8. Capidava; 9. *Carsium*-Harsova; 10. *Beroe*-Piatra Frecatei; 11. *Troesmis*-Iglita; 12. *Arrubium*-Macin; 13. *Dinogetia*-Garvan; 14. *Noviodunum*-Isaccea; 15. *Aegyssus*-Tulcea; 16. Nufaru-Proslavita; 17. Nufaru-Ilganii de Jos; 18. Tomis-Constanta.

Fig.12. Romania, Dobruja area. Settlements on the commercial routes. (Paraschiv-Talmaţchi / Talmaţchi 2013, 348, fig.1).

Fig. 13. Crimea, Chersonesos. Glazed pottery.

Lead seal of Manuel II (patriarch of Constantinople, AD 1244–1254), d 40 mm, field 36 mm, Constantinople, 13th century AD. *Obverse:* Virgin, seated facing on a throne with a high back, holding the Child in her lap. Inscription on either side of Virgin, with a border of dots: MHP and ΘΥ. (M. Vaniosova)

*Reverse: Inscription of seven lines with many ligatures and a border of dots:*
+ ΜΑΝΟΗΛ
ΕΛΕΩΘΥΑΡΧΙ
ΕΠΙΣΚΟΠΟΩΝ
ΣΤΑΝΤΙΝΟΠΟΛΕ
ΩΣΝΕΑΣΡΩΜΗΣ
ΚΑΙΟΙΚΟΜΕΝΙΚΟΣ
ΠΡΙΑΡΧΗΣ

Lead seal of Stephanos of Abydos, (AD 659–668), d 28 x 30 mm, Abydos, 7th century AD. *Obverse:* Facing bust of Constans II (long beard and moustache) and Constantine IV, each wearing a crown and holding, in his right hand, a globus and cross. Three-line inscription below busts, with a linear border:
+ ΣΤΕΦΑΝΟ
ΑΤΡΙΚΙΟΚΑ
ΙΚΟΜΜΕΡ
(K. Zykova)

*Reverse: Facing busts of Herakleios and Tiberios, each wearing a crown with cross and holding, in the right hand, a globus and cross. Three-line inscription below, with a linear border:*
ΚΙΑΡΙΟΑΠ
ΟΘΗΚΗΣΑ
ΒΥΔΟ

Lead seal of N. Sinadinos (sebastos), 37 mm, Byzantium, 12th century AD. *Obverse:* St. Michael, standing on a dais with open wings, holding in his right hand a long scepter ending in trefoil, and a globe in his left hand. On either side, a vertical inscription: . | . | . | - A | MI | X (M. Vaniosova)

*Reverse: Inscription of eight lines, preceded by a crosslet, and with a border of dots:*
ΣΦΡΑΓΙ.
ΣΕΒΑΣΤΟ.
ΣΥΝΑΔΗΝ.
ΜΗΤΡΑΘΕΗ.
ΤΟΥΤ . . .
. ΟΜΗΧΑΗ .
ΕΚΠΑΤ .
ΟΕΝ

Lead seal of Damian (kommerkiarios), 21 mm. Chersonesos, 11th century AD. *Obverse:* Mother of God, nimbate bust facing, holding the Christ child. Border inscription: ΘΚΕϐΟΗΘ[...]ΔΟΥ (A. Semĕnov)

*Reverse: Inscription of four lines, with a cross above:*
ΔΑΜΗΑ
Ν.ΥΚΟΥΜΕΡ
..ΑΡΗΟΥΧ
...ΟΝΟΣ

Fig.14. Crimea, Chersonesos. Byzantine lead seals (Coleman Carter 2003, 182).

Fig.15. Georgia, Tsikhisdziri (Petra). Byzantine lead seals (Mikeladze 2013, 388, fig.6).
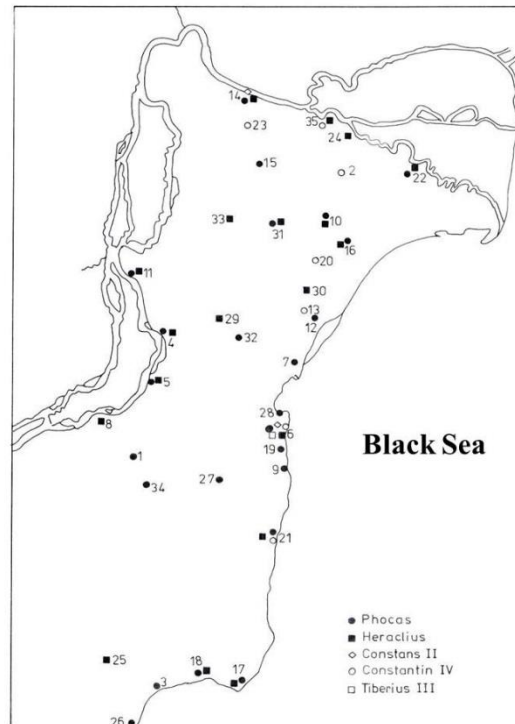
Scatered coin finds in Scythia Minor (7th century AD)

1. Adamclisi; 2. Agighiol; 3. Balcic; 4. Capidava; 5. Cernavodă; 6. Constanţa-Tomis; 7. Corbu de Sus; 8. Dunăreni-Sacidava; 9. Eforie; 10. Enisala; 11. Hârşova; 12. Histria; 13. Istria-sat; 14. Isaccea; 15. Iulia; 16. Jurilovca-Argamum; 17. Kaliacra; 18. Kavarna; 19. Lazu; 20. Lunca; 21. Mangalia; 22. Murighiol; 23.Niculiţel; 24. Nufăru; 25. Odârci; 26. Osenovo; 27. Osmancea; 28. Palazu Mare; 29. Pantelimonu de Sus; 30. Sinoe; 31. Slava Rusă; 32. Târguşor-Ester; 33. Topolog; 34. Tufani; 35. Tulcea.

Fig.16. Romania, scattered coin finds in Scythia Minor (7th c. AD) (Custurea / Nastasi 2013, 331, fig2).

Fig.17. Crimea, Chersonesos. Imported steatite icon (11th-12th c.).

Fig.18. Bulgaria, Balchik. Ampoulla (Totev / Pletnyov 2011, 170).



Fig.19.Bulgaria, Euxinograd (Kastritsi). Glazed bowl with the monogram of St. Demetrius ((Totev / Pletnyov 2011, 172).

Fig.20. Bulgaria, Nessebar. Church of Christ Pantokrator.



Fig.21. Crimea, Kerch. Church of St. John.

Fig. 22. Ukraine, Belgorod-Dnestrovsky. Aerial View (Paradeisopoulos / Suntsov 2014, 334).

**Northern Emporia and Maritime Networks. Modelling past Communication using Archaeological Network Analysis**
Søren M. Sindbæk

## (H2) Introduction

As network theory has become a focus of increasing attention in archaeological research, it has been demonstrated in recent years that questions regarding communication and organisation in past societies can be fruitfully discussed as network problems. While computer-based network modelling has proven an effective way of refining such problems, attempts to address these by applying methods of network analysis to archaeological data have faced complications, and sometimes led to confusing results. Archaeological datasets of a sufficient size to justify the application of statistical methods are usually structured by a multiplicity of parameters, which makes it unlikely that a two-dimensional mapping as nodes and edges may capture and represent patterns of culturally significant relationship in a coherent way. This paper argues that network analysis in archaeology should not be regarded primarily as a means of mapping out data pertaining to past relations and interactions, but as a method of framing, assessing, and criticizing such data. Discussing an example from the archaeology of early medieval maritime interactions in Northern Europe, it demonstrates how network analysis may help to highlight the strengths and limitations of the data, and thus contribute to a better contextualisation of assemblages and artefact groups as evidence of past communication.

## (H2) Network analysis in archaeology

Network analysis is framework of methods, which has a long pedigree as a toolbox for mathematics, physics and social sciences. Yet until a decade ago, the various statistical tools and visualisations developed within these and other disciplines for the analysis of relational data in terms of nodes and edges had seen only sporadic application in archaeology. Recently this has changed with the appearance of a number of studies applying forms of network analysis to archaeological problems (cf. surveys in Sindbæk 2007b; 2013; Brughmans 2013; Brughmans, et al. 2012; Knappett 2011; 2013). The emerging use of network analysis in archaeology can be attributed in part to a society-wide interest in networks conditioned by the growth of electronic information technologies, but also to an increasing access to large electronic data-bases, together with easily available computing power and software, which have dramatically lowered the threshold – in terms of workload, costs and specialist facilities – for exploring complex statistical methods as an approach to archaeological data. More specifically, archaeologists who have turned to network analysis have cited inspiration from new approaches originating in physics and complexity science since the late 1990s, and popularized in particular by two innovative proponents of complex network theory (Barabási 2002; Watts 2003). These works also seem to have provided a large share of the inspiration and motivations for the adoption of more conventional models and analytical tools for social network analysis.
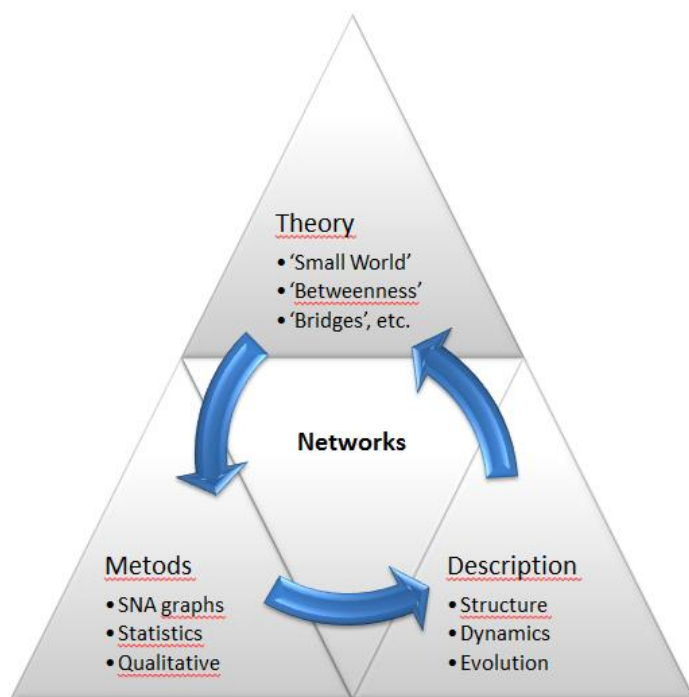
*Fig. 1. The impact of network theory and analysis in archaeology includes the application of several sets of methods adopted from other disciplines, but also comprises a research framework in terms of theoretical concepts, as well as specific research problems in terms of the description of structural and dynamic properties of real-world networks.*

The application of network analysis in archaeological research has appeared in several main forms (**fig. 1**). In terms of methods, it has been adopted either as a means of analysing archaeological data, or of modelling system or processes for the purpose of simulating data (Peeples/Roberts 2013; Östborn/Gerding 2014). Computer-based network modelling has proven its value as an effective way of refining problems relating to past communication and social organisation (e.g. Knappett et al. 2008; 2011; Brughmans et al. 2014). Approaches based on data-analysis (as distinct from modelling) may be subdivided into those proceeding by way of statistical methods derived from complex network studies in physics and mathematics, which focus in particular on the characterization of general patterns and properties of systems, and those guided by social network analysis (SNA), in which the structural roles and relationships of individual nodes are also highlighted (Brughmans et al. 2012). Amongst both groups, one may equally recognise studies which proceed by means of quantitative data, and others which argue from qualitative observations on network performance and events (e.g. Ormerod/Roach 2004; Sindbæk 2007a; 2012a; Munson/Macri 2009).

The influence of network theory and analysis in archaeology goes beyond methods, however. Arguably an even more substantial effect has been attained in providing a new research framework in terms of models and measures of centrality and other aspects of network organisation. Centrality is often a nebulous concept in archaeological analyses, and is mostly discussed as social or spatial hierarchies. Network theory provides another framework for characterising more complex forms of centrality. Measures based on the degree, closeness and 'betweenness' of nodes provide concepts, which are readily applicable to archaeological research problems pertaining to geographical space or social organisation, while also providing quantifiable measures for which data or proxies may be gathered from archaeological evidence (Rivers et al. 2013). Similarly, concepts characterizing global network features (such as the influence of hubs or 'small-world' properties) or the roles of individual nodes or network

components (for example bridges, clusters or cliques) may be used to articulate problems and build research designs to explore archaeological problems.

In terms of descriptive content, network analysis has so far been explored in archaeology in particular as a means of exploring the dynamics of communications and relationships between relational and geographical space (Knappett et al. 2008). A group of research method from Social Network Analysis which have been adopted with notable results in archaeology are those based on affiliation networks, in which links are not identified as specific, directed connections between individual actors, but in terms of joint participation in particular classes of actors according to selected criteria. In social networks these may be defined, for example, as membership a particular school class or work place, or by aspects of identity such as supporting a particular sports team or following a particular television series. Examples of archaeological equivalents to this form of affiliation groups include shared finds, features or locational parameters of sites, or similar formal traits in a set of artefacts or monuments (Sindbæk 2007b; 2009; Mizoguchi 2009; Mills et al. 2013).

While this and other methods have made some progress in characterizing structural properties of relational data in archaeology, few studies have as yet attempted to describe the dynamics and evolution of real world networks based on archaeological data. Some headway has been made by comparing temporal "slices" of networks built on similar criteria, and by suggesting historical models and trajectories as causes for major shifts in network topology (e.g. Knappett et al. 2011; Golitko et al. 2012). Similar approaches have been applied to examine the simultaneous interaction of several distinct modes of organizational in what has been called the "multiplex" relations of multidimensional networks (Preiser-Kapeller 2012).

A recent critic has noted that the application of network analysis in archaeology is "remarkably versatile but equally dangerous", in that it can be hard "to see past their striking visual representations and apparently objective metrics to the complex set of factors that give rise to them" (Isaksen 2013, 43). Complexities are introduced not only by the multiple dynamics which may be involved in network formation and performance, but also by the "fragmentary nature of our sources", and by the fact that, as concerns archaeological data, we are often ignorant "of the entire population our sample is derived from" (Brughmans 2012, 196).

As recently pointed out more generally of complex systems, a description of a networked system is inevitably limited by our ability to observe or estimate that system's internal state from accessible data, which are almost invariably limited to only a subset of variables (Liu et al. 2013). For an archaeological network to be observable, we must be able not only to detect the effects of network performance, but to be able to reconstruct from those effects the system's internal state. As attempts to apply methods of network analysis to archaeological data have shown, these limitations often lead to complications, and sometimes to confusing results.

## (H2) Maritime Networks in Early Medieval Northern Europe

The potentials – and problems of applying Social Network Analysis methods to archaeological material can be illustrated with reference to a case study developed over a numbers year with reference to a growing base of archaeological records (Sindbæk 2007b; 2010; 2012b; 2013). The main aim of this study has been a methodological one, an effort to refine the use of network analysis based on affiliations between sites and artefacts as a means of discovering and demonstrating patterns of association in assemblages from various sets of archaeological sites. In current archaeological research, the most commonly applied tool for the analysis of archaeological artefact distributions and association is based on distribution maps, today typically assembled and analysed by means of Geographical Information Systems. The emergence of GIS analysis since the 1990s has advanced archaeology's means of detecting and highlighting patterns in geographical space immensely. However, they have been generally less successful as a means of discerning and integrating other modes of association, including the homologies between distributions of multiple sets of artefact types (beyond the limited number

of entities which may be effectively visualised through the use of colour codes and symbols). Conversely, statistical methods such as clustering analysis or principal component analysis are used to highlight patterns of typological or topological association, but are not ideal for integrating such patterns with spatial parameters. Network analysis presents itself as potential instrument for bridging the gap between these methods, by integrating spatial and non-spatial patterns.

The case to be discussed presently concerns the development of maritime connectivity in Northern Europe in the early Middle Ages, and the concomitant the establishment of large maritime settlements, emporia. The earliest of these sites are seen in the North Sea region, where places including Quentovic at the mouth of Canche River in northern France, Hamwic (Southampton) and Lundenwic (London) in England, Dorestad at the mouth of the Rhine, and Ribe in Denmark emerge in the second half of the seventh and the early eight centuries. The network of emporia continues to develop in the Baltic Sea area where sites including Åhus and Birka in Sweden, Gross Strömkendorf near Wismar in Northern Germany, Truso at the mouth of the Vistula in Poland, and Staraja Ladoga in north-west Russia emerge in the course of the eight century (Hill & Cowie (eds.) 2001; Skre 2008; Hodges 2012). By the 10th century the network of maritime and riverine trading sites included towns such as Dublin and York in the British Isles and Hedeby in Northern Germany, which are highlighted in contemporary sources both as commercial centres and as foci of political and military action.

The archaeology of the northern emporia is set apart from other contemporary settlements by a number of characteristics (Sindbæk 2007a). Firstly, their assemblages are marked by the frequent occurrence of imported items such as glass beads or non-local pottery, which mark a preferential availability of long-distance trade-flows. Secondly, they tend also to include finds of heavy, bulky commodities such as amphora, quern stones and other stone products, or wine barrels (often found reused as a reinforcement for wells). Due to their considerable weight, these were items, which were rarely moved over great distance by means of land-transport. Their distribution thus tends to mark the attachment-points of maritime or riverine transport networks. As a less obvious, but equally distinctive characteristic, particular crafts using imported raw materials were practiced especially in the coastal trading towns. Craftspeople like bronze-smiths, glass-workers, or even antler carvers, who could only maintain a sustainable level of production by securing regular access to scarce raw-materials, had better opportunities for thriving in the long term in places where long-distance traffic regularly convened. Finally, these sites are also places where evidence of foreign life-styles and exotic visitors tend to be found; and they are, within their respective regions, amongst the locations most frequently mentioned in written sources, sometimes in ways which suggest a considerable level of political interest.

A particular point of contention in the history of early medieval emporia in northern Europe concerns the developments of organisation and communication following the break-up of the Carolingian empire the late 9th century. Some researchers suggest a marked decline in long-distance exchange in the decades around year 900 (Hodges 1989, 164; Hinton 1990, 92; Richards 2000, 162). Others, on the contrary, argue for an expansion of long-distance networks in conjunction with a re-direction of the gravity point (and possibly agency) of trade towards the east (Ambrosiani 2002; Blackburn 2003, 31. Schofield/Vince 2005, 153; Lebecq 2007, 178; Skre 2008, 351).

Network analysis offers a way of assessing these questions further concerning the structure of long-distance communication. As an example, I shall discuss aspects of an analysis presented in greater detail in a recent study (Sindbæk 2012b). The case issues from the distribution of common artefact types in a set of sites, which were active in the early tenth century. For sake of simplicity the comparison is limited to cooking pots of stone or clay. In most regions of 10th century northern Europe particular forms and styles of vessels are characteristic of particular regions, and can be recognised as non-local products when found elsewhere. Being objects of

comparable character and use, it can be assumed that they were displaced in more or less comparable ways. Though some types were produced by craft specialists and marketed over some area, none of them were luxury items likely to have entered into wider chains of circulation. Notably, cooking vessels are not among the artefact types, which are diagnostically linked to the working of emporia or maritime interactions. Their distribution thus offer a view of developments, which is independent from that of more common assessments, based on finds of imported wares or instruments of trade such as coins or weights.

For the purpose of the analysis in question, a set of ten styles of cooking vessels are selected, based on a combinations of typological dimensions of fabric, technology, shape, decoration (for further discussion see Sindbæk 2012b). The occurrence of these ten wares is charted in a selection of 152 published settlement assemblages in Norway, Sweden, Denmark, Germany, Belgium, The Netherlands and the United Kingdom, plus selected comparative sites in France, Ireland and Poland.

The association between the artefact types and the selected sites is illustrated in the graph **fig. 2**, produced using the network-analysis programme Pajek (Nooy et al. 2005). In this graph, affiliations have been remodelled from a two-mode network (sites and artefacts) to a single-mode one (sites only), in which links between sites express joint affiliation, i.e. the presence of one or more shared artefact types. In order to suppress random connections only links with a combined strength of two or more shared artefact types are included, and sites with only a single recorded vessel type have been removed. The relative strength of the links (i.e. the number of shared artefact types which support them) is indicated by the shading of the lines, darker lines indicating stronger links.
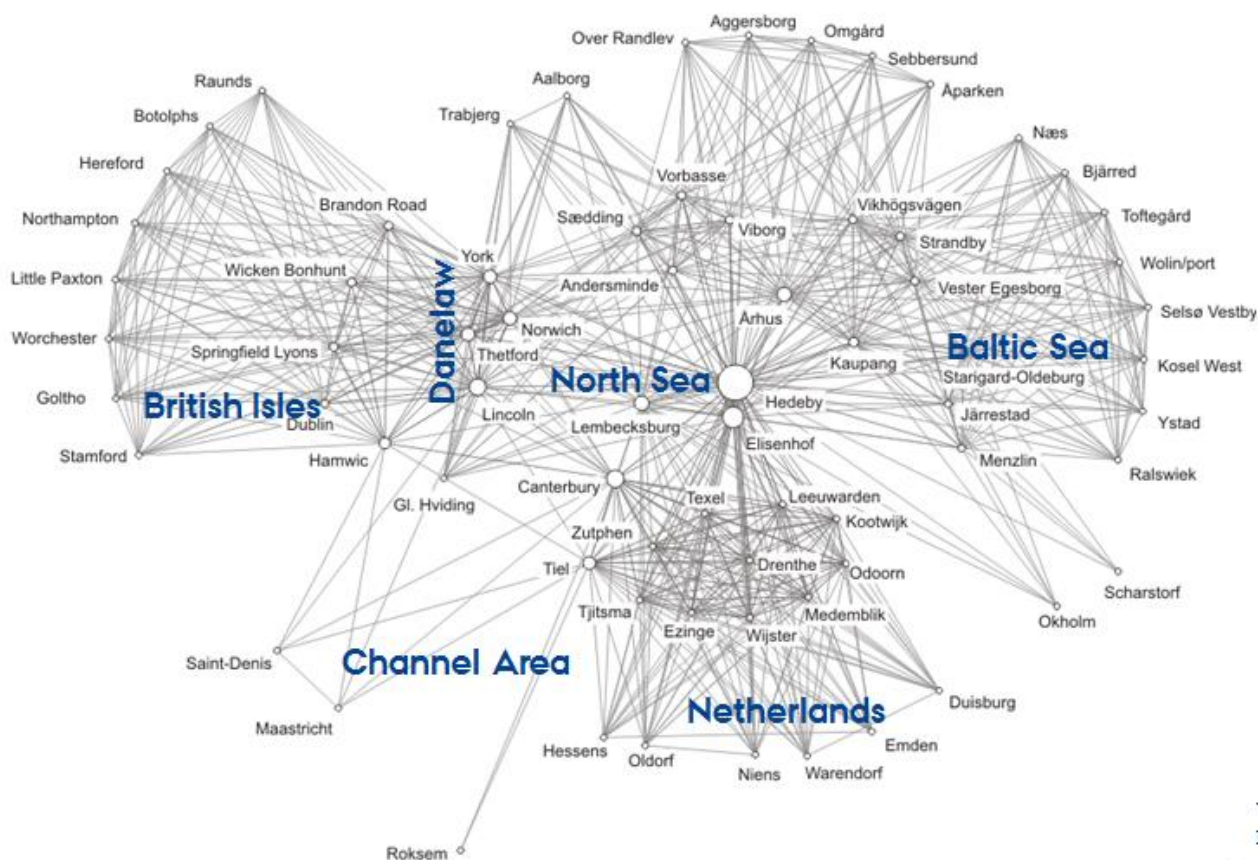


*Fig. 2. Network representation of the associations of ten different types of cooking pots in 152 settlement-site assemblages from the 10th century in the North Sea region and adjacent areas. Sites with less than two artefact types are not visualised, and affiliations are represented as a*

*single-mode (sites only) network in which links indicate two or more shared artefact types. Graph produced by author using Pajek.*

The resulting network, comprising 71 sites, does not show specific connections – the occurrence of particular artefact types – but structural patterns of their relations, i.e. the relative weight of shared traits. In this way the graphs indicates properties, which would not be apparent from the examination of any single distribution pattern. It is possible for the same reason to calculate statistical measures for the individual nodes. The size of the nodes is scaled according to one such measure, the "betweenness centrality", i.e. the ratio by which a given node forms part of all the shortest possible chains between any two other nodes in the network. "Betweeness" is a pointer to the relative importance of nodes in the global network structure (Nooy et al. 2005, 131f).

The layout of the graph is "energised" (using the Kamada-Kawai algorithm) to show the relative relatedness between nodes. The energising algorithm may be compared metaphorically to placing springers between connected nodes and adjusting their position according to the relative pull. The resulting graph is a simple visual representation of the data, rather than an analysis as such. It gives an approximate representation the relative relatedness between nodes and to some extent of their centrality.

The topological distribution of sites, as expressed in the position calculated on the basis of relative relatedness in respect of shared artefact types, show a notably hierarchical structure, in which a few sites – with a high index of betweenness – occupy the centre of the graph, while other sites with fewer links, and a weaker measeure of betweenness-centrality, are placed in roughly concentric clusters towards the periphery. Interestingly, the distribution, calculated entirely on the pattern of relations, places most sites in groups of a largely correct, relative geographical order. This pattern – adequately captured by the network algorithm – expresses the regional clustering of types, along with a tendency for non-regional types to occur more frequently in sites closer to their home-range. It is possible to recognize a 'wrath' of links connecting English sites to continental ones, continental sites to Scandinavian ones, and so forth.

Sites with more diverse assemblages appear in the middle of the graph. There can be several reasons as to why a site yields more than one type of ware. In regions where distributions overlap, or where easy coastal navigation facilitates transport, the presence of several wares in sites may result from regional rather than long-distance interaction. Regardless of these uncertainties, sites that gain centrality in the graph by having other than local domestic wares may generally be expected to have had a role in long-distance communication.

The central sites include several historically famous towns and cities. Still, the links between these should not be mistaken for a direct measure of communication routes. They express general affiliations, and connect any pair of sites in which a shared artefact type occurs. Thus, for example, Elisenhof, which appears in the graph as a highly central site, is likely on further interpretation of its archaeology to be a rural site marked by the vicinity of the emporium Hedeby and the sailing routes thither. Moreover, the selection of recorded assemblages does not include every major site which was active in long-distance communication. Any patterns observed will concern regional trends in long-distance communication, rather than routes between the specific sites indicated.

An exceptional position in the Network is claimed by Hedeby, as indicated by its very high index of "betweenness". The basis for this position is to be discussed further below. Among the surprises to be noted in the pattern is the marginal position of London, often regarded as a major port of trade throughout the early Middle Ages and beyond. On this point, however, the results of the network analysis are in notable agreement with assessments based on traditional archaeological analyses, and the testimony of contemporary written sources (Vince 1985, 34;

1988, 92; Malcolm & Bowsher 2003, 190f). Its position in the network graph presents a justified summary of a real trend in the archaeological record.

Apart from the few central sites, the rarity of finds pointing to communication beyond neighbouring pottery regions suggests that the centres to which long-distance travels were mainly directed acted as 'filters' for communication further afield. This may suggest a segmented system through which long-distance communication was not only directed *to* selected sites but generally passed *from* these to other similar sites. Such a pattern would have generated a system of intermediate trunk segments, which combined to form a ring along the coasts of the North Sea area. Judging by the artefact distributions, then, these trunk segments would carry the bulk of long-distance interactions, forming a "backbone" structure in the communication network (cf. Klincewicz 1998).

We are thus able to suggest a plausible outline of the core structure of the network, as a ring of route segments passing between sites along the coasts of the North Sea area. The central sites in this network were predominantly sites with privileged access to maritime traffic, and typically sites with an urban character. The model implies that the 10th century long-distance exchange network in the North Sea area cannot be regarded simply as a fragmented pattern, a reduced inheritance of the Carolingian period. The outline can be drawn of a network, which featured focused long-distance links, and which represents growth in terms of several new sites, and new axes of integration, above all the very active links between the Scandinavian peninsula and the British Isles.

The example, based as it is on a small number of distributions, presents a highly simplified experiment. Yet the case demonstrates how this method may work to facilitate structural comparison, as a tool for exploring, validating and demonstrating observations about communication in the past.

**(H2) Critique: mapping knowledge**

While the example discussed above demonstrates the ability of network analysis and visualization to capture patterns of archaeological data relating to communications and social networks in the past, it also highlights several potential weaknesses. However, considered at another level, the same weaknesses point to the ability of the method as a means to improve our understanding of the structure of the evidence for such interactions.

For one thing, it may be noted that sites in the periphery of the region chosen for study almost invariably fail to demonstrate a significant level of centrality. This almost certainly reflects at least in part the fact that a portion of the regional networks of those sites have been arbitrarily left out of consideration, being outside the area included in the sample. In reviewing the results of the analysis, one must recognize this negative boundary effect as a major structuring feature of the analytical network topology. Cultural differences also affect the comparison. Connectivity in the southern and western parts of the British Isles may thus be underrepresented in the study due to the very limited use of ceramic vessels in these regions. However, the absence of local pottery could equally have been an incentive for non-local visitors to have brought and used their own vessels on a more significant scale than elsewhere. In this case, the rarity of non-local wares in these regions is therefore likely to reflect a genuinely low frequency of non-local visitors to the recorded sites.

The exceptional centrality, which the emporium Hedeby (or Haithabu) gains in the analysis, is sustained by a number of independent observations, which support the conclusion that Hedeby did have an exceptional role in long-distance communication in the early 10th century (Janssen 1987, 70–75; Bately 2007; Radke 2009, 144; Hilberg 2009, 80–82; Kalmring 2010, 240, ff.). The results of the network analysis would thus seem to provide a plausible illustration of the wider situation. However, the results may also be exaggerated by the very large scale of the excavations, which have been undertaken in Hedeby, and thus the enhanced opportunities for retrieving examples of rare items. Moreover, a particular cultural particularity may affect the

apparent centrality of Hedeby *vis-à-vis* English sites like York or Norwich. The latter sites were certainly major ports and trading centres, as also reflected in the relative centrality they gain in the present analysis; yet in the analysis they appear to be much less central to the system as compared to Hedeby. It is likely that a contributing cause for this pattern is the fact that the English sites were located in regions where, unlike the region of Hedeby, the production of good-quality wheel-thrown pottery was common from the late ninth century onwards. Foreign visitors to the English towns would thus have been less likely to use and discard vessels brought from their home regions, than would visitors to Hedeby. It is possible, therefore, that the apparent topology of communication indicated by the network analysis is in fact at least in part a topology of pottery production.

A final aspect of the network visualised in fig. 2, which may represent an unintended bias of the data, is the three apparent discontinuities, marked as sparsely connected areas around the margin of the graph, in geographical positions corresponding to the areas of the North Sea, the English Channel, and (roughly) to Lower Saxony. The first of these "silent" spaces is a plausible reflection of patterns of cultural affiliations: as much as the North Sea was a highway of maritime traffic, it did separate quite different regional communities. Yet the difference may well be highlighted by the relative scarcity of excavated and published sites in Norway and Scotland, which could be included in the analysis. A similar situation can be noted with respect to sites in the Netherland, which form a conspicuously isolated cluster. This pattern almost certainly relates to a relative shortage in the analysis of data from Belgium and Northern France on one hand, and from inland provinces of Northern Germany on the other. This weakness of the data set was not clear when the data was collected for the analysis, yet on critical reflection it appears to be a likely cause for the observed pattern.

We may conclude that salient patterns of the analysed network are unlikely to reflect the topology of communication, which our data was selected to study, but refer instead to trends and biases in the selected data set itself. Even in this carefully collected, purpose-made data set, minor inconsistencies introduce major patterns in the structure. This realization is a disappointment if we pursue network analysis as a means of mapping past relations and interactions. However, the patterns, which have been revealed, are in fact highly relevant if we are to understand the structure of the evidence itself. Considered as a method for assessing and criticizing knowledge, the exercise in network analysis has produced highly enlightening observations. What we have been mapping is not interactions as such, but our knowledge of these.

## (H2) Eight lessons for archaeological network analysis

The above discussion has served to highlight some general challenges encountered in the process of developing research methods adapted from social network analysis to explore archaeological evidence. The principal lessons may be summarised as a guideline to be considered in the development of a research design.

*1. Good data is rarely 'big'.* Despite the richness of the archaeological record – and increasingly also of its imprint in electronic archives – It is rare to find archaeological data which may be compared to the very large data-sets on social, technological or biological networks, which have become available as 'big data' for complex computerized filtering and analysis. Even for a part of the world where field work is relatively abundant (Northern Europe), for a very common class of sites (early medieval settlements), and for an extremely common group of find types (cooking vessels), it has proven a difficult task to assemble, record and control a set of a few scores of nodes (sites) and less than a dozen classes of affiliations (vessel types) as a balanced basis for a network analysis. The resulting data-base is closer in size to that of a typical community analysis in social network studies than to what might be considered as a relevant basis for detecting statistical properties of network topology.

2. *'Big data' is rarely good.* Some existing archaeological data repositories do approach a size, which could be relevantly considered as 'big data'. They include find inventories of major museums, records of surface collections gathered from regional surveys, in some countries also including databases of metal detected finds, archives of digital or digitized reports, data from topographical or geophysical surveys. Yet the character of such data is generally too heterogeneous to make network analysis an appealing approach, except if deliberately pursued as a means to detect patterns relating to modern recording practice than to aspects of past societies. Records of data gathered over extended periods of time by large numbers of users are unlikely to be sufficiently consistent or complete to be used for detailed statistical studies without detailed screening and revision.

3. *Bad data is bad data is bad data*. An important potential of network analysis is the ability to detect minor topological features, which may have a major effect on the global connectivity of a system. This has far-reaching implications for data sets, whether 'big' or small. While uncontrolled, skewed or incomplete data might be expected to average-out or to be screened off in some modes of statistical analysis, it is likely to be amplified in network analysis. For example, a few accidental bridges between clusters, caused by faulty identification of links, would dramatically change measures of clustering, path lengths and centrality (cf. the Watts and Strogatz model of small-world graphs, Watts 2003). In order for the results of a complex analysis to be valid, it will be necessary to maintain a high degree of detailed control of the data.

4. *Good data + bad data = bad data*. What is true for ill-controlled data sets in general can be equally true for well-controlled data which is augmented or reduced according to practical limitations. Even the inclusion of a small amount of misconstrued data (or, as in the case of the analysis reviewed above, a lack of data for some regions) is likely to shift the balance of the evidence, due to the very power of network analysis to detect relational structure.

5. *Boundaries are for crossing*. Except for the unlikely situation where one may record a complete, and completely delimited system, or obtain a completely random sample of such a system, a network of archaeological evidence will be delimited by arbitrary boundaries in space and time. These boundaries will affect the link structure of some nodes, and by implication the global balance of networks. For the purpose of some modes of analyses this will not be problematic, but for others, such as the calculation of centrality measures or the detection of clusters, boundaries may introduce a significant bias. In the critical assessments of any results it must be asked whether crossing the boundaries would change outcome significantly.

6. *A node is a nexus of contracts*. To a much greater extent than is the case for a social network of people or a technological network of internet routers or freight line carriers, it is open to the researcher to determine what constitutes a node in a network of archaeological evidence. Entities which could be considered as nodes – whether sites, finds, assemblages, regions, types etc. – are often not defined in a self-evident way, but are to some extent arbitrary gathering of events (or, as some economists argues for firms, a "nexus of contracts"). They may be considered on some principle as an entity for the purpose of analysis; but it will remain for the researcher to argue, for example, if the conjunction of two finds made in the same feature, or pertaining to the same structure, or made in separate areas of the same site, or perhaps even the fact that they have been found in the same shire or on the same island will suffice for them to be considered as properties of the same node.

7. *Sites are archaeological accidents*. Whether deriving from accidental losses in settlements or intentional deposit in hoards or graves, archaeological assemblages are the unpredictable result of multiple dynamics. What is found in a site is the end result of use, deposition, retrieval, and identification. For each site the interplay between these variable will differ. A set of multiple assemblages that may be subjected to network analysis can thus never be expected to reflect any one dynamic in an entirely systematic way, but will display accidental variation regardless which variable one seeks to isolate.

8. *Archaeological links are dead*. Due to the complex process leading from practice in the past to archaeological retrieval, a network of archaeological finds will very rarely contain specific, detectable links similar to those that connect people in a genealogy, or transmission lines in a power grid. For any single item found in an archaeological context, one may suggest a number of equally plausible itineraries through social and spatial networks which eventually led to its deposition in the context from which it was retrieved. What may be observed in an archaeological network is thus very rarely directional links, but clusters of affiliation. The possibilities for working back from the end result to the original process are very limited. The actual links are broken.

## (H2) Conclusion

This paper has argued that network analysis may contribute to a better contextualisation of archaeological assemblages and artefact groups as evidence of past communication. As it has been exemplified, however, the complexity of archaeological data implies it is unlikely that a two-dimensional mapping as a network will represent culturally significant relationship in a simple, coherent way. Network analysis in archaeology should not be regarded primarily as a means of mapping out data pertaining to past relations and interactions, but as a method of assessing such data, and as an aid to highlight its strengths and limitations.

In a recent paper, I have argued that while archaeology, in common with other forms of social science and humanities, can benefit greatly from network analysis, it calls for different methods from those, which are currently being adapted across other disciplines (Sindbæk 2013). Archaeological data typically represents fragmentary samples of material affiliations, in which we are ignorant as to what happened between input and output. In most forms of network analysis, the analyst seeks to characterise the structural patterns of a known set of interactions, and to interpret their implications. The challenge faced when analysing archaeological data is, in important ways, the diametrical opposite: a problem that starts from a known response and seeks a network that will produce that response. In the terms of a mathematician, we are not faced with a case of network analysis, but rather of network synthesis.

Network synthesis has a long tradition of research in studies of logistic and technological networks (Cheng et al. 2006; Gen et al. 2008). The application of similar methods to archaeological datasets holds much potential. As with any complex modelling, however, they entail a risk of presenting models whose basis is difficult to assess, and whose predictions may be equally difficult to validate. Besides formal, quantifiable modes of analysis, archaeological approaches to network synthesis must, I suggest, inevitably involve a different hermeneutic: a close-reading of individual pieces of evidence and context, which is almost impossible to reduce to a mere matrix, but which may sometimes supply self-evident answers to what would be difficult or arbitrary steps in a purely formal analysis.

## References

Ambrosiani 2002: B. Ambrosiani, Osten und Westen im Ostseehandel zur Wikingerzeit. In: K. Brandt/M. Müller-Wille/C. Radtke (eds.), Haithabu und die frühe Stadtentwicklung im nördlichen Europa (Neumünster 2002) 339-348.

Barabási 2002: A.-L. Barabási, Linked: The New Science of Networks (Cambridge 2002).

Bately 2007: J. Bately, Text and translation: the three parts of the known world and the geography of Europe north of the Danube according to Orosius' Historiae and its Old English version. In J. Bately/A. Englert (eds.), Ohthere's Voyages. A late 9th-century account of voyages along the coasts of Norway and Denmark and its cultural context (Roskilde 2007) 40-58.

Blackburn 2003: M. Blackburn, 'Productive' Sites and the Pattern of Coin Loss in England 600-1180. In: T. Pestell/K. Ulmschneider (eds.), Markets in Early Medieval Europe. Trading and 'Productive' sites, 650-850 (Macclesfield 2003) 20-36.

Brughmans 2012: T. Brughmans, Facebooking the Past: a Critical Social Network Analysis Approach for Archaeology. In: A. Chrysanthi/P. Murrieta-Flores/C. Papadopoulos (eds.), Thinking Beyond the Tool. Archaeological Computing and the Interpretive Process. BAR Int. Ser. Vol. 2344 (Oxford 2012) 191-203.

Brughmans 2013: T. Brughmans, Thinking through networks: a review of formal network methods in archaeology. Journal of Archaeological Method and Theory 20 (4), 2013, 623-662.

Brughmans et al. 2012: T. Brughmans//L. Isakssen/G. Earl, Connecting the Dots: an Introduction to Critical Approaches in Archaeological Network Analysis. In: M. Zhou/I. Romanowska/Z. Wu/ P. Xu/P. Verhagen (eds.), CAA2011 - Revive the Past: Proceedings of the 39th Conference in Computer Applications and Quantitative Methods in Archaeology, Beijing, China, 12-16 April 2011 (Beijing 2012) 359-369.

Brughmans et al. 2014: T. Brughmans/S. Keay/G. Earl 2014: Introducing exponential random graph models for visibility networks. Journal of Archaeological Science 49, 2014, 442–454.

Cheng et al. (eds.) 2006: M.X. Cheng/Y. Li/D.-Z. Du (eds.), Combinatorial Optimization in Communication Networks (Boston, MA 2006).

Gen et al. 2008: M. Gen/R. Cheng/L. Lin, Network Models and Optimization: Multiobjective Genetic Algorithm (London 2008).

Golitko et al. 2012: M. Golitko/J. Meierhoff/G. M. Feinman/P. R. Williams, Complexities of collapse: the evidence of Maya obsidian as revealed by social network graphical analysis, Antiquity 86, 2012, 507-523.

Hilberg 2009: V. Hilberg, Hedeby in Wulfstan's days. A Danish emporium of the Viking Age between East and West. In: A. Englert/A. Trakadas (eds.), Wulfstan's Voyage.The Baltic Sea region in the Early Viking Age as seen from shipboard (Roskilde 2009) 79-113.

Hill & Cowie (eds.) 2001: D. Hill/R. Cowie (eds.), Wics: the Early Medieval Trading Centres of Northern Europe (Sheffield 2001).

Hinton 1990: D. Hinton, Archaeology, economy, and society: England from the fifth to the fifteenth century (London 1990).

Hodges 1989: R. Hodges, The Anglo-Saxon Achievement (London 1989).

Hodges 2012: R. Hodges, Dark Age Economics: A new audit (London 2012).

Isaksen 2013: L. Isaksen, ‚Oh what a tangled web we weave' – towards a practice that does not deceive. In: C. Knappett (ed.), Network analysis in archaeology: New approaches to regional interaction (Oxford 2013) 43-67.

Janssen 1987: W. Janssen, Die Importkeramik von Haithabu, Die Ausgrabungen in Haithabu 9 (Neumünster 1987).

Kalmring 2010: S. Kalmring, Der Hafen von Haithabu. Die Ausgrabungen in Haithabu 14 (Neumünster 2010).

Klincewicz 1998: J.G Klincewicz, Hub location in backbone/tributary network design: a review. Location Science 6, 1998, 307-335

Knappett 2011: C. Knappett, An archaeology of interaction: network perspectives on material culture and society (Oxford 2011).

Knappett 2013: C. Knappett, Introduction: Why networks? In: C. Knappett (ed.), Network analysis in archaeology: New approaches to regional interaction (Oxford 2013) 3-15.

Knappett et al. 2008: C. Knappett/T. Evans/R. Rivers, Modelling maritime interaction in the Aegean Bronze Age. Antiquity 82, 2008, 1009-1024.

Knappett et al. 2011: C. Knappett/R. Rivers/T. Evans, The Theran eruption and Minoan palatial collapse: new interpretations gained from modelling the maritime network. Antiquity 85, 2011, 1008–1023.

Lebecq 2007: S. Lebecq, Communication and exchange in northwest Europe. In: J. Bately/A. Englert (eds.), Ohthere's Voyages. A late 9th-century account of voyages along the coasts of Norway and Denmark and its cultural context (Roskilde 2007) 170-179.

Liu et al 2013: Y. Y. Liu/J. J. Slotine/A. L. Barabási, Observability of complex systems, Proceedings of the National Academy of Sciences 110(7), 2013, 2460-2465.

Malcolm/Bowsher 2003: G. Malcolm/D. Bowsher, Middle Saxon London: Excavations at the Royal Opera House 1989-99, MoLAS Monograph 15 (London 2003).

Mills et al. 2013: B.J., Mills/J.M. Roberts/J.J. Clark/W.R. Hass/D. Huntley/M.A. Peeples/L. Borck/ S. C. Ryan/M. Trowbridge/R. L. Breiger, The Dynamics of Social Networks in the Late Prehispanic US Southwest. In: C. Knappett (ed.), Network analysis in archaeology: New approaches to regional interaction (Oxford 2013) 181-202.

Mizoguchi 2009: K. Mizoguchi, Nodes and edges: A network approach to hierarchisation and state formation in Japan. Journal of Anthropological Archaeology 28, 2009, 14-26.

Munson/Macri 2009: J. L. Munson/M. J. Macri, Sociopolitical network interactions: A case study of the Classic Maya. Journal of Anthropological Archaeology 28(4), 2009, 424-438.

Nooy et al. 2005: W. de Nooy/A. Mrvar /V. Batagelj, Exploratory Social Network Analysis with Pajek (Cambridge 2005).

Ormerod/Roach 2004: P. Ormerod/A.P. Roach, The Medieval inquisition: scale-free networks and the suppression of heresy. Physica A 339, 2004, 645-652.

Östborn/Gerding 2014: P. Östborn/H. Gerding, Network analysis of archaeological data: a systematic approach. Journal of Archaeological Science 46, 2014, 75-88.

Peeples/Roberts 2013: M. A. Peeples/J. M. Roberts Jr, To binarize or not to binarize: relational data and the construction of archaeological networks. Journal of Archaeological Science 40 (7), 2013, 3001-3010.

Preiser-Kapeller 2012: J. Preiser-Kapeller, Networks of Border Zones: Multiplex Relations of Power, Religion and Economy in South-Eastern Europe, 1250-1453 AD. In: M. Zhou/I. Romanowska/Z. Wu/ P. Xu/P. Verhagen (eds.), CAA2011 - Revive the Past: Proceedings of the 39th Conference in Computer Applications and Quantitative Methods in Archaeology, Beijing, China, 12-16 April 2011 (Beijing 2012) 381-393.

Richards 2000: J.D. Richards, Viking Age England (Stroud 2000).

Rivers et al. 2013: R. Rivers/C. Knappett/T. Evans, What makes a site important? Centrality, gateways and gravity. In: C. Knappett (ed.), Network analysis in archaeology: New approaches to regional interaction (Oxford 2013) 125-150.

Schofield/Vince 2005: J. Schofield/A. G. Vince, Medieval towns: the archaeology of British towns in their European setting (London 2005).

Sindbæk 2007a: S.M.Sindbæk, Networks and nodal points. The emergence of towns in Early Viking Age Scandinavia. Antiquity 81, 2007, 119-132.

Sindbæk 2007b: S.M.Sindbæk, The Small World of the Vikings. Networks in Early Medieval Communication and Exchange. Norwegian Archaeological Review 40:1, 2007, 59-74.

Sindbæk 2010: S.M.Sindbæk, Re-assembling regions. The social occasions of technological exchange in Viking Age Scandinavia. In: R. Barndon/I. Øye /A. Engevik (eds.), The Archaeology of Regional Technologies: Case Studies from the Palaeolithic to the Age of the Vikings (Lewiston 2019) 263–287.

Sindbæk 2012a: S.M.Sindbæk, Enter the Gripping Beast. Artistic innovation and social networks in Viking-period towns. In: R. Berge/M.E. Jasinski/K. Sognnes (eds.), N-TAG TEN Proceedings of the 10th Nordic TAG conference at Stiklestad, Norway 2009, BAR International Series 2399 (Oxford 2012) 129-135.

Sindbæk, S.M. 2012b: S.M.Sindbæk, Viking Disruptions or Growing Integration? Contextualising Communication Networks in the 10th century North Sea. In S. Kleingärtner/G. Zeilinger (eds.), Raumbildung durch Netzwerke. Der Ostseeraum zwischen Wikingerzeit und Spätmittelalter aus archäologischer und geschichtswissenschaftlicher Perspektive, Beiträge des am 28. und 29. Oktober 2010 in Kiel veranstalteten Workshops (Kiel 2012) 19-38.

Sindbæk 2013: S.M.Sindbæk, Broken links and black boxes: material affiliations and contextual network synthesis in the Viking world. In: C. Knappett (ed.), Network analysis in archaeology: New approaches to regional interaction (Oxford 2013) 71-94.

Skre 2008: D. Skre, Dealing with Silver: Economic Agency in South-Western Scandinavia AD 600-1000. In: D. Skre (ed.), Means of Exchange. Dealing with Silver in the Viking Age, Kaupang Excavation Project Publication Series, Bd. 2 (Aarhus 2008) 343-355.

Vince 1985: A.G. Vince, The Saxon and Medieval Pottery of London: A Review. Medieval Archaeology 53, 1985, 25-92.

Vince 1988: A.G. Vince, The economic basis of Anglo-Saxon London. In: R. Hodges/B. Hobley (eds.), Rebirth of towns in the West, AD 700-1050, CBA Research Report 68 (London 1988) 83-92.

Watts, D. J. 2003. Six Degrees: The Science of a Connected Age (London 2003).

**Harbours and maritime mobility: Networks and Entanglements**
Johannes Preiser-Kapeller

**(H2) Introduction and methodological issues**
As outlined in the thematic introduction to this volume, network theory claims "not only that ties matter, but that they are organized in a significant way, that this or that individual [or site, JPK] has an interesting position in terms of his or her [or its] ties."[388] In order to capture, analyse and visualise networks, relational data is organised in the form of matrices (with rows and columns) and visualised in the form of graphs (with nodes and links). As explained in the introduction, various mathematical procedures aim at a structural analysis of these networks at the level of individual nodes, of groups (clusters, cliques) of nodes and of the entire network. Various modern day software tools (Pajek*, ORA* [both used for this study], UCINET etc.) allow for a relatively simple input and organisation of such data and easy mathematical analysis as well as impressive visualisations.[389] This sometimes tempts to use such computer programmes as "black boxes" without a thorough reflection on the mathematical background and assumptions underlying these procedures as well as their appropriate interpretation with regard to the specific quality and quantity of historical or archaeological evidence. One danger is the creation of "artificial complexity by mixing heterogeneous ties on long periods" into one network model without taking into account different qualities and the temporality of relations and thereby "obscuring its historical meaning".[390]

Another issue is the "completeness" of data, a question also often raised by critics of this approach.[391] Besides the simple fact that this is a central issue not only for network analysis, but for any attempt to reconstruct the past on the basis of the always fragmentary historical or archaeological evidence (even more so if this is done in the form of an allegedly coherent narrative), Claire Lemercier has made clear: "Historians often seem to fear that their painfully discovered, often fragmentary sources are not suited to the data requirements of network analysis. This seems to be caused by an ambiguity in vocabulary, as a part of formal network analysis is often described as the study of "complete networks". This however does not imply that the aim is to describe, or map, all the ties that exist around one actor, or between a set of actors. Here lies a fundamental ambiguity of network studies, that has too often been maintained by network specialists themselves, commenting on graphs as if they were maps or photographs of "all the ties that exist here". In fact, the map of photograph metaphor holds if we remember that these other representations also are abstractions: a map concentrates on some patterns of reality (roads and/or altitude and/or location of restaurants, etc.) and even a photograph only captures one point of view. Similarly, network graphs and the databases that are used to build them concentrate on one or a few sort of ties between a limited set of actors, deliberately ignoring the fact that these actors necessarily have other relationships among themselves and with outsiders. Choices in "boundary specification" (whom do we observe? Which ties among them? at what time(s)?) heavily constrain the sort of questions that can be analysed by network analysis".[392] Thus, we are aware "that our data set is not complete"; but if we apply network analysis, we are also confident that "it is possible to find enough relational data in the sources to show general structures and developments".[393] This does not necessarily imply an elaborate quantitative analysis; as also some samples below illustrate, sometimes the visualisation of relational patterns alone provides valuable insights into the range and complexity of

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[388] Lemercier 2012, 22.
[389] Cf. also Brughmans 2012; Knappett 2013.
[390] Lemercier 2012, 17. For similar observations see also the contribution of Sindbæk to this volume.
[391] See also the contribution of Sindbæk to this volume.
[392] Lemercier, 2012, 24-25. For limits and necessary reflections on the use of archaeological data cf. also esp. Peeples / Roberts 2013.
[393] Burkhardt 2009.

connections inherent even to a single archaeological assemblage and allows for the creation of "topographies of entanglements".[394]

As also outlined in the introduction, in the absence of sufficient relational data, network theory can also be used to reflect on possible structural properties and to build models either only on the basis of such theoretical considerations or also by integrating data on the distribution of sites or artefacts, for instance. In the following, I first try to sketch such a model for a harbour site on the basis of two theories of settlement systems and reflect on its structural properties; I then combine these considerations with models of maritime connectivity in the late medieval Black Sea and in the ancient Aegean, in the later case based on data on the localisation of harbours and landing sites and a specific mode of maritime exchange (cabotage). Finally, I outline some approaches towards the maritime mobility of people and objects and how it can be mapped and analysed in order to capture the complexity of entanglements between ports, ships and humans. Thereby, some elements of a "relational toolkit" for further studies within the framework of the Special Research Programme (SPP 1630) "Harbours from the Roman Period to the Middle Ages" shall be established.

**(H2) Networks and the emergence of port cities: models and structures**
**(H3) Urban systems and networks**
In 1985 Hohenberg and Hollen Lees in their book "The Making of Urban Europe" discussed two models for urban systems: the classic central place theory developed by Walter Christaller in the 1930s and what they called a "network system". While in the first model, cities emerge as central places within a hierarchy of lesser central urban sites in their "umland", for which they serve a focal point of exchange and administration[395], in the "network system" cities gain importance as gateways[396], as intermediary points between sites in their "hinterland" and other more distanced cities in their wider "foreland" (also defined as "the area of the overseas world with which the port is linked through shipping, trade and passenger traffic"[397]). As Hohenberg and Hollen Lees made clear, in many cases a combination of both models can be used to describe the rise of urban sites and especially port cities. They also stated: "„If the links among cities could be described mathematically, it would be with topology rather than Euclidian geometry". As a matter of fact, concepts and tools of network analysis allow us to describe such systems also mathematically and to quantify and compare structural patterns.[398]
Both models of urban systems can be connected with basic concepts of centrality in terms of quantitative network analysis: the "central place system" focuses on the significance of a site due to the number and strength of links with "subordinated" sites within its immediate umland, thus its "degree centrality" (**fig. 1**). The "network system" attributes centrality to the potential of a site to serve as intermediary or "gateway" between otherwise unconnected nodes, thus to its "betweenness centrality" (cf. also the introduction to this volume) (**fig. 2**). From a structural point of view, via a multitude of short distance ties, a central place would be embedded in a densely connected cluster of sites in its umland; at the same time, it would be also integrated into a cluster of sites in its wider foreland via its long distance connections (of maritime exchange); between these two clusters, the site would serve as gateway or hub. The other sites in the foreland may also in turn be embedded in dense clusters of their respective hinterlands (**fig. 3**). These sites are therefore central both in terms of degree and betweenness, combining local and "global" network centrality; this differentiation between sites with regard to their

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[394] Krempel 2005; Dorling 2012. Cf. also http://oeaw.academia.edu/TopographiesofEntanglements for some samples.
[395] Cf. also Fujita / Krugman / Venables 1999, 26-27.
[396] Cf. also Horden / Purcell 2000, 392-395.
[397] Pearson 2003, 31.
[398] Hohenberg / Hollen Lees 1995, 47-73.

centrality would also lead to a hierarchisation within the settlement systems both on the local level (as in the model of central places) and the "global level", with port cities of different size and power of attraction for commerce or migration.[399]

Even more, such a model would predict the existence of a multitude of clusters of interconnected nodes on the local as well as the trans-local level across spatial scales. Interesting enough, a similar structural pattern has been observed in many complex networks across disciplines. Such "small world networks" combine network density at the local level with high connectivity among central hubs at the global level, thereby maintaining a high degree of local cohesion and a "globally" relatively small average length of paths among nodes. Clusters can be observed at different hierarchical levels, nested within each other and contributing to a self-similar structure of the entire network (**fig. 4**).[400] Similarly, in our model the umlands of central places can be understood as clusters nested within the foreland network, which in turn could be connected via the hub to an even wider ranging network of trans-regional hubs, each in turn embedded in a regional foreland cluster which shelters several local umland clusters, etc. (**fig. 5**). Thereby, this model takes into account both the significance of "local maritime communities", "small worlds" and the "logic of spatial proximity" as postulated by Tartaron[401], for instance (see also the introduction) as well as the emergence of ports as differentiated "nodes of density in the matrix of connectivity" across spatial scales via the establishment of longer distance connections.[402]

**(H3) Attempts to evaluate the model**

This model of course is not valid for all types of ports: some harbour sites for instance were established as secondary maritime gateways for a central place further inland (Portus for Rome), others emerged as places of temporary exchange between maritime communities without being embedded in a wider settlements system in the umland.[403] But based on modern day empirical data, Ducruet and Zaidi have observed such a structure of nested clusters in maritime networks, identifying "spatial proximity" as one factor for the emergence of port systems, while other factors such as "trade preferences" or "specialization" of sites lead to the establishment of connections among ports over wider distances.[404]

In the absence of a similar density of evidence for the strength of connections both maritime and terrestrial between settlements, it is very difficult to check the validity of this network model against data for the ancient or medieval period. At least the differentiation between sites within settlement systems with regard to their population or size has been observed on the basis of demographic, economic or archaeological data (settlement sizes) for various cases across periods and regions; these follow typical distribution patterns, i. e. the "rank-size distribution" first discovered by George Kingsley Zipf in the 1940s. According to the "classical" Zipf-distribution, the second largest city within a settlement system would have one half of the population of the largest city, the third largest city one third of the population of the largest city, et cetera.[405] This can be expressed with the formula:

$$P(r) = P(1)/r^Z$$

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[399] Cf. also Fujita / Krugman / Venables 1999, 227-236, on the emergence of hubs and ports, and 181-213 on hierarchical urban systems.
[400] Watts 1999.
[401] Tartaron 2013, 6-7, 80, 88.
[402] Horden / Purcell 2000, 393.
[403] Cf. also Horden / Purcell 2000, 395-400 and the contribution of Veikou in this volume resp. Veikou 2014.
[404] Ducruet / Zaidi 2012.
[405] de Vries 1984; Fujita / Krugman / Venables 1999, 215-225; Preiser-Kapeller / Mitsiou 2010.

where P(r) is the population of the city of the r-ranked city within the totality of the sample, P(l) the population of the largest city, r the rank of the city (1, 2, 3, …) and Z is a constant in the order of magnitude of 1. Values of Z smaller than 1 indicate a more equal distribution of population (or any other indicator selected) than in the classical Zipf-model while values larger than 1 indicate a higher degree of inequality within the settlement system. If plotted on a double-logarithmic scale, the rank-size-model show also many similarities with the unequal distribution of centrality among nodes in complex networks ("power law distribution", see the introduction; here, the probability of finding a node with a degree value of "k" follows the mathematical form $p(k) = k^{-\gamma}$, $\gamma$ being a coefficient similar to Z) and hints at similar mechanisms of differentiation due to the embedding of sites in dynamic webs of exchange (**fig. 6 a-c**).[406] Schörle has observed similar hierarchical patterns (with regard to the size of harbours as far as it can be determined on the basis of archaeological data) among ports of the central Tyrrhenian coast in Roman Italy.[407] The development of such patterns within settlement systems cannot be attributed solely to local differences, but more as emergent property of the dynamics of networks.

**(H3) Differentiation and clustering among sites in maritime networks: the Black Sea and the Aegean**

One rare case of medieval data not only on the maritime routes between ports, but also on the number of ships using them in a specific year is provided by Genoese charter letters for 60 ships sailing between 13 cities in the Black Sea, then one of the most important mercantile regions for the Italian sea powers, in 1290.[408] Based on this data, I created a network model of sites and routes (see **fig. 7**) and determined the relative centrality of nodes according to the number of their connections ("degree", see the thematic introduction). We observe a strong differentiation among sites in this regard; the plot of the rank-size-distribution of degree centrality shows a pattern identified as typical for other settlement systems (see above) (**fig. 8**). But the data from 1290 allows us even more to "weight" the links between nodes (on the basis of the number of ships actually travelling between them) (see **fig. 10a** and **10b**); this of course also influences the results of the calculation of degree centrality values.[409] The actual differences between nodes become more pronounced: while the unweighted degree centrality of Pera is only three times the one of Sinope, its weighted degree centrality is 16 times higher, for instance (see table below). This stronger differentiation is also visible in the increase of the factor Z, which is 1.515 for the weighted distribution vs. 0.919 for the unweighted one (**fig. 9**). Still, we observe the similar rank-size distribution pattern for the centrality values in the weighted and unweighted network (**fig. 8** and **9**), which indicates that even a "simple" binary network model (containing only information on the presence or absence of routes between sites) would allow for some meaningful inferences on essential structural properties of the traffic system of interest. Additional quantitative data of course enables us to significantly refine results, especially at the level of individual nodes and links.

| Node | Unweighted degree | Weighted degree |
|---|---|---|
| Kaffa | 8 | 37 |
| Trebizond | 7 | 17 |
| La Copa | 5 | 14 |

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[406] de Vries 1984; Fujita / Krugman / Venables 1999, 215-225; Albert / Barabási 2002; Preiser-Kapeller / Mitsiou 2010; Marzano 2011. For the power law distribution see Estrada 2012, 29-30.
[407] Schörle 2011. Cf. also Marzano 2011 and Hanson 2011 for rank-size distributions for other regions of the Roman Empire.
[408] Balard 1978, 849-857. On the Black Sea cf. also the contribution of Karagianni in this volume.
[409] Cf. Opsahl / Agneessens / Skvoretz 2010, and Ducruet / Rozenblat / Zaidi 2010, for a similar model.

| Ciprico | 4 | 12 |
|---------|---|----|
| Simisso | 4 | 5 |
| Tana | 3 | 9 |
| Pera | 3 | 16 |
| Bosporus | 2 | 3 |
| Faxium | 2 | 2 |
| Zaccaria | 1 | 1 |
| Kerasus | 1 | 2 |
| Sinope | 1 | 1 |
| Nipo | 1 | 1 |

Still, even the weighted network model for the Black Sea provides access only to selected aspects of the general complexity of connectivity across scales we intend to capture in our model. Due to the character of Genoese commerce and the specific navigational conditions of the Black Sea, which lacked the insular stepping stones as we find them in the Aegean, for instance, we can capture solely the longer distance links between sites and not their embedding in more local clusters of connections.[410] Equally, only the existence of data for other time slices would allows us to capture the temporal dynamics of such networks, shifts in the importance of ports and routes as well as possible changes or continuities in the overall structural properties.

In most cases, we remain dependent on data (settlement and harbour sizes, distribution of artefacts, fragmentary written evidence) which may enable us to capture some "signatures" hinting at complex network dynamics (statistical distribution patterns, rank-size-distributions) or to build models integrating our assumptions on the character of maritime traffic (long distance connection and/or cabotage) and the clustering of sites due to the "logic of spatial proximity, for instance.

In order to develop such a probabilistic model, we used the "Geodatabase of Ancient Ports and Harbors" created by A. de Graauw and since 2013 integrated in the Digital Atlas of Roman and Medieval Civilization of Harvard University.[411] This database includes names, (often hypothetical) localisations and geo-data for all ports and landing sites documented in ancient sources up to Late Antiquity. I extracted all sites located within the Aegean and the Sea of Marmara, a totality of 791 localities. These sites I converted into a point layer, which I projected onto a map of the area. Then I used the Delaunay-triangulation tool of QuantumGIS, which connects all points within a layer within its nearest neighbours[412]; from the emerging network, I deleted those connections leading across land or spanning distances beyond 100 km (as a maximum distance covered by a ship on one day at this time).[413] I extracted the data from QuantumGIS and transformed it into a network matrix which could be further used for network analytical calculations with the software tools *ORA\** and *Pajek\**.[414] Thereby, I created a next neighbourhood network for the Aegean and the Sea of Marmara, consisting of 791 nodes (= sites) and 2,188 links (= [hypothetical] routes from one site to another) (**fig. 11**).[415] In this model, all port sites are connected with all other sites within a certain distance, thereby simulating a mode of commerce and transport based on ships travelling from one port to the

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[410] Cf. Balard 1978. Cf. also the contribution of Sindbæk to this volume for similar shortcomings of network models.

[411] de Graauw 2013.

[412] Cf. Kappas 2011, 82–87.

[413] Cf. Kislinger 2010, 149–174 (with an average distance of 85 km for one day of journey); Pryor 1992, 25–101.

[414] For ORA\*: http://www.casos.cs.cmu.edu/projects/ora/software.php. On Pajek\* see: de Nooy / Mrvar / Batagelj 2005.

[415] For this model see also Preiser-Kapeller 2013. In general cf. also Conolly / Lake 2006, 164–166; Estrada 2012, 250-252 and 389-395.

next one, following the model of cabotage.[416] Also in order to follow the "logic of cabotage" (spatial proximity) as well as to integrate the cost of interaction between two sites as limiting factor for the strength of connection between them, I weighted links by using the inverted geographical distance between them; thus, a link would be the stronger the shorter the distance between two nodes ("distant decay" effect).[417]

As I have discussed some general properties of this model (in its unweighted form) elsewhere[418], I focus on two characteristics of special interest for the evaluation of the (weighted) network model as outlined above: the distribution of degree centrality values among nodes and the identification of clusters.

The logarithmic plot of the distribution of degree centrality values shows a pattern different from the one we have observed above for complex networks and settlement systems (**fig. 12**); it follows more the pattern of a "(log)normal distribution", where values are concentrated to the left and the right of a predominant average value, and not the more unequal, skewed pattern of a power law, for instance. This could indicate that the emergence of such more unequal distributions and the higher degree of differentiation among sites associated with it depend on the establishment of further connections over long distances beyond local clusters, which would distinguish some sites as "gateways" between their umlands and a wider foreland (see also above).

On the other side, the multitude of regional clusters (= groups of nodes more densely connected among each other than with the rest of the network) predicted by the above-mentioned model becomes clearly visible in such a model if we apply one very powerful algorithm of cluster detection, developed by the physicist M. E. J. Newman.[419] In the Aegean network model, the algorithm identifies 25 clusters which include nodes within a distance of what would have been one to three day´s journeys on an ancient or medieval ship (80-250 km) from each other (**fig. 13**). Such clusters would qualify for what Tartaron has called "small worlds" of maritime interaction: "Local and microregional maritime networks are best expressed by the concept of the "small world" (…), composed of communities bound together by intensive, habitual interactions due to geography, traditional kinship ties, or other factors. There may be a high level of interdependence and communities may come to think of themselves as forming a natural entity, defined by the dense web of connections that supports a combination of political, social, and economic relationships. Small worlds are nested within larger regional and interregional economic and sometimes political networks."[420] If we apply furthermore the same algorithm on one of these regional clusters, we detect a further multitude of clusters (16, in this case) nested within the larger one (**fig. 14a** and **b**), each representing something of a "local small world" connecting sites within a distance of less than a day´s journey from each other (**fig. 15**).

Thus, by integrating the relatively simple logic of cabotage into a model based only on data on the spatial distribution of harbour sites, we are able to identify some non-trivial structural patterns in accordance with the second "signature" of a complex maritime network (nested clustering) as discussed above. A further refinement of this model by the augmentation with the long distance routes identified from ancient source evidence for this region by Pascal Arnaud, for instance[421], may lead to the emergence of the other signature of stronger differentiation among sites leading towards the more unequal distribution of node centrality as observed above.

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[416] Cf. Horden / Purcell 2000, 123-170, as well as Wilson 2011, 33–60 and Arnaud 2011, 61–80, on these issues, as well as Kislinger 2011, for the validity of such a model for the middle Byzantine period.
[417] Cf. also Barthélemy 2011; Fujita / Krugman / Venables 1999, 97-115; Gorenflo / Bell 1991; Leidwanger 2013; Bevan / Wilson 2013; Opsahl / Agneessens / Skvoretz 2010.
[418] Preiser-Kapeller 2013.
[419] Newman 2010, 371-392.
[420] Tartaron 2013, 6-7, 80, 88.
[421] Cf. also Arnaud 2005.

Such models are of course of limited explanatory value when compared with networks based on "complete data" as the one created by Ducruet et al. for the modern day Atlantic; still, the can be used as heuristic tools to reflect on possible mechanisms (such as the "logic of spatial proximity" or "long distance connectivity") of maritime connectivity as one central factor for the emergence and existence of harbours and ports and to compare available data (such as the distribution and size of sites) with predicted structural patterns.[422]

### (H2) The entanglements of maritime mobility

Models focusing on ports and routes highlight some structural "macro-properties" of past maritime traffic systems. But the underlying "multiplexity" of entanglements between places, individuals and objects emerging from maritime mobility on a day-to-day, more "microscopic" basis is of course beyond (or maybe "below") the resolution of these instruments; yet, similar concepts of connectivity and network theory can be applied and combined with further sociological theories in order to approach these phenomena.

### (H3) Maritime mobility: people and shipboard societies

Ports can be understood as hubs of communication, connected by a network of maritime routes; but for their usage, merchants and all other travelers had to rely on the knowledge accumulated in the workforces of navigators, mariners and shipbuilders. Christer Westerdahl has described the emergence of "maritime communities" in "maritime cultural landscapes", "the people who in their daily practice engage with the sea in roles such a fishermen, coastal traders, seafarers, and shipbuilder" and construct their identities often in deliberate differentiation from the "landsmen".[423] Gilles Deleuze has defined the sea as the "realm of the unbound, unconstructed, and free", where possibilities for the control of mobility of individuals and objects were much more limited.[424] Some studies have called for the study "of communities of mariners aboard ships, or shipboard societies", also integrating Michel Foucault´s notion of the "ship as the heterotopia par excellence", meaning a "real place in which society is simultaneously represented, contested, and inverted", capable "of juxtaposing different places that are in themselves incompatible in a single real place"[425]

We observe that, similarly to ports, ships, regardless of the flag under which they were sailing, served as (mobile) contact zones of individuals of different religious or ethnic backgrounds.[426] Besides temporary passengers, ship crews permanently consisted of individuals from many areas along shores; the manpower necessary to man a large late Medieval Mediterranean galley with 200 oarsmen, for instance, could only be found by attracting hands from a lot of places.[427] In a Venetian account book, we possess the list of names and places of origin of many of the oarsmen working on a ship, which sailed from Venice to Jaffa and back between May 9th and August 15th 1414 under the command of Francesco Querini.[428] This data also allows us to visualise the relative significance of localities on the basis of the respective number of oarsmen coming from each of them (**fig. 16**). The largest numbers came from Venetian possessions and other sites in Dalmatia and Albania as well as from further inland of the Western Balkans, but also from the Italian hinterland of Venice, Hungary and Germany, as well as from the Eastern and Western Mediterranean.[429] If we combine this data into a network model, we can visualise

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[422] Cf. also Rodrigue / Comtois / Slack 2013.
[423] Westerdahl, 1992; citation from Van de Noort 2011, 25.
[424] Cited after Van de Noort 2011, 1.
[425] Van de Noort 2011, 33-35.
[426] Cf. also Preiser-Kapeller 2014.
[427] Doumerc, 2007.
[428] Stahl 2009, 42-43.
[429] For this geographical distribution, cf. also Doumerc 2007, and Stahl 2009.

how the ship connects the places of origin of its crew with the localities on its route from Venice to the East. This social network of the ship of 1414 is of course a mobile one, so that this assemblage of people and their places of origin connects to all ports on its route from Venice to Jaffa, establishing a complex web of individual entanglements across the entire Mediterranean (**fig. 17**). The ship thus emerges as a "heterotopia", capable "of juxtaposing different places that are in themselves incompatible in a single real place".[430] This mobile poly-ethnic and poly–religious network in turn interacted and overlapped with the networks in the various ports and maritime contact zones, adding to their diversity and structural complexity. This dynamic aspect of maritime mobility must be imagined as underlying our static visualisations of networks of ports and routes. At the same time, this example also illustrates the potential of a combination of prosopography and geographical visualisation in order to survey the frequencies and range of mobility via ports and maritime network, but also beyond further inland (to Central Europe or the interior of the Balkans, as for the ship of 1414); where we possess such data, it very much helps to contextualise the significance of individual ports and landing sites.

### (H3) Maritime mobility: objects and archaeological assemblages

As Sindbæk demonstrates in this volume with his affiliation networks, for instance, sites can also be connected through objects.[431] Even more, theorists of Actor-Network-Theory (ANT) such as Bruno Latour postulate to regard humans and objects as equal actors within a network; he states: "if we stick to our decision to stark from the controversies about actors and agencies, then anything that modifies a state of affairs by making a difference is an actor – or, if it has no figuration, an actant. Thus, the question to ask about any agent is simply the following: does it make a difference in the course of some other agent´s action or not? (…) what is new is that objects are suddenly highlighted not only as being full-blown actors, but as allowing society to exist as a durable thing, to exert a dominating influence, to have power". [432]

Within historical disciplines ANT has found special attention in archaeology, especially in two recent books by Carl Knappett and Ian Hodder. Carl Knappett closely follows Latour, when he states: "But agency needs not to be so closely coupled to intentionality." (p. 172); and he stresses: (…) whole assemblages of objects are critical to human thought and interaction. These are often arranged as networks spanning time and space. Indeed, it is these very networks that allow humans to harness time and space to their advantage, across ever-expanding scales". [433]

Ian Hodder even more emphasises the intensity of entanglements between humans and things: "things depend on people when they are procured, manufactured, exchanged, used and discarded but in particular they depend on people to maintain them if they are to remain as people want them. Or they depend on humans to maintain the environments in which they thrive. Made things are not inert or isolated. Their connections with other things and their maintenance depend on humans. (…) this dependence of things on humans draws humans deeper into the orbit of things. Looking after things as they get depleted or fall apart or as they grow and reproduce trap humans into harder labor, greater social debts and duties, changes schedules and temporalities. (…) Humans have had increasingly to invest labor and new technologies to manage and sustain these things and have found themselves organized by them."[434] One may connect this observation with our discussion of the demands of the maintenance of harbours and harbours basins in the introduction to this volume.

Within the framework of Actor-Network-Theory, Latour formulated a further postulation: to "globalise the local" respectively to "localise the global". He wrote: "we have to lay continuous

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[430] Van de Noort 2011, 33-34.
[431] See also Sindbæk 2007 and 2013.
[432] Latour 2004, 224-227
[433] Knappett 2011, 172 and 214.
[434] Hodder 2012, 85-87.

connections leading from one local interaction to the other places, times, and agencies through which a local site is made to do something. (…) If we do this, we will render visible the long chains of actors linking sites to one another without missing a single step."[435] Again, Knappett follows this approach and states: "assemblages are groups of artefacts that serve to span space and time".[436] In greater detail, Latour explained his concept with the example of a lecture hall and all the actors and places connected to it across time and space in order to make a lecture possible: "First, no interaction is what could be called isotopic. What is acting at the same moment in any place is coming from many other places, many distant materials, and many faraway actors. If we wanted to project on a standard geographical map the connections established between a lecture hall and all the places that are acting in it at the same time, we would have to draw bushy arrows in order to include, for instance, the forest out of which the desk is coming, the management office in charge of classroom planning, the workshop that printed the schedule that has helped us find the room, the janitor that tends the place, and so on. And this would not be some idle exercise, since each of these faraway sites has, in some indispensable way, anticipated and preformatted this hall by transporting, through many different sorts of media, the mass of templates that have made it a suitable local—and that are still propping it up. Second, no interaction is synchronic. The desk might be made of a tree seeded in the 1950s that was felled two years ago; the cloth of the teacher's dress was woven five years ago, while the firing of neurons in her head might be a millisecond old and the area of the brain devoted to speech has been around for a good hundred thousands years (…). Time is always folded. (…) No wonder interactions provided social scientists with the strong impression that they were overflowing in all directions. They are! That does not mean that some solid overarching context holds them solidly in place through the grip of some hidden structural force. It means that a bewildering array of participants is simultaneously at work in them and which are dislocating their neat boundaries in all sorts of ways, redistributing them away and making it impossible to start anywhere that can be said to be 'local'."[437] Such a theoretical framework seems even more valid for the maritime sphere, defined as the "realm of the unbound, unconstructed, and free", or the "ship as the heterotopia par excellence", capable "of juxtaposing different places that are in themselves incompatible in a single real place" (see above).

In this passage, Latour himself also hints at the possibility to visualise these entanglements; Knappett has proposed to do so with bi/multimodal network models of actors and artefacts, for instance, which then could be transformed in one-mode network of actors or of artefacts as common in network analysis (see the contribution of Sindbæk).[438] Various thinkers of Actor-Network-Theory have also hinted at the potential of structural network analysis. Latour wrote: „the social landscape is just as differentiated a landscape as a rugged and mountainous terrain"[439], and Jane Bennet emphasised: "Assemblages (…) have uneven topographies, because some of the points at which the various affects and bodies cross paths are more heavily trafficked than others, and power is not distributed equally across its surface".[440] Yet the number of actual attempts to combine ANT with structural network analysis have been few and not entirely convincing until now; also could be some potential for further pioneering work within the framework of the SPP 1630.[441]

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[435] Latour 2005, 173.
[436] Knappett 2011, 104.
[437] Latour 2005, 200-202.
[438] Cf. also Sindbæk 2007 and 2013.
[439] Latour 2004, 224.
[440] Bennet 2010, 24.
[441] For my own attempts along these lines, cf. http://www.academia.edu/3792891/Medieval_Entanglements_Trans-Border_Networks_in_Byzantium_and_China_in_Comparison_c._300-900.

Visualisations, on the other side, can provide an impression of the density and range of entanglements as envisioned by Latour, also for artefacts of medieval maritime mobility. This may be illustrated with a further example: in 1998, a 9th century shipwreck was discovered offshore the island of Belitung in Indonesia. This enormous archaeological assemblage contained more than 60,000 objects, especially ceramics from Tang China intended for sale in the Arab Caliphate. The ship alone documents the far reaching entanglements of the 9th century Indian Ocean; following the design of an Arab dhow, it was built with East African timber, but later repaired with South East Asian lumbers. The lion share of the cargo consisted of 50,000 pieces of ceramics from the kilns of Changsha in Southern China, where they were produced in masses for export. These and other ceramics as well as further valuable objects from various sites of production in China had been assembled as cargo of the ship in the famous port of Guangzhou (Kwangchow; maybe better known as Canton).[442]

A network model of the assemblage of the Belitung Shipwreck entangles clusters of objects (triangles) and localities (hexagons) through the agency of the ship in an impressive way (fig. **18a** and **b**). If we visualise the emerging web of localities and scale the links relative to the number of objects migrating between them, centres and peripheries in the narrative of the Belitung-assemblage become visible, even more so, if we scale nodes according to their betweenness (**fig. 19**). The port of Guangzhou, connecting the maritime web with the sites of production within China, emerges as central hub; at the same time, this narrative of commerce is one without the imperial centres. Chang´an, the capital of the then already less powerful Tang dynasty, is only a peripheral node; and the Abbasid capital Baghdad is absent from this narrative of maritime networks criss-crossing the Indian Ocean. Centres and peripheries can also be visualised on the map (**fig. 20**), highlighting the impressive geographical range of entanglements. The assemblage of the shipwreck tells us about an Indian Ocean cluster of transportation and a Chinese cluster of production, which also accords with other sources of this time, when trade with China was still mostly in the hand of "foreigners" before direct Chinese shipping to Southeast Asia began on a larger scale from the second half of the 9th century onwards.[443] The Belitung assemblage thus is truly "localising the global" and "globalising the local" as observed by Latour.[444]

Along similar lines, it could be useful to visualise the networks of artefacts found on the individual harbour sites analysed within the framework of the SPP 1630; beyond distribution maps[445], scales, ranges and densities of entanglements across space and time in the sense of Latour may become visible in a way useful, both for researchers and the wider public (see for instance the variety of connections through objects among ports in the medieval Black Sea surveyed in the contribution of Karagianni to this volume).

**(H2) Conclusion**

In this paper, I have tried to describe two categories of instruments for a "relational toolkit" within the framework of the SPP 1630: network models to survey, analyse or model structural properties of networks of ports and maritime routes and their underlying dynamics or "logics"; and concepts for the inspection of the entanglements created through maritime mobility on the micro-level. Both categories have in common the assumption:

- that harbours cannot be understood in isolation
- that their emergence, existence, disappearance and character depended on their function as "nodes of density within the matrix of connectivity" [446]

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[442] Krahl / Guy / Wilson / Raby 2010.

[443] Cf. Guy online, and So 2000.

[444] For a more general analysis of the social historical aspects of maritime archaeology cf. Gould 2011.

[445] On advantages of network models over distribution maps for the analysis of archaeological data cf. also the contribution of Sindbæk to this volume.

[446] Horden / Purcell 2000, 393.

- and that "ties not only matter, but that they are organized in a significant way" [447], in specific, non-trivial structural patterns, which emerge from mechanisms of exchange and mobility and in turn provide a framework for further interaction

Harrison White, one of the leading theorists of relational sociology, has described this complex interplay in short: „nodes create ties create nodes". Individuals and maritime communities do not only establish connections over shorter and longer distances; within these frameworks, their very identity as merchant, seaman or port city is maintained, modified and negotiated.[448] Following Bruno Latour, such webs do not only entangle people: the dependence of things on humans and of humans on things draw them into each other´s orbit: the necessity to sustain the operability of a harbour basin in the face of sedimentation provokes the emergence of new ties of organisation and cooperation within a port community, whose existence in its current form in turn depends on the functionality of such installations.[449] The relational approach thus is inherent to any analysis of the phenomenon of harbour.

**(H2) Acknowledgements**

**Bibliography:**

Albert / Barabási 2002: R. Albert / A.-L. Barabási, Statistical Mechanics of Complex Networks. Reviews of Modern Physics 74, 2002, 48-97.

Arnaud 2005: P. Arnaud, Les routes de la navigation antique. Itinéraires en Méditerranée (Paris 2005).

Arnaud 2011: P. Arnaud, Ancient Sailing-Routes and Trade Patterns: the Impact of Human Factors. In: D. Robinson / A. Wilson (eds.), Maritime Archaeology and Ancient Trade in the Mediterranean, Oxford Centre for Maritime Archaeology Monographs (Oxford 2011) 61-80.

Balard 1978: M. Balard, La romanie génoise (XIIe-début du XVe siècle), 2 Vols. (Rome, Genoa 1978).

Barthélemy 2011: M. Barthélemy, Spatial Networks. Physics Reports 499, 2011, 1-101.

Bennet 2010: J. Bennet, Vibrant Matter. A political ecology of things (Durham, London 2010).

Bevan / Wilson 2013: A. Bevan / A. Wilson, Models of settlement hierarchy based on partial evidence. Journal of Archaeological Science 40, 2013, 2415-2427.

Brughmans 2012: T. Brughmans, Thinking through networks: a review of formal network methods in archaeology. Journal of Archaeological Method and Theory 20, 2012, 623-662.

Burkhardt 2009: M. Burkhardt, Der hansische Bergenhandel im Spätmittelalter: Handel – Kaufleute – Netzwerke (Vienna, Cologne 2009).

Conolly / Lake 2006: J. Conolly / M. Lake. Geographical Information Systems in Archaeology, Cambridge Manuals in Archaeology (Cambridge 2006).

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[447] Lemercier 2012, 22.
[448] White 2008.
[449] See also the port-harbour feedback model in the introduction to this volume.

de Graauw 2013: A. de Graauw, Geodatabase of Ancient Ports and Harbors/Digital Atlas of Roman and Medieval Civilization – DARMC, 2013: http://darmc.harvard.edu/icb/icb.do?keyword=k40248&pageid=icb.page601659

de Nooy / Mrvar / Batagelj 2005: W. de Nooy / A. Mrvar, / Vl. Batagelj, Exploratory Social Network Analysis with Pajek, Structural Analysis in the Social Sciences (Cambridge 2005).

de Vries 1984: J. de Vries, European Urbanization 1500-1800 (London 1984).

Dorling 2012: D. Dorling, The Visualization of Spatial Social Structure (Chichester 2012).

Doumerc 2007: B. Doumerc, Cosmopolitanism on Board Venetian Ships (Fourteenth-Fifteenth Centuries). Medieval Encounters 13, 2007, 78-95.

Ducruet / Rozenblat / Zaidi 2010: C. Ducruet / C. Rozenblat / F. Zaidi, Ports in multi-level maritime networks: evidence from the Atlantic (1996–2006). Journal of Transport Geography 18, 2010, 508–518.

Ducruet / Zaidi 2012: C. Ducruet / F. Zaidi, Maritime constellations: A complex network approach to shipping and ports. Maritime Policy and Management 39, 2, 2012, 151-168.

Estrada 2012: E. Estrada, The Structure of Complex Networks. Theory and Applications (Oxford 2012).

Fujita / Krugman / Venables 1999: M. Fujita / P. Krugman / A. J. Venables, The Spatial Economy. Cities, Regions, and International Trade (Cambridge, Mass., London 1999).

Gorenflo / Bell 1991: L. J. Gorenflo / Th. L. Bell, Network Analysis and the Study of past regional Organization. In: Ch. D. Trombold (ed.), Ancient road networks and settlement hierarchies in the New World (Cambridge 1991) 80-98.

Gould 2011: R.A. Gould, Archaeology and the Social History of Ships (Cambridge 2011).

Guy online: J. Guy, Late Tang Ceramics and Asia's International Trade. http://nsc.iseas.edu.sg/documents/belitung/The%20Belitung%20Wreck/03_guy_056to073.pdf

Hanson 2011: J. W. Hanson, The Urban System of Roman Asia Minor and Wider Urban Connectivity. In: A. Bowman / A. Wilson (eds.), Settlement, Urbanization and Population, Oxford Studies on the Roman Economy (Oxford 2011) 229-275.

Hodder 2012: I. Hodder, Entangled. An Archaeology of the Relationships between Humans and Things (Malden, Oxford 2012).

Hohenberg / Hollen Lees 1995: P. M. Hohenberg / L. Hollen Lees, The Making of Urban Europe 1000-1994 (Cambridge, Mass., London 1995).

Horden / Purcell 2000: P. Horden / N. Purcell, The Corrupting Sea. A Study of Mediterranean History (Malden, Oxford 2000).

Kappas 2011: M. Kappas, Geographische Informationssysteme, Das Geographische Seminar (Braunschweig 2011).

Kislinger 2010: E. Kislinger, Verkehrsrouten zur See im byzantinischen Raum. In: E. Kislinger / J. Koder / A. Külzer (eds.), Handelsgüter und Verkehrswege. Aspekte der Warenversorgung im östlichen Mittelmeerraum (4. bis 5. Jahrhundert), Veröffentlichungen zur Byzanzforschung 18 (Vienna 2010) 149–174.

Knappett 2011: C. Knappett, An Archaeology of Interaction. Network Perspectives on Material Culture and Society (Oxford 2011).

Knappett 2013: C. Knappett (ed.), Network-Analysis in Archaeology. New Approaches to Regional Interaction (Oxford 2013).

Krahl / Guy / Wilson / Raby 2010: R. Krahl / J. Guy / J. K. Wilson / J. Raby, Shipwrecked. Tang Treasures and Monsoon Winds (Singapore 2010).

Krempel 2005: L. Krempel, Visualisierung komplexer Strukturen. Grundlagen der Darstellung mehrdimensionaler Netzwerke (Frankfurt, New York 2005).

Latour 2004: B. Latour, Nonhumans. In: St. Harrison / St. Pile / N. Thrift (eds.), Patterned Ground. Entanglements of Nature and Culture (London 2004) 224-227.

Latour 2005: B. Latour, Reassembling the Social. An Introduction to Actor-Network-Theory (Oxford 2005).

Leidwanger 2013: J. Leidwanger, Modeling distance with time in ancient Mediterranean seafaring: a GIS application for the interpretation of maritime connectivity. Journal of Archaeological Science 40, 2013, 3302-3308.

Lemercier 2012: Cl. Lemercier, Formale Methoden der Netzwerkanalyse in den Geschichtswissenschaften: Warum und Wie?. In: A. Müller / W. Neurath (eds.), Historische Netzwerkanalysen, Österreichische Zeitschrift für Geschichtswissenschaften 23/1, (Innsbruck, Vienna, Bozen 2012) 16–41.

Marzano 2011: A. Marzano, Rank-Size Analysis and the Roman Cities of the Iberian Peninsula and Britain. Some Considerations. In: A. Bowman / A. Wilson (eds.), Settlement, Urbanization and Population, Oxford Studies on the Roman Economy (Oxford 2011) 196-228.

Newman 2010: M. E. J. Newman, Networks. An Introduction (Oxford 2010).

Opsahl / Agneessens / Skvoretz 2010: T. Opsahl / F. Agneessens / J. Skvoretz, Node centrality in weighted networks: Generalizing degree and shortest paths, Social Networks 32 (3), 2010, 245-251.

Pearson 2003: M. Pearson, The Indian Ocean, Seas in History (London, New York 2003).

Peeples / Roberts 2013: M. A. Peeples / J. M. Roberts Jr, To binarize or not to binarize: relational data and the construction of archaeological networks. Journal of Archaeological Science 40 (7), 2013, 3001-3010.

Preiser-Kapeller / Mitsiou 2010: J. Preiser-Kapeller / E. Mitsiou, Hierarchies and fractals: ecclesiastical revenues as indicator for the distribution of relative demographic and economic potential within the cities and regions of the Late Byzantine Empire in the early 14th century, Byzantina Symmeikta 20, 2010, 245-308.

Preiser-Kapeller 2012: J. Preiser-Kapeller, Networks of border zones – multiplex relations of power, religion and economy in South-eastern Europe, 1250-1453 CE. In: Proceedings of the 39th Annual Conference of Computer Applications and Quantitative Methods in Archaeology, "Revive the Past" (CAA) in Beijing, China (Amsterdam 2012) 381-393.

Preiser-Kapeller 2013: J. Preiser-Kapeller, Mapping maritime networks of Byzantium. Aims and prospects of the project "Ports and landing places at the Balkan coasts of the Byzantine Empire". In: F. Karagianni (ed.), Proceedings of the conference "Olkas. From Aegean to the Black Sea. Medieval Ports inthe Maritime Routes of the East" (Thessalonike 2013) 467-492.

Preiser-Kapeller 2014: J. Preiser-Kapeller, Liquid Frontiers. A relational analysis of maritime Asia Minor as religious contact zone in the 13th-15th century. In: A. Peacock et. al. (eds.), Proceedings of the International Workshop "The Reception of Islam in Anatolia and its Neighbours", Istanbul 2013 (forthcoming).

Prell 2012: Ch. Prell, Social Network Analysis. History, Theory and Methodology (Los Angeles, London 2012).

Pryor 1992: J. H. Pryor, Geography, Technology, and War: Studies in the Maritime History of the Mediterranean, 649–1571 (Cambridge 1992).

Rodrigue / Comtois / Slack 2013: J.-P. Rodrigue / Cl. Comtois / B. Slack, The Geography of Transport Systems (3rd ed., London, New York 2013).

Schörle 2011: K. Schörle, Constructing Port Hierarchies: Harbours of the central Tyrrhenian Coast. In: D. Robinson / A. Wilson (eds.), Maritime Archaeology and Ancient Trade in the Mediterranean, Oxford Centre for Maritime Archaeology Monograph 6 (Oxford 2011) 93-106.

Sindbæk 2007: S. M. Sindbæk, The Small World of the Vikings. Networks in Early Medieval Communication and Exchange. Norwegian Archaeological Review 40, 2007, 59-74.

Sindbæk 2013: S. M. Sindbæk, Broken links and black boxes: material affiliations and contextual network synthesis in the Viking world. In: C. Knappett (ed.), Network-Analysis in Archaeology. New Approaches to Regional Interaction (Oxford 2013) 71-94.

So 2000: B. K. L. So, Prosperity, Region, and Institutions in Maritime China. The South Fukien Pattern, 946-1368 (Cambridge, Mass., London 2000).

Stahl 2009: A. M. Stahl, Michael of Rhodes: Mariner in Service to Venice, in: P. O. Long (ed.), The Book of Michael of Rhodes. A Fifteenth-Century Maritime Manuscript, Volume 3: Studies. (Cambridge, Mass., London 2009) 35–98.

Tartaron 2013: Th. Tartaron, Maritime Networks in the Mycenaean World (Cambridge 2013).

Van de Noort 2011: R. Van de Noort, North Sea Archaeologies: a Maritime Biography, 10,000 BC to AD 1500 (Oxford 2011).

Veikou 2014: M. Veikou, Byzantine Histories, Settlement Stories: Kastra, "Isles of Refuge", and "Unspecified Settlements" as In-between or Third-Spaces. In: T. Kiousopoulou (ed.), Oi byzantines poleis 8os-15os aionas. Prooptikes tes ereunas kai nees ermeneutikes prosengiseis (Rethymno 2014) 159-206.

Wassermann / Faust 1994: St. Wassermann / K. Faust, Social Network Analysis: Methods and Applications, Structural Analysis in the Social Sciences, Cambridge 1994.

Watts 1999: D. J. Watts, Small Worlds. The Dynamics of Networks between Order and Randomness. Princeton Studies in Complexity (Princeton, Oxford 1999).

Westerdahl 1992: Ch. Westerdahl, The maritime cultural Landscape. The International Journal of Nautical Archaeology 21/1, 1992, 5-14.

White 2008: H. C. White, Identity and Control. How Social Formations emerge (Princeton, Oxford 2008).

Wilson 2011: A. Wilson, Developments in Mediterranean Shipping and Maritime Trade from the Hellenistic Period to AD 1000. In: D. Robinson / A. Wilson (eds.), Maritime Archaeology and Ancient Trade in the Mediterranean, Oxford Centre for Maritime Archaeology Monographs (Oxford 2011) 33–60.

**Figures to: Harbours and maritime mobility: Networks and Entanglements**
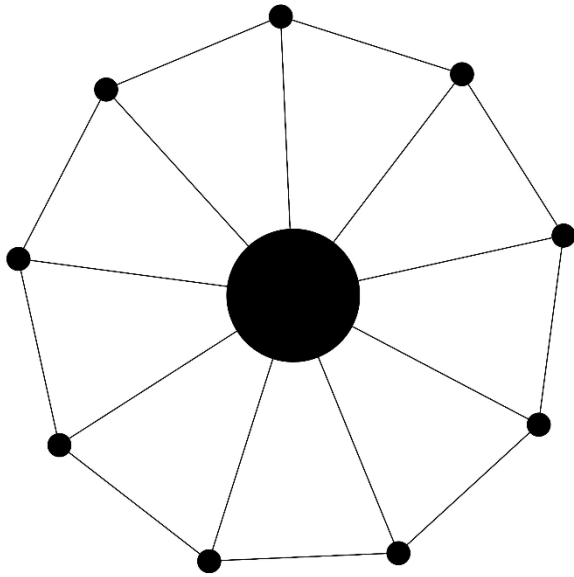


**Fig. 1: A "central place" as central node within its umland (nodes sized according to their "degree centrality" (J. Preiser-Kapeller, 2014)**
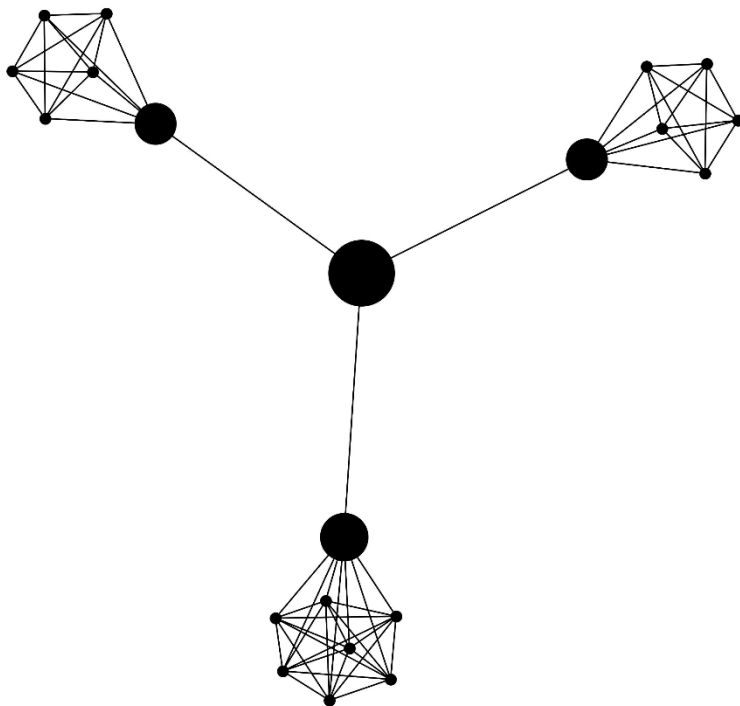


**Fig. 2: A "gateway" as intermediary hub between otherwise unconnected cluster of nodes (nodes sized according to their "betweenness centrality") (J. Preiser-Kapeller, 2014)**
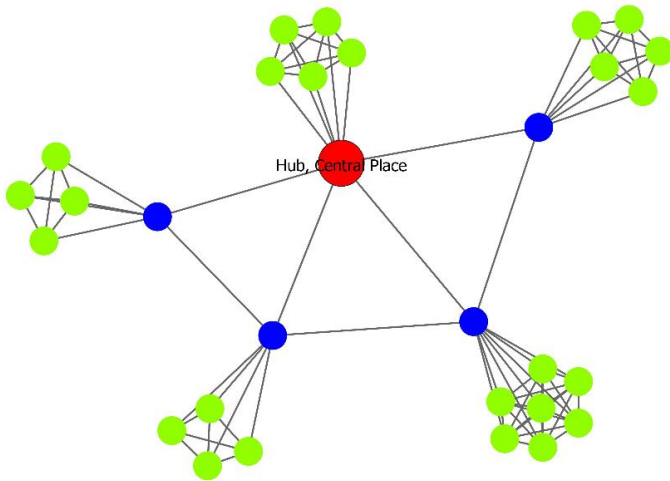
**Fig. 3: A port city as central place for its umland cluster (green nodes) and as intermediary gateway between its umland and the ports in its maritime foreland (blue nodes) which in turn serve as central places for their umlands (J. Preiser-Kapeller, 2014)**
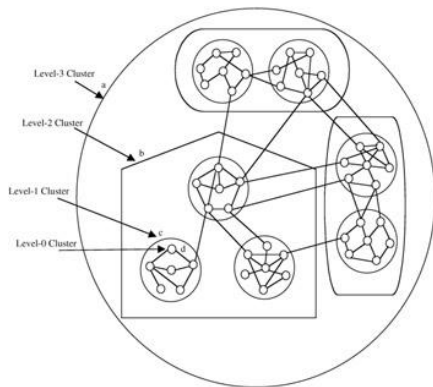


**Fig. 4: Clusters at various levels of a network, nested within each other (from: www.flylib.com)**
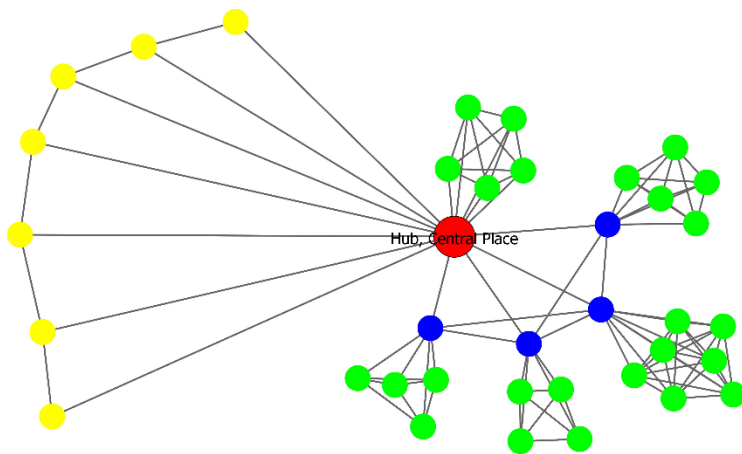


**Fig. 5: A port city as central place for its umland cluster (green nodes) and as intermediary gateway between its umland and the ports in its maritime foreland (blue nodes, which in turn serve as central places for their umlands) and as hub between its foreland cluster and a wider maritime foreland (yellow nodes) (J. Preiser-Kapeller, 2014)**
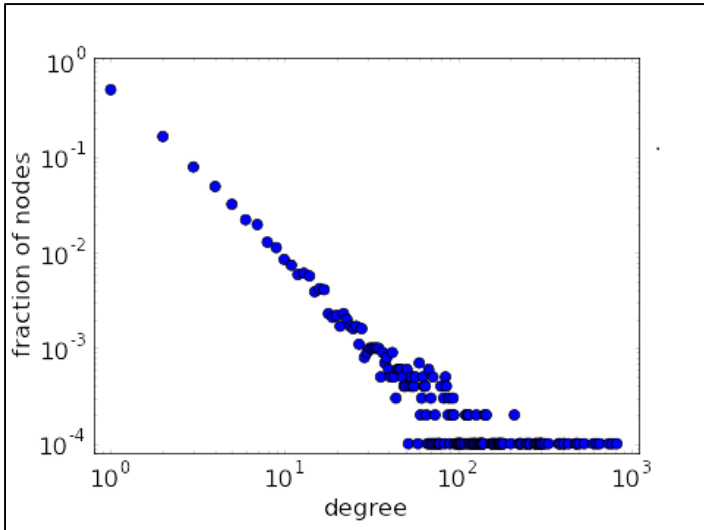
**Fig. 6a: The pattern of distribution of degree centrality values among nodes in a complex network on a double-logarithmic scale ("power law distribution"; from: www.mathinsight.org)**
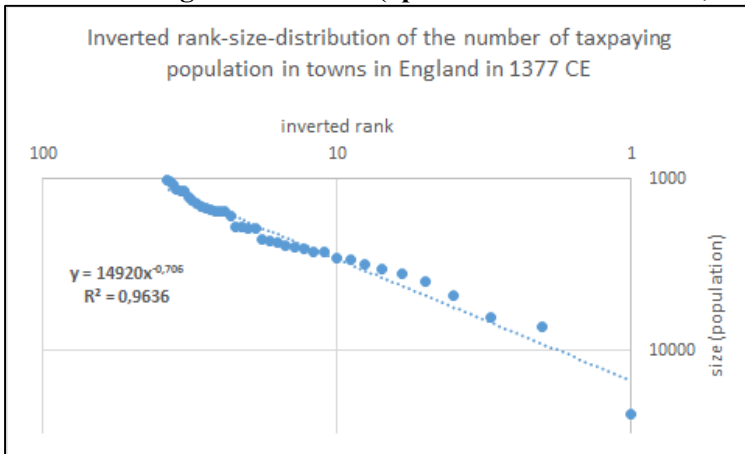


**Fig. 6b: Rank-size distribution of the number of taxpaying population in towns in England in 1377 AD on a double-logarithmic scale (J. Preiser-Kapeller, 2014)**
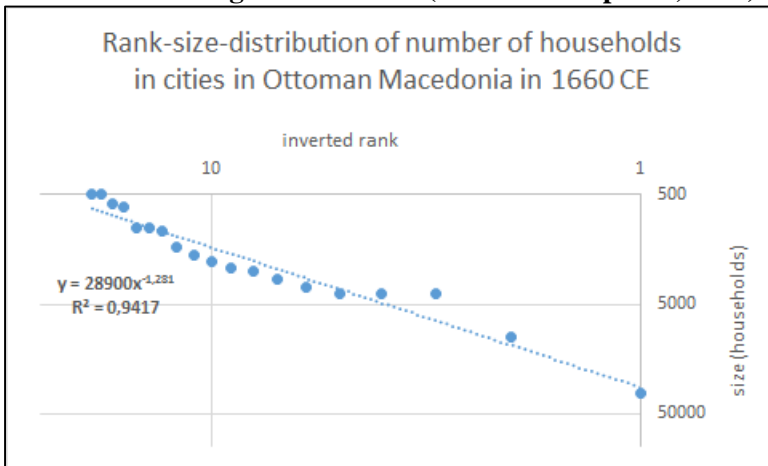


**Fig. 6c: Rank-size distribution of the number of households in cities in Ottoman Macedonia in 1660 AD on a double-logarithmic scale (J. Preiser-Kapeller, 2014)**
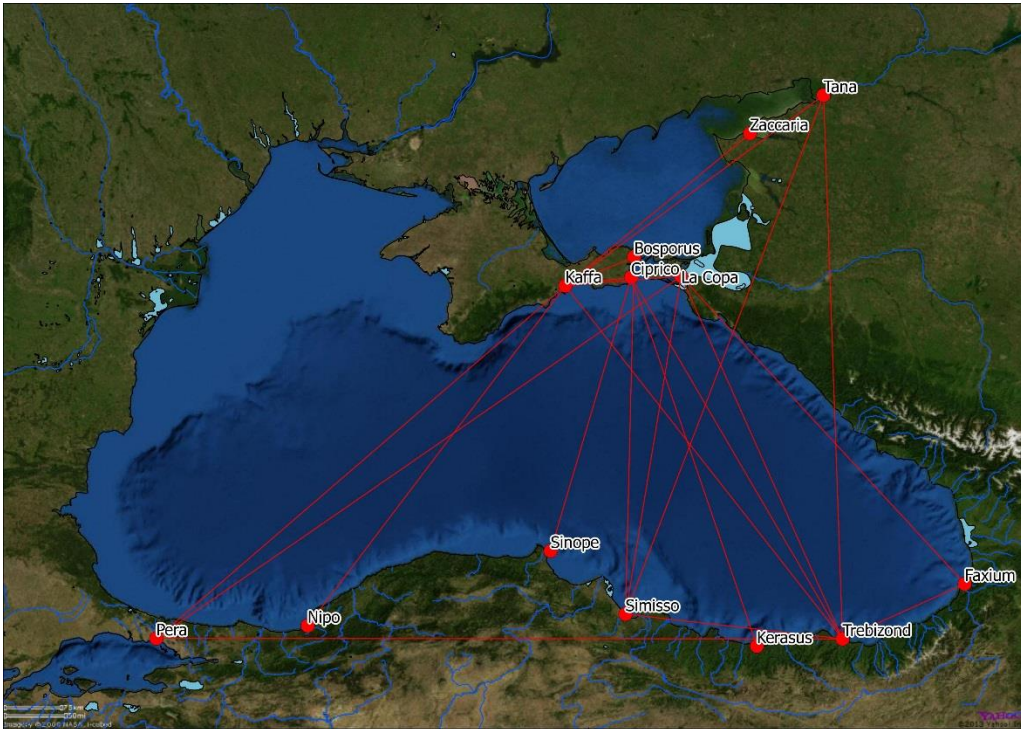
**Fig. 7: Network model of routes and ports in the Black Sea on the basis of data on the journeys of 60 Genoese ships in 1290 AD (J. Preiser-Kapeller, 2014)**
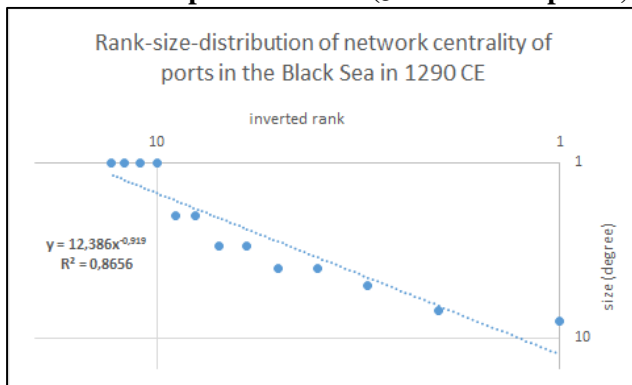


**Fig. 8: Rank-size distribution of degree centrality values of ports in the Black Sea network model for 1290 (J. Preiser-Kapeller, 2014)**
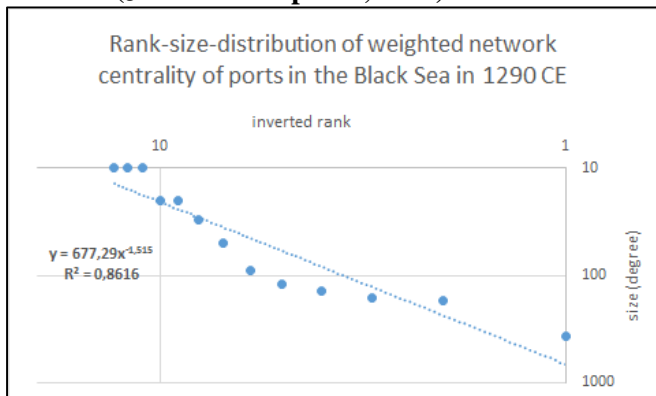


**Fig. 9: Rank-size distribution of weighted degree centrality values of ports in the Black Sea network model for 1290 (J. Preiser-Kapeller, 2014)**
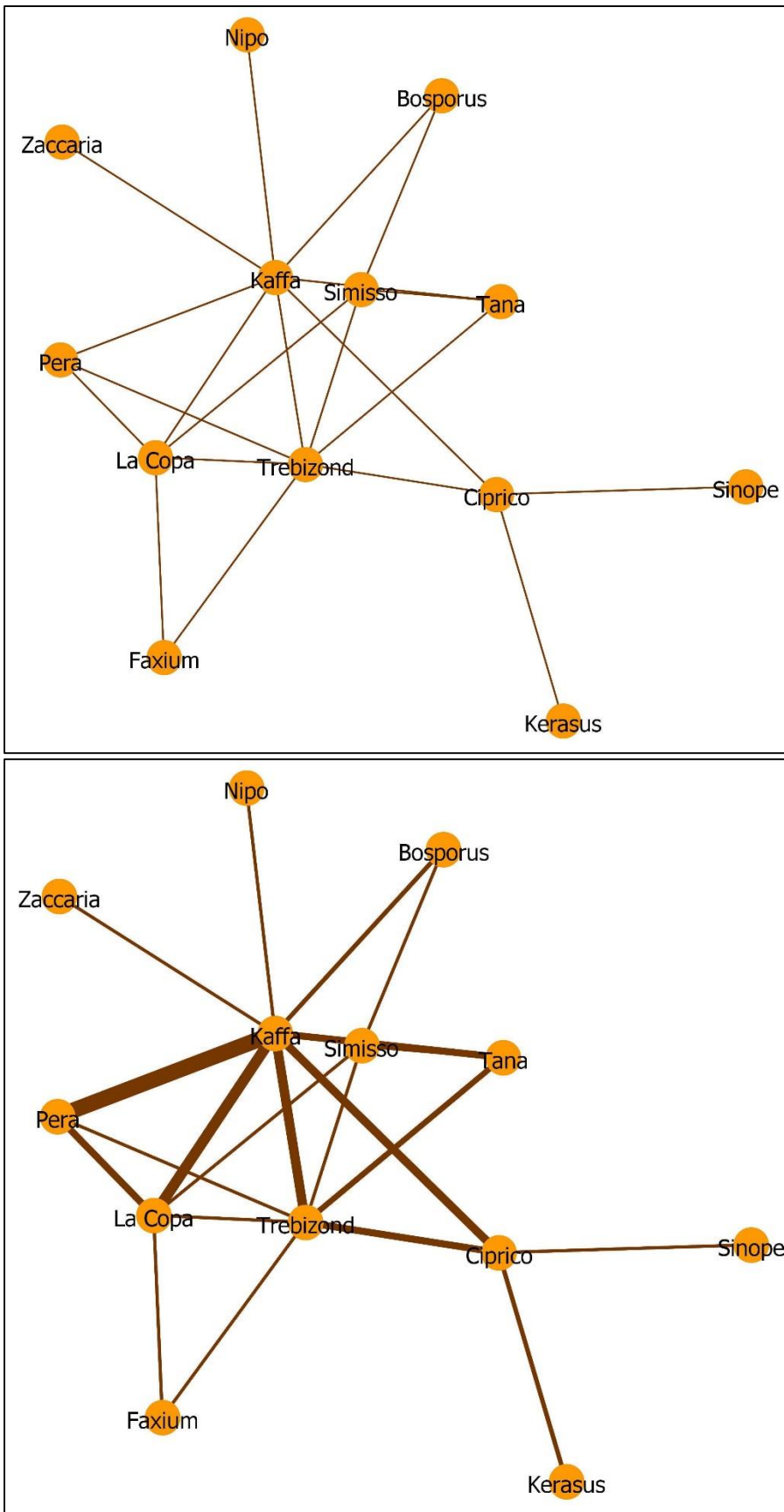
**Fig. 10a and 10b: Unweighted and weighted topological network model of ports and routes in the Black Sea in 1290 AD (J. Preiser-Kapeller, 2014)**

**Fig. 11: Nearest neighbour network model for 791 ancient harbour sites in the Aegean (J. Preiser-Kapeller, 2013)**
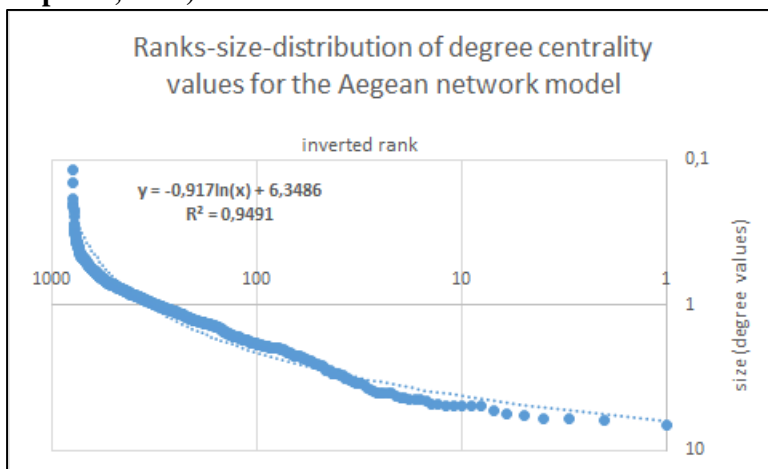


**Fig. 12: Rank-size distribution of degree centrality values of ports in the Aegean network model (J. Preiser-Kapeller, 2014)**
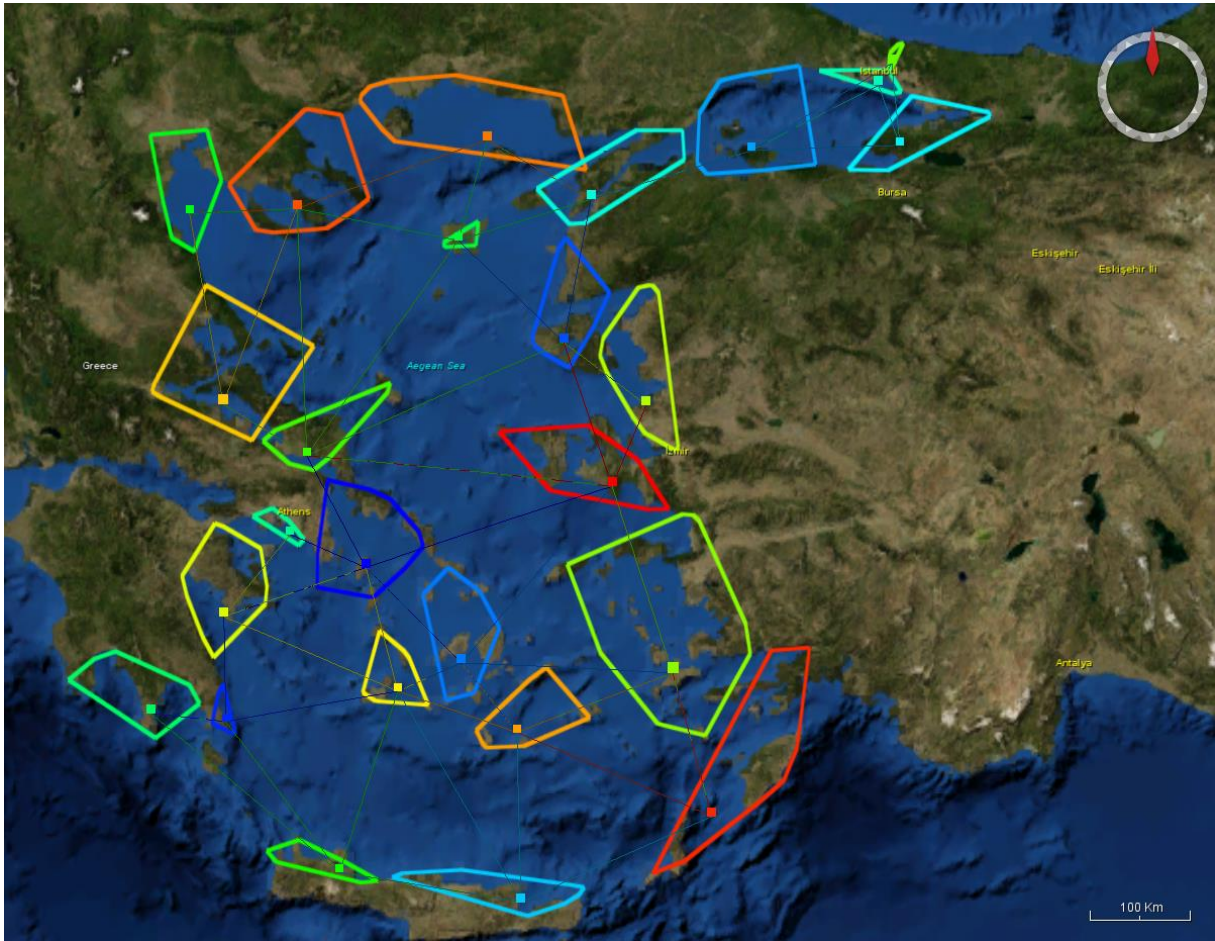
**Fig. 13: Visualisation of 25 regional clusters identified in the Aegean network model with the help of the Newman algorithm (J. Preiser-Kapeller, 2014)**
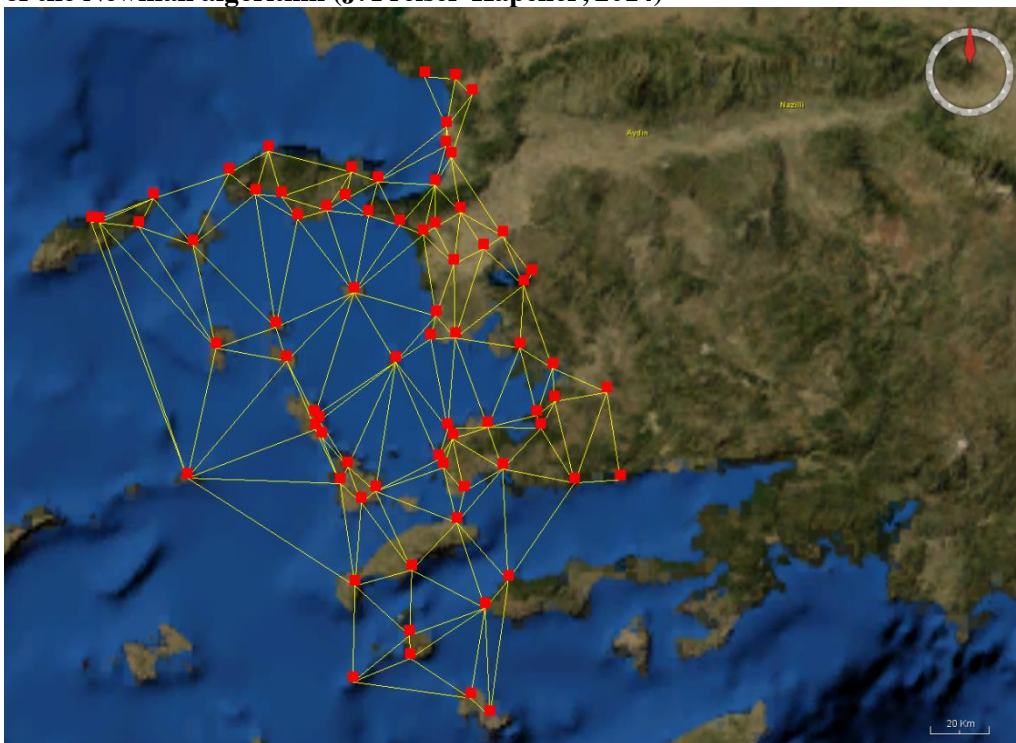


**Fig. 14a: Network graph of one of the 25 regional clusters identified in the Aegean network model with the help of the Newman algorithm (J. Preiser-Kapeller, 2014)**

**Fig. 14b: Visualisation of 16 local clusters identified in one of the regional clusters in the Aegean network model with the help of the Newman algorithm (J. Preiser-Kapeller, 2014)**



**Fig. 15: Network graph of one of the 16 local clusters identified in one of the regional clusters in the Aegean network model (J. Preiser-Kapeller, 2014)**
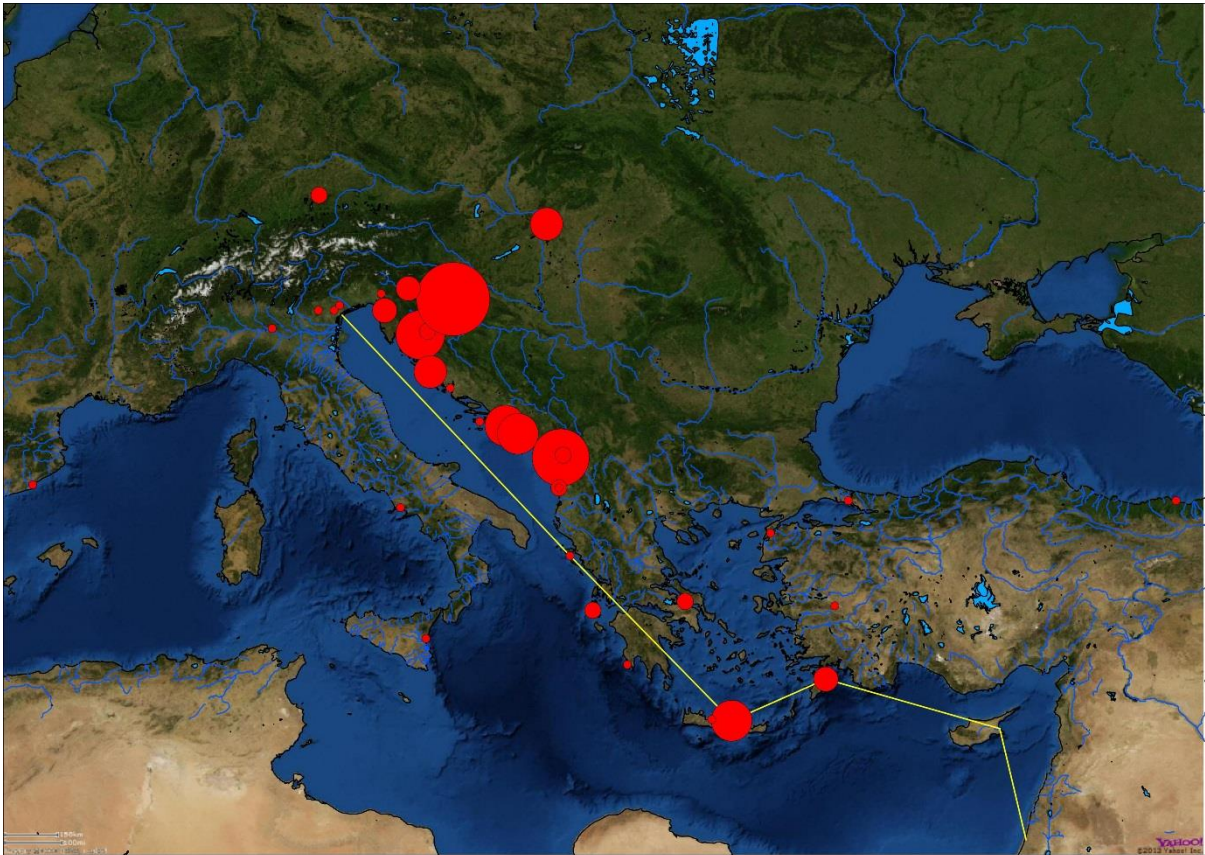
**Fig. 16: Places of origin of oarsmen serving on a Venetian ship sailing from Venice to Jaffa in 1414 (yellow route; sites sized according to the number of oarsmen coming from there; J. Preiser-Kapeller, 2014)**
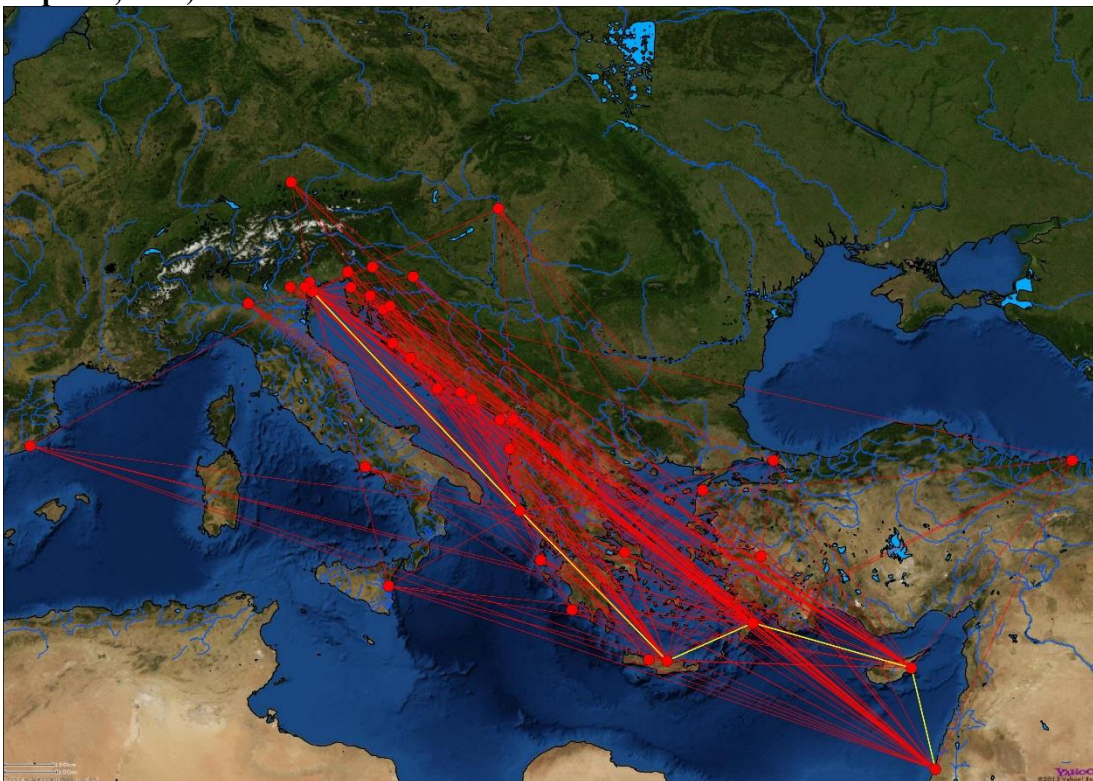


**Fig. 17: Visualisation of the network between places emerging due to the mobility of the oarsmen and the ship sailing from Venice to Jaffa in 1414 (J. Preiser-Kapeller, 2014)**
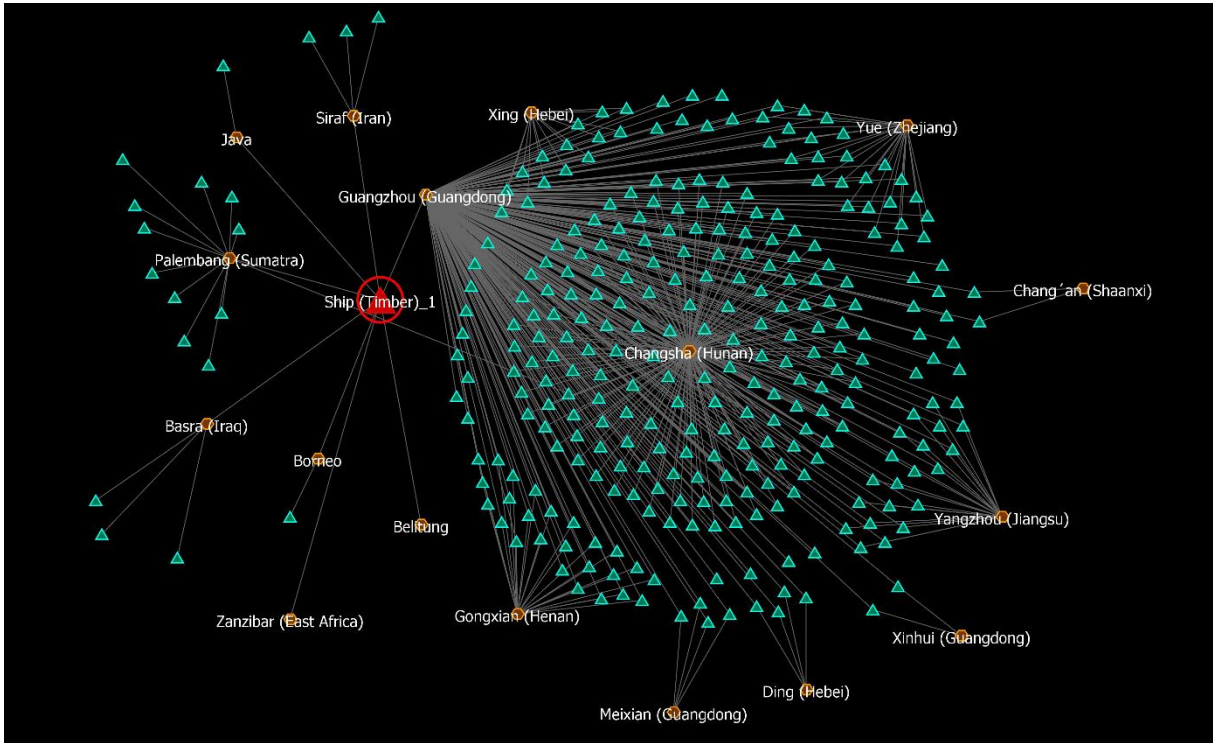
**Fig. 18a: Network graph of the archaeological assemblage of the 9th century Belitung shipwreck with artefacts (triangles) and places of production and exchange (hexagons) and the ship in the centre (J. Preiser-Kapeller, 2014)**
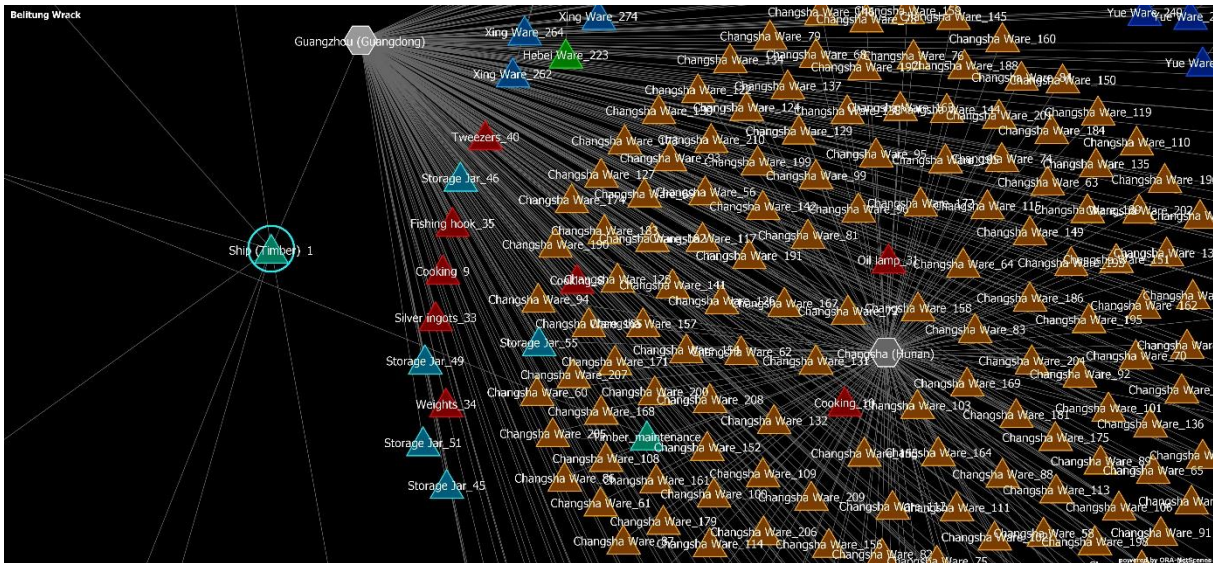


**Fig. 18b: Extract from the network graph of the archaeological assemblage of the 9th century Belitung shipwreck with artefacts (triangles; coloured according to their place of origin) and places of production and exchange (hexagons) (J. Preiser-Kapeller, 2014)**
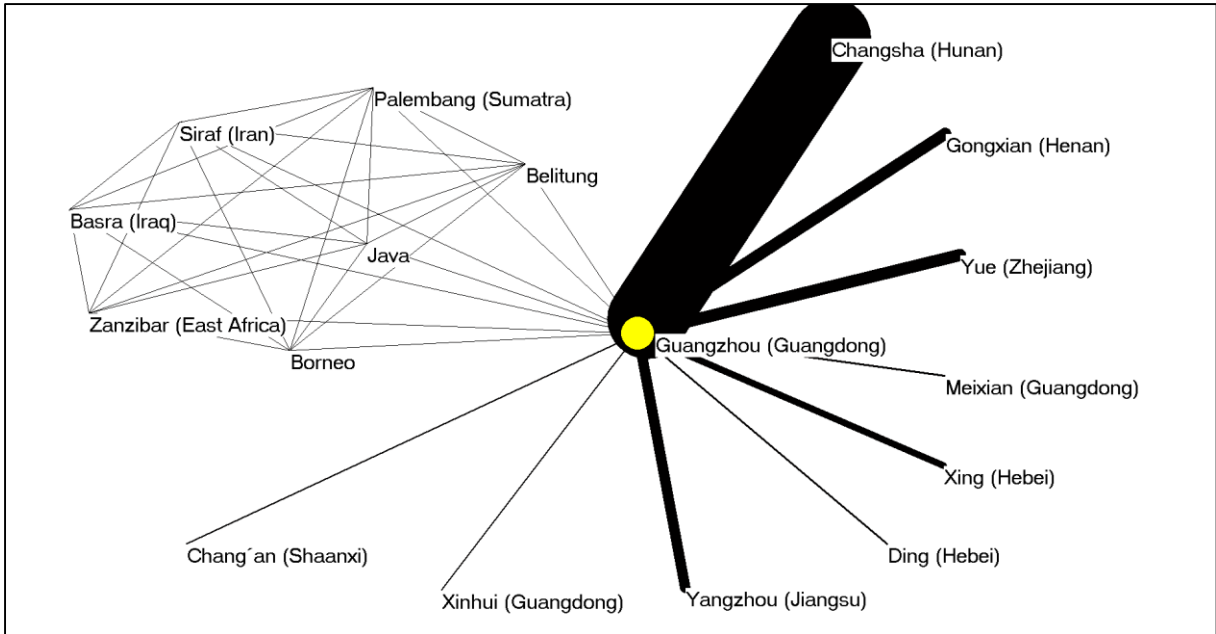
**Fig. 19: Network of places in the assemblage of the 9th century Belitung shipwreck, with links sized according to the number of artefacts moving between two places and nodes sized according to their betweenness centrality (J. Preiser-Kapeller, 2014)**
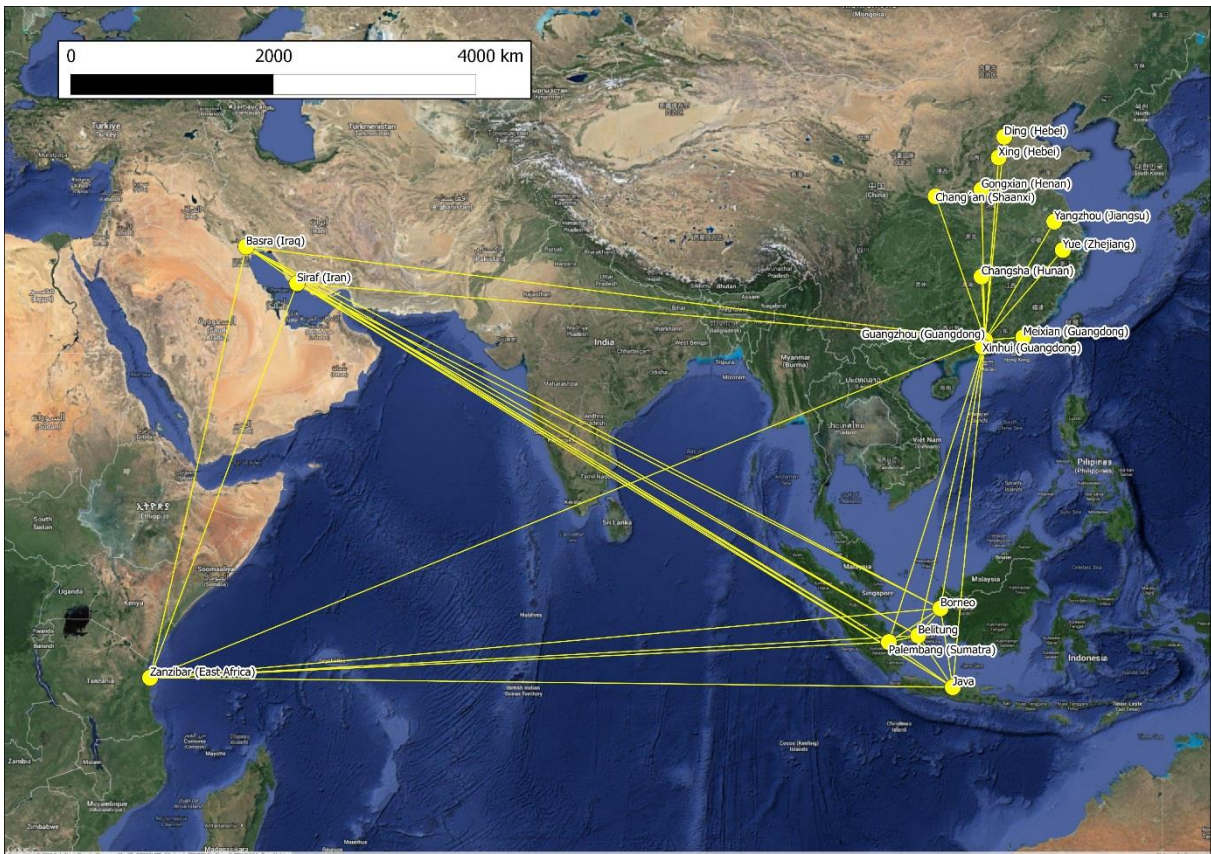


**Fig. 20: Network of places in the assemblage of the 9th century Belitung shipwreck on a geographical map (J. Preiser-Kapeller, 2014)**