In the last ten years or so, online visualizations of maritime data become more and more numerous and popular. Their great majority uses Automated Identification Systems (AIS) data to map the current density of ships across the globe. In addition, many scholars used AIS data to visualize the environmental impacts of shipping, the diffusion of marine bioinvasions, and how certain vessels deviate from main shipping corridors, with applications in various domains such as maritime surveillance, traffic engineering, coastal management, and security. Dynamic visualizations have also been proposed, based on AIS data but also similar information extracted from historical records such as ship logs (see Ducruet, 2017 for a forthcoming review of the field) to study, among other issues, climatic, political, and socio-economic changes. In parallel, certain initiatives added to the aforementioned works a European Atlas of the Seas, the OpenSeaMap project, the Trans-Atlantic Slave Trade Database, the ORBIS project, and the Venice Atlas, to name but a few.

Although many of such online solutions are aesthetically sound and provide an accurate picture of past or today's shipping activity across the globe, their vast majority suffers from being too much static, being bound to current, real-time flows, focusing on specific geographic regions, and relying upon a limited set of analytical tool (ex: heatmaps). To tackle such issues, the ERC World Seastems project [1], already introduced in Portus (Issue 26, November 2013), is currently developing a new software capable of visualizing and analyzing worldwide maritime flows in the past 120 years or so. Such an innovation is now able to reconstruct the network of maritime circulations as well as the hierarchy of ports based on vessel movement data. The core question raised by such an exercise is whether the spatial distribution of maritime flows reflects (or transgresses) already known events and trends occurring both in the port/maritime business and in the wider territorial, economic, and political systems connected by such flows.

We introduce briefly the data and methodology serving such an objective in the next section and move forward to some preliminary results obtained for the Mediterranean region over the 1890-1925 period, with a specific focus on sail and steam shipping flows.

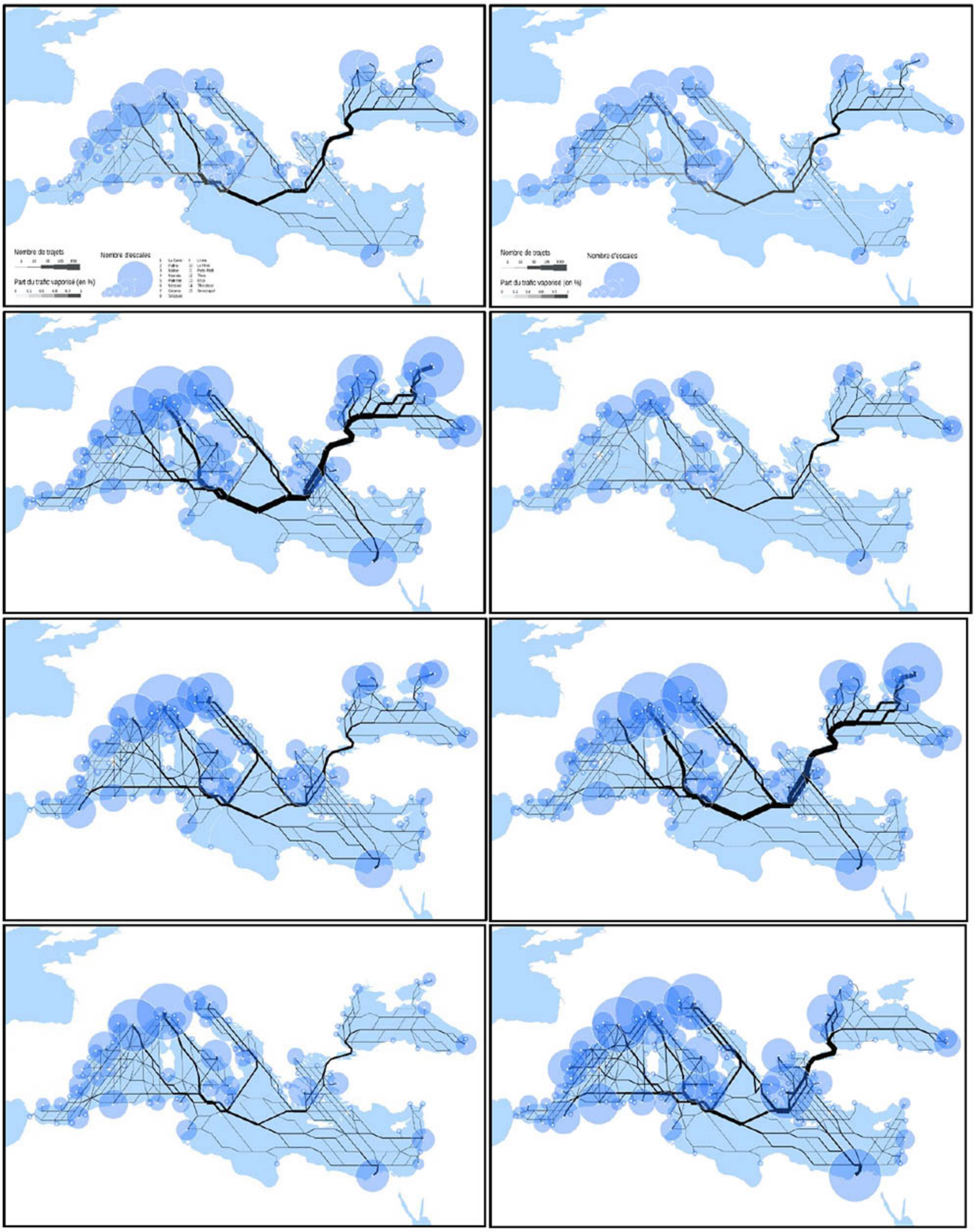
Data and research methodology

One solution proposed in this paper is to use the *Lloyd's List* corpus – and in particular the

Shipping Index – that is the only source capable of documenting the movements of merchant vessels globally and back in time (see Ducruet et al., 2015 for a detailed description). We extracted from this database, after successive phases of printed image digitization and extraction, the movements of vessels connecting ports of the Mediterranean and Black Seas based on 8 entire Lloyd's publications, namely in 1890, 1895, 1900, 1905, 1910, 1915, 1920, and 1925. Such a source details the last movement of each vessel at the date of the publication between two ports. This clearly causes problems of data visualization when it comes to represent such flows on the world map, because straight lines tend to cross terrestrial areas, thus creating artificial lines far from the reality of shipping. In our system, a new grid provides an approximation of maritime paths to map maritime movements while respecting the geographic constraints of territories [2].

A worldwide meshing was built based on the iterative division of 8 initial squares of 90° side. Each time a continent was intersected by a square, the latter becomes subdivided among four smaller squares, etc. until such a process leads to a refined meshing near coastlines. The final meshing includes 23,000 squares that are the basis for constructing the "virtual" maritime grid. In such a grid, a trajectory is a sequence of adjacent squares based on the computation of shortest paths (cf. pg_routing algorithm) turning squares into line strings by linking their respective centroids, using the Moore neighborhood. The resulting grid was then complemented by river and lake links using Natural Earth physical data. The last procedure had been to create links between the grid and the actual position of ports, the latter being grouped into clusters. Finally, links are weighted according to the distance between their two extremities.

The Lloyd's database is thus imported and integrated to the maritime grid like any other origin-destination (O-D) matrix, weighted by the number of vessels or vessel calls by link and by node. In this study, we have been able to differentiate amongst sailing vessels and steamer vessels, to give a better idea of the specialization and differentiation of port activities and maritime routes back in time, thereby complementing the sole approach based on traffic volume and hierarchy. A view on the Mediterranean region is proposed in the next section as a case study before diving into larger ponds and more extended time-periods as planned in the GeoSeastems project. One important choice in this study had been to exclude transit trade passing through the Mediterranean region, such as Asia-Europe flows, which only transited through the Med without connecting any port internally.


Nombre de trajets
Nombre d'escales
Part du trafic vaporisé (en %)

Distribution of maritime flows and port hierarchies in the Mediterranean and Black seas, 1890-1925.

Mediterranean shipping in the late 19th and early 20th centuries

The map for 1890 reveals the high level of steam traffic in the Black Sea, which is one the first seas where steam power was used at the beginning of the 19th century (Ducruet and Marnot, 2017). The Black Sea also had been a major grain exporter to the United Kingdom at the time (Mohammed and Williamson, 2004). Like for the Mediterranean or Baltic Seas, the Black Sea is a closed sea, which can be easily served by several coal bunkering ports. The significance of the Black Sea steam traffic can be illustrated by the role of the Russian and later Soviet steam merchant and military fleets in the ports of Odessa and Sebastopol. In fact, the very low attendance by sailing ships on the Suez Canal route is almost a remarkable exception before 1900. Many factors can explain the superiority of the Black Sea in terms of steam shipping: the successful transition from sail to steam of the Greek fleet (Vassallo, 2001), the early and proactive industrialization of Soviet shipyards since 1890 (Walters, 1995), mainly under Russian influence pushing for industrialization (Harlaftis, 2010).

Overall, maps confirm the high port performance of West Mediterranean ports such as Genoa and Marseilles, being at the time gateways and hubs for colonial trade, but also Piraeus in Greece, Alexandria in Egypt, and the Trieste/Koper cluster in the Adriatic Sea. World War I impacts are clearly visible for the years 1915 and 1920, as major naval battles occurred in this area between European powers and the Ottoman Empire. Despite a recovery in 1925, back by the emergence of the Soviet Union (1922), Black Sea ports and flows clearly underwent drastic decline during such conflicts. The regional pattern of flows, despite such conjectural disruptions, remained unchanged, with one main East-West trunk line and secondary North-south lines. Nevertheless, the whole pattern seems to be much influenced by the Black Sea evolution, since the trunk line evolved in accordance with the Black Sea trend, and even the West Mediterranean ports could not sustain high traffic levels in times of disruption. This means that this geographic area was at the time much integrated and well connected, given the absence of a clear divide between East and West or North and South that one could have expected. Further research is being made to go further into the specific dynamics taking place in the region, coping with the lack of specific scholarly works on the matter insofar.

Notes

[1] www.world-seastems.cnrs.fr

[2] Lloyd's records were stored in a PostGreSQL/PostGIS database, which is requested by Django, a Python web framework. The Python language is used for development on the server side to allow the use of numerous libraries specialized in mathematic calculation (cf. Numpy), or network analysis (cf. NetworkX). On the web browser, results are planned to be mapped with OpenLayers and Cesium javascript libraries, completed by graphs done with D3.js.

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Head Image: Distribution of maritime flows and port hierarchies.