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Positioning possibilities for human geographies of the sea: Automatic Identification Systems and its role in spatialising understandings of shipping

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Abstract

This paper *positions* possibilities for human geographies of the sea. The growing volume of work under this banner has been largely qualitative in its approach, reflecting, in turn, the questions posed by oceanic scholars. These questions necessitate corresponding methods. Whilst this is not necessarily a problem, and the current corpus of work has offered many significant contributions, in making sense of the human dimensions of maritime worlds, other questions —and methods—may generate knowledge that is useful within this remit of work. This paper considers the place of quantitative approaches in posing lines of enquiry about shipping, one of the prominent areas of concern under the banner of 'human geographies of the seas'. There is long-standing work in transport geographies concerned with shipping, logistics, freight movement and global connections, which embraces quantitative methods which could be bridged to ask fresh questions about oceanic spatial phenomena past and present. This paper reviews the state of the art of human geographies of the sea and transport geographies and navigates how the former field may be stimulated by some of the interests of the latter and a broader range of questions about society-sea-space relations. The paper focuses on Automatic Identification Systems (or AIS) as a potentially useful tool for connecting debates, and deepening spatial understandings of the seas and shipping beyond current scholarship. To advance the argument the example of shipping layups is used to illustrate or rather, position, the point.

KEYWORDS
Automatic Identification Systems (AIS), geographies of the sea, oceans, seas, shipping, transport

JEL CLASSIFICATION
Urban

1 | SETTING OFF/OFFSETTING

During the coronavirus pandemic, ships—the behemoths of the global economy—started to stop. Whilst many vessels, of course, kept moving, many others were also coming to a standstill as trade patterns altered but also as many countries started to close their borders to seafarers in a bid to seal-off threats of assumed contagion, carried by global workers (Borovnik, 2012; De Beukalaer, 2021a, 2021b). For example, the *Pauline*, a roll-on roll-off ferry, registered in Malta with a home port of Valletta, owned by Cobelfret Ferries in Belgium, was visibly identifiable from the coast of North East England in early to mid-2020. On a coast where typically only 'close by' vessels are fishing fleets and leisure craft (with bigger vessels detectable only in the distance, and ever in motion), the presence of the *Pauline* was much debated (Bridlington Echo, 2020). Later in June, the *Alfa Italia*, a crude oil tanker—248 m in length—registered to the Bahamas with a home port of Nassau, owned by Lundqvist Rederierna in Finland, and crewed internationally, also appeared, static on the 'same' horizon. The ship was clearly at anchor. It turned only with the tide. It was present for one day. Then the next. And then the day after. What was happening with this ship and the *Pauline*? What was their exact location, why, and for how long? Where had they been and where were they going? Why were they stuck a few miles from the shore of the small town of Hornsea?

In this paper we *set off* from the fixed points of the *Pauline* and the *Alfa Italia* to examine the shape of a now established sub-disciplinary field: 'human geographies of the sea' (Anderson & Peters, 2014; Peters et al., 2022; Steinberg, 2001). Within this area, shipping—past, present and future—is perhaps the most prominent area of concern. It is captured a main theme (where shipping is the key focus, be it in relation to ports (Chua, 2022), seafarers (Kothari, 2021), routeing (Peters, 2020) and so on). It is also a substantial 'subsidiary' theme in critical work on globalisation, colonialism, labour practices, resource geography and the history of geographical knowledge (to name but a few areas). Other research areas or topics are of course covered under the thematic umbrella of 'human geographies of the sea' (including human embodied engagements with oceans and studies of more-than-human worlds, see Peters et al., 2022 for an overview). Within what is a significant corpus of work on shipping, however, such work is primarily qualitatively driven. This is, in itself, no problem. It rather reflects the questions being asked about shipping thus far in this field. That said, we are interested in whether some further research questions and avenues of exploration may be examined by introducing some quantitative tools, and use of big data both as ways to expand the research area 'human geographies of the sea' and to complement and extend existing work and the questions it poses, through mixed methods. In particular, insofar as shipping goes, transport geography, an important area of understanding the shipping dynamics (see Ducruet for an excellent review, 2020), may give human geographers of the sea some food for thought that could enhance understandings of maritime logistics (at present although both fields explore shipping and the fluid worlds of sea transport, but they are quite separate). Moreover, Automatic Identification Systems (AIS), a special technology related to shipping may furthermore provide an important methodological window to ways of knowing that could build further lines of questioning to the field of human geographies of the sea.

In what follows we *position* possibilities for geographies of the sea and shipping, embracing 'topical alchemy' by bringing elements of the field of maritime transport geographies together with human geographies of the sea. We take inspiration from the agenda-setting work of Ducruet (2020, 2017), who has also argued for such alchemy in bringing together network analysis with shipping more firmly; and Manderscheid (2016), who contends that studies of mobilities per se tend to focus heavily on qualitative analysis over quantitative insights. Following suite, we *offset* debates—counteracting the tendencies of geographies of the sea to embrace mainly qualitative methods by balancing them with a discussion of what AIS—quantitative data—*could* offer to asking a suite of additional or different questions about society-sea-space relations. To progress our argument, we first outline existing debates, providing an overview of the state-of-the-art of human geographies of the sea, then an insight into maritime transport geographies, and the rich work in this area. We next look at how AIS data is used currently, as well as a very short introduction to how it is produced and composed. Based on the literature review we highlight possibilities of interaction. Here we draw on the example of AIS data revealing so-called layup, the practice of putting ships on the 'roadside' in order to regulate global shipping rates. In other words: we offer an insight to ships that stop at sea. We end by using this as a point for *positioning* possibilities for future of studies of shipping and the sea in human geographies.

2 | A POSITION PIECE/POSITIONING THE PIECE

2.1 | Geographies of the seas

Although perhaps not as visible a sub-disciplinary area as 'urban geography' or 'rural geography', with its own journals, textbooks and course titles, it would be fair to say that human geography now has a long-standing and established body of scholarship dedicated to the sea (from geopolitical and socio-cultural, historical lenses, e.g. see Halford Mackinder's (1907) or Emrys George Bowen's (1972) discussion of 'British Seas' to a more recent and sustained resurgence at the turn of the millennium with books such as Philip Steinberg's *The Social Construction of the Ocean* (2001)). Indeed, research on the sea has been increasing with rapidity (see Steinberg, 2001, through to Anderson & Peters, 2014; Peters et al., 2022). Research 'on land' has traditionally dominated human geography with earlier issues of access keeping scholars 'dry', as well as an orientation that has denigrated the importance of the ocean in understandings of peopled engagements with space and place (Steinberg, 1999).

With a raft of work now taking to the seas, what defines this quite diverse research (see Peters et al., 2022 for an illustration) is that it is almost exclusively qualitative in style. There is now a wealth of work in areas as wide as historical geographies (for example, Anim-Addo, 2013; Davies, 2019; Hasty, 2011; Lambert et al., 2006; Stafford, 2017) to cultural geographies (such as Anderson, 2012; Choi, 2022; Satizábal & Dressler, 2019; Spence, 2014; Walsh, 2018), more-than-human geographies (see Bear, 2016; Gibbs & Warren, 2014; Johnson, 2015; Squire, 2020; Wang & Chien, 2020 to name but a few), to specific areas such as 'carceral' geographies (Dickson, 2022; Peters & Turner, 2015; Stierl, 2021). The works listed here, which 'take to the seas', are not exhaustive. Many, as noted, have to do with shipping in various guises. Work has also focused on the (geo)political dimensions of oceans (Childs, 2020; Dittmer, 2021; Dunnavant, 2021; Squire, 2021 to name but a few) and the geographical aspects of ocean management (Boucquey et al., 2019; Gray, 2018; Jay, 2018, amongst other scholarship). In a recently published *Routledge Handbook of Ocean Space* (Peters et al., 2022), however, *not a single chapter* showcases quantitative oceanic research. The book reflects well, the shape of oceanic world within human geographies. The methods shaping this field are driven by the kinds of questions asked within it. As such, there is not necessarily any 'problem' here. However, the complexity of maritime worlds, and of shipping, may mean some questions could still be asked, as well as existing studies bolstered through a form of quantitative and/or big data analysis.

2.2 | Mobilities and networks

Indeed, an enduring concern shaping human geographies of the sea, and shipping concerns explicitly, has been an interest in mobilities and networks. On the one hand, as Anderson and Peters posit, the development of 'human geographies of the sea' has built upon a wider geographical interest *networks*—in ontologies of relation—whereby space is not understood as a neat container of social activities but a domain of entanglement and connection (2014, 6). Human geographies of the sea are hence concerned with fluidity (Anderson & Peters, 2014)—movement across borders, and excessiveness (Peters & Steinberg, 2019). Geographers alert to flat or 'wet' ontologies, also then understand the sea as a space where movement is crucial—of people, technologies, etc. in, through, across and over it, as well as the movement or churn of the ocean itself. As such, human geographers have been attentive to understanding *mobilities* as part of their studies of the sea (see Sheller & Urry, 2006 and at sea especially Anim-Addo et al., 2017; Birtchnell et al., 2015; Peters & Squire, 2019).

However as Manderscheid notes, this research is primarily qualitative in style and other questions may asked by quantitative analysis and in complementing some qualitative concerns (2016, see also Darlington-Pollock & Peters, 2020). What such data offers may be a 'bigger picture' context to the 'small stories' of qualitative work (Lorimer, 2003). It may also be offering a different window to understanding maritime worlds. Indeed, if 'human geographies of the sea' want to meet a promise of exploring the human dimensions of water worlds, arguably it should ask questions that are directed in manifold directions, including those that necessitate quantitative methods: patterns or trends of ship traffic, longitudinal understandings of stoppages and frictions in systems; correlations of factors such as geopolitical crises, economic shocks or the role of conservation management policies on shipping movements. This would allow insights into the human dimensions of the sea by other means. However, these concerns remain separated from the field 'human geographies of the ocean'.

2.3 | Geographies of transport and shipping logistics

It is Ducruet's work, independently and with colleagues, that represents perhaps the most essential corpus of scholarship concerned with transport geography, shipping, and networks of connections (see Ducruet and Notteboom, 2012, Ducruet, 2017, Ducruet et al., 2018, Ducruet, 2020, for just a few overarching examples). Here, research has revealed the patterns and trends of flows globally, using quantitative analysis but also linked to wider socio-economic factors, deepening the understanding of the logics of the shipping sector. Scholarship has generally taken a more positivist structuralist view of the world over the last decades (Notteboom et al., 2009). While this allowed a greater integration of transport geography with economists, and business and management studies, it has seemingly driven a distance between port geographies and human geography per se to a point where even publications in the same journals are almost unheard of (Ng et al., 2014). The last paper considering both aspects in one synthesis dates back to 2014 (Ng et al., 2014). With the ocean the most heavily utilized natural infrastructure on the planet, and more than 90% of all goods are transported across the waves at least once during their lifecycle (George, 2013), there is great potential for human geographies of the sea to engage with the network of maritime trade in transport geographies, to ask pivotal questions linked to, and beyond, their concerns. As Steinberg contends:

> As the quantity of trade across ocean-space increases, the role of the ocean in the world economy is deserving of attention from urban, economic, and industrial geographers. Ports and patterns of

> transportation flows have long received study from economic transportation geographers (Hardy 1941; Morgan 1952; Alexandersson and Norström 1963; Couper 1972).
>
> (Steinberg, 1999, p. 370)

Steinberg reveals a vital point: economic and transport geographers (such as Ducruet) have long paid attention to the movement of vessels around the global, and to their hub points: ports (see also Notteboom et al., 2009). Yet, whilst Steinberg hints to the relevance of this for a 'human geography of the sea', this field of study is absent of the sort of analysis Ducruet and colleagues have come to specialise in. However, Steinberg notes its worth. Engagement with quantitative and/or, big data analysis, for example via the use of AIS, could reveal new knowledges by posing different questions about society-sea-space relations.

Research into maritime networks is also spread out into very different fields (anthropology, history, engineering or studies of economy and geography—but really only within a transport context). The lack of conversation between the latter field and human geographies of the sea potentially hinders research progression, failing to build on shared concepts (i.e. mobilities and networks). If maritime transport geographies of shipping and human geographies of the sea speak with one another, it may produce new questions as well as a more holistic picture of what is happening at sea. In the next section we introduce AIS as offering a useful lens for the enduring concerns of human geographers of the sea.

3 | AUTOMATIC IDENTIFICATION SYSTEMS

3.1 | The potentials of positioning

Returning to the *Pauline* and *Alfa Italia*, the vessels from the start of this paper, both could be seen from the shore with the naked eye. Yet many vessels 'disappear' as they slink behind the horizon. Charting vessels on the ocean has relied on both direct observation (at shore and at sea) combined more recently, with radar technologies. But AIS technology renders vessels visible in previously impossible ways (Ducruet, 2020). It becomes possible not just to see the *Pauline* and *Alfa Italia* but to capture how long they have been there, where they have moved from to arrive at that point, and where they will travel next. Time, distance, route, port, flag, gross tonnage can all be captured, amongst other information. Such information makes it possible to ask new questions of our water worlds.

Hence, where oceans are often called out as 'unknowable' (and untameable, see Urbina, 2019), and where their vastness and depth has historically obscured understanding (Peters, 2010; Psuty et al., 1998) positioning technologies such as AIS write the oceans in new ways (Boucquey et al., 2019; Ducruet, 2020; Lehman, 2016). AIS is a communication technology that 'transmits a ship's position so that other ships are aware of its position' (Global Fishing Watch, 2021). AIS is a dynamic, real-time global position communication system where data is collected and visualized on various paid-for industry platforms such as 'Marine Traffic', 'Fleetmon' and charitable organisation webpages (such as 'Global Fishing Watch'). Other companies also provide raw data and collect past data via archiving vast amounts of information. One of the newer additions to the AIS system is the reception of the radio signals by satellites in a low earth orbit, allowing for vessels to be tracked on the open ocean where, up until then, the range constraints of the technology prevented a collection of data from coastal receivers. As such, whether free or paid-for, live data from ships is shared in mapped form with marine industries, but also the public (see, for example any of the sites mentioned above). It is also used by navies, and can also be collected and shared by me and you (indeed, as part of our project we installed our own AIS transponder to collate shipping data in the Jade Bay region of Germany). Transmission of AIS locational data is legally required by the International Maritime Organization (IMO) on certain categories and sizes of ship and it has made visual the often-obscured offshore world of shipping (IMO, 2019, n.p).

In effect, this means vast numbers of vessels—their human geographies—can be known and understood in new ways. Moreover, in spite of legal requirements, many smaller ships than those specified by IMO carry transponders and share their positions (from fishing vessels, to luxury yachts). They do this for transparency and monitoring. They hence make ocean worlds seen and provide information to forge fresh knowledge(s) of those worlds (see Figure 1). Once understood as the 'empty spaces' between metropolitan centres (Steinberg, 2001), we can grasp oceans for what they so often are: bustling, busy; configured of lines, established routes, hotspots and pinch points (Müller et al., 2023). We can see (even if we still might not fully appreciate) that 'our world is an ocean world' (Langewiesche, 2004, p. 2). Many more ships, of course, turn off their transponders (in an act that is hard to police, see Kontopoulos et al., 2020). They do this to fuel ever-growing invisible offshore industries that rely on opaqueness to operate (for example transhipment, smuggling, unregulated and illegal fishing and so on, see Urbina, 2019, Paolo et al., 2024).

AIS technologies began in an effort to mitigate hazards to vessels and hence life. Going out to sea can be a dangerous undertaking made more so with bad weather, shallow areas of sandbanks and as well as the behaviour of other large vessels moving through the water. Ships are often moving at high speed and carry significant loads, making collisions a constant and recurring danger. Most maritime accidents are still caused by human error (Harati Mokotari et al., 2007). AIS helps to alleviate these problems by making the movements of vessels in the area more predictable.[1] Bridge crews are made aware of every vessel in a 11–40 nautical mile[2] radius, depending on antenna installation and weather conditions. The information allows for in-the-moment monitoring of traffic lanes and straits by coastal state authorities, further improving traffic safety. AIS provides a range of users with an 'additional sense'—providing real-time information of maritime domain (Bueger, 2022). Its data points show, when projected onto a map, the direction speed and destination of all major vessels in the surrounding sea area and the natural hazards in such a space too.

In technical terms, the actual data received through AIS, a set of up to 25 parameters about a ship, is transmitted, and these can be divided into dynamical, voyage and static data. Dynamical data is navigational information that constantly shifts, positioning vessels in respect of their longitude and latitude, course over ground, speed over ground, and navigational status. Voyage data is specific to any given current voyage and is put into the system

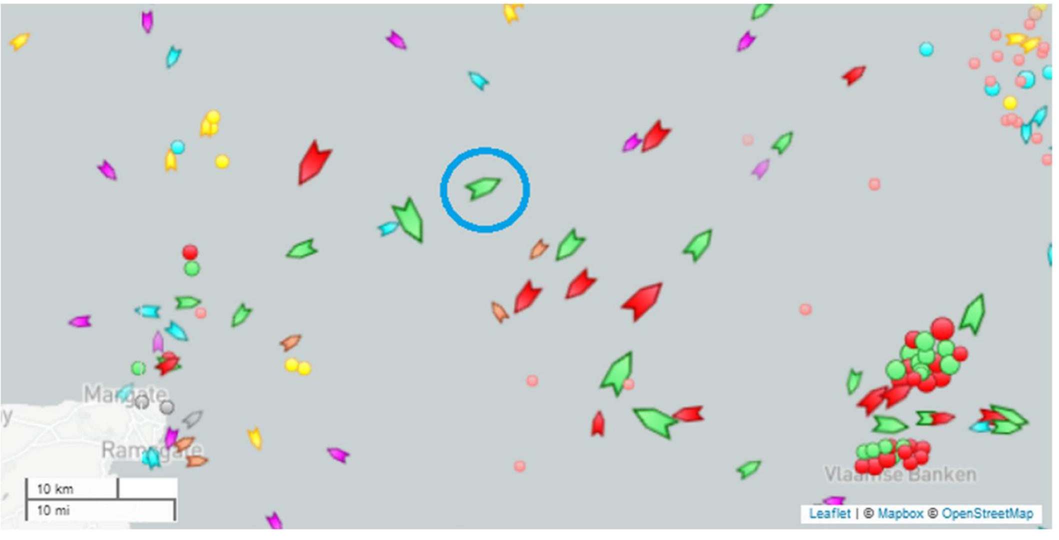

FIGURE 1 A representation of the ocean through the eyes of real time Automatic Identification Systems (AIS), the picture was taken on the 5th of September 2023 on the website Marine Traffic and shows a cutout of the English Channel. The ships are represented by the arrowhead shapes, colours delineating their classification. In the blue circle the vessel starting this train of thought, the *Pauline* can be found on her current regular trips between London and Zeebrugge.

manually, including cargo, draught, destination, and estimated time of arrival. Static data are properties on the vessel that shift rarely or not at all. This includes a ships' Maritime Mobile Service Identity, IMO number (registration number of the hull (does not change with owners or names, though see literature on the evasion of hull numbers, Langewiesche, 2004)), vessel name (call-sign), vessel type designation (oil tanker, container ship, passenger craft and so on), as well as the dimensions of the ship surrounding the global positioning system receiver for a precise appraisal of the space needed by the vessel (Shelmerdine, 2015).

While collision avoidance traffic regulation and national security have been the main reasons for the introduction of AIS, a number of fields have already picked up on the opportunities such a treasure of data has for undertaking research (Fiorini et al., 2016, Robarts et al., 2016, Svanberg et al., 2019 and see Table 1). In this paper,

TABLE 1 Prospective overview of current uses for Automatic Identification Systems (AIS) in research. The fields here represent lenses to view the research through and the topics of importance from these viewpoints.

Field	Topic	Aspect & sources
Navigation	Collision prevention	Risk determination (Montewka et al., 2010; Rong et al., 2020), close calls (Zhang et al., 2015), speed control (Mou et al., 2010), risk awareness (Li et al., 2018; Su et al., 2012)
	Route planning	Avoiding ice (Löptien & Axell, 2014), traffic influence (Li et al., 2018), in straits (Chen, Lu, & Peng, 2015)
	Ship automation	Prediction of ship behaviour (Pallotta et al., 2013), optimal reaction to dangerous situations (Su et al., 2012)
Network of ships	Network properties	Structure (Kaluza et al., 2010; Montes et al., 2012), flow matrix (Alessandrini et al., 2017)
	Spatial patterns	Traffic (Arguedas et al., 2017; Jia, Lampe, et al., 2017), vessels (Etienneet al., 2015; Shelmerdine, 2015), shipping lanes (Breithaupt et al., 2017; Dobrkovic et al., 2018)
	Temporal patterns	Seasonality (Jensen et al., 2015), reactions to events (Fang et al., 2018; UNCTAD, 2020)
Logistics	Indicators	Port performance (Jia, Daae Lampe, et al., 2017; Chen, Zhang, et al., 2015; d'Afflisio et al., 2021), trade volume (Adland et al., 2017)
	Economic optimization	Speed adjustments (Andersson & Ivehammar, 2017b; Jia, Adland, et al., 2017), fuel consumption (Andersson & Ivehammar, 2017a), sea land interaction (Guerrero et al., 2017)
Environmenta impact of ships	Pollution	Sound/Vibration (Erbe et al., 2012), oil (Fernandes et al., 2016), air (Jalkanen et al., 2009), water (Parks et al., 2019)
	Invasive species	Ships as vector (Seebens et al., 2013), remote areas (McCarthy et al., 2022)
	Physical disturbance	Anchor strikes (Broad et al., 2023), whale collisions (Guzman et al., 2013)
Governance	Marine spatial planning	Current ocean utilization (Shelmerdine, 2015; Vespe et al., 2018), capacity planning (Le Tixerant et al., 2018)
	Surveillance	Fisheries (Global Fishing Watch, 2021; Vespe et al., 2016), oil spill (Fernandes et al., 2016), waste dumping (Parks et al., 2019) traffic separation (Guzman et al., 2020)
	Real time management	Traffic adaption to whales (Guzman et al., 2020; Peters, 2020), vessel traffic systems (Pallotta et al., 2013), collision early warning (Su et al., 2012)

Note: The list is non exhaustive but provides an overview on the breadth of application the technology has.

we show how AIS data and its use might offer a way of extending the concerns of *human geographers* studying the sea under the remit of this subfield.[3] This is not to say that the use of AIS is unproblematic. Like any data use, AIS points and the knowledge they reveal is shaped by the process (and politics) of their collection. As mentioned above, not all ships may switch on their transponders leaving gaps in the 'data double' of the ocean (Paolo et al., 2024). What is more, any analysis of the raw AIS data and its findings is dependent on the analysis of that data: the variables as they are correlated.

For example, in a paper on the use of data portals for marine management, Boucquey and colleagues note how raw points from different data (turtle abundance and the use of gillnets by fishers) was overlaid to show the relation between the two and hence risk to marine life. Yet it was "difficult to derive meaning … because the turtle data are vague (users are not told what "average" means in this 1979–2003 dataset) and because the gillnet data are limited to an entirely different 3-year period (2011–2013)" (Boucquey et al., 2019, pp. 491-2). Similarly, with shipping data, there may be slippages in the relations to be unpacked (AIS data with oil prices or other market fluctuations, for example, which may not be captured within the same parameters). Hence, it is necessary for research to be careful, but also cognisant to, data limitations and also the algorithms that might drive modes of computation of results. Nonetheless, AIS provides possibilities to ask different or complementary questions related to the 'classical' interests of human geographers who are studying the seas and to create a more holistic picture beyond the qualitative analysis often conducted. It is to examples of this, we move in the next section through the example of using AIS to understand layups.

4 | POSITIONING POSSIBILITIES FOR HUMAN GEOGRAPHIES OF THE SEAS

Having introduced the state-of-the art of human geographies of the seas and also maritime transport geographies, we next position possibilities that asking quantitatively driven questions, and also using AIS data, could bring to understanding sea-society-space relations. Here we focus on identifying the spatial dynamics of shipping mobilities relating to layup behaviour.

4.1 | Layup and the global economy

Sibilia (2019) describes two reactions of the global shipping economy to overgrowth and the cyclical decline of freight rates. The first is shipbreaking. This removal and disposal reduces the overall capacity of ships within the sector in a process that can have devastating effects on the lives of workers and the surrounding environment. The second reaction is so called layup, where shipping companies flexibly reduce freight capacities by mothballing shipping capacities at places of convenience, outside of ports, and therefore beyond spaces where fees are applicable. A skeleton crew of sometimes as few as two crewmembers is left onboard in the outer harbour precinct and the vessel is maintained at bare minimum levels, and sometimes never restated. Sibilia's paper focuses on the Outer Port Limits (OPL) of the Port of Singapore where layup occurs close to the main hub of global shipping and relatively close to the shipbreaking beaches of Alang or Chittagong Bay. As Singapore is one of the most central pivots of global shipping, waiting here to reintroduce shipping capacity seems sensible. There are no fees for putting ships into the OPL and here inexpensive crew exchange can take place, as well as resupply or change of registration on vessels that would cost 1000 dollars a day within the port limits. The wake of the financial crisis in 2008 left an enormous number of vessels in the Singapore OPL with estimates rising up to almost a thousand vessels by 2014. Sibilia's analysis is insightful. It is also, in view of the questions she asks, necessarily qualitative and discursive in style. Quantitative analysis using AIS data, currently underpresented in human geographies of the sea, might add to the story.

4.2 | Bringing Automatic Identification Systems data to human geographical analysis of the seas

Linking the quantitative insights gained from AIS back to qualitative geographies of the sea we open up a number of interesting further discussions and explorations. We may be able to not only reflect on the economic dynamics of layup but see patterns and then trends over time in this phenomenon. In stark contrast to the traditional perception of ocean space as void of life, visualising layups with AIS allows areas of near constant inhabitation to be unveiled. Although we could not look at the exact time and place linked to Sibilia's study, it inspired our own. Our analysis of layups off the coast of the US shows such occurrences. How big is the population of these "ocean residents" might we ask? How long do they stay where they do? These questions can be linked back to the qualitative fields in order to foster an active dialog, and provide additional lenses to view the ocean environment through.

In addition, with regard to the environment, ships are usually poorly maintained during periods of extended layups. AIS data may allow ecologists and marine protection advocates to check the waters of layup areas for contamination with oil, residue of anti-fouling agents and dumped waste (Parks et al., 2019). All of this pollution can be a major threat to vulnerable marine ecosystems or the people reliant on them for sustenance. The AIS data set allows the different modes of commercial shipping, tanker cargo and passenger transport to be separated out in analysis so that relations to the economic environment can be analysed through sectoral (kind of transport) spatial (where) and temporal (when) lenses.

4.3 | How it is deployed

The potentials of AIS for understanding a range of interests relevant to human geographies of the sea (relations between sea-society-space) is enhanced by its particular qualities. Depending on the speed of a vessel, AIS sends out an update of the position every two to 12 seconds. Taking a glimpse on a website like marinetraffic.com, where only the *current* positions of the vessels are displayed, it can be inferred that a *raw* AIS dataset (the points recorded, not visualised on a platform like marinetraffic.com) provides an enormous amount of data points for every day. Working with this data requires it to be broken down to a comprehensible degree. In the case of understanding layups, we needed to isolate the ships on layup and identify where they are. In our work we have used the freely available AIS dataset provided by the US Coastguard (source marine cadaster.org), which includes all signals that have been recorded through the US authority infrastructure. It is uploaded half-yearly to the platform with an approximate 5-month delay and does contain all information, except for the information on current freight, information the US coastguard advises against publishing due to safety concerns.

Using this data, our own studies aimed to understand some of the socio-economic trends of ship-layups. We asked *how* ship layups manifest, and whether ships are waiting outside of the inner harbour limits for an extended period of time. We can then offer an insight not just to ship behaviour but also ask what this means for crews, for the environment, etc. We can build new lines of research enquiry and substantiate knowledge of experiential ocean worlds with the quantitative figures. We checked ship layup using two conditions, firstly a ship during the whole day must not have exceeded a speed of 2 knots (total stationarity is not a good indicator as the ships are prone to wind, waves and currents that slowly move ships at anchor). To prevent slow moving vessels from passing through our net we then applied a second filter to check if the ship was still located in a radius of one mile from the starting position of the day. The next filter was applied to the class and position of the vessel. Only commercial cargo vessels (tankers and freighters) were included into the analysis as they are the ones partaking in global shipping. Other vessels will show differing patterns of movement based on purpose (such as cruise ships) (Shelmerdine, 2015). The geographical boundaries of our own analysis were from the baseline to the Exclusive Economic Zone border of the United States.

In the data utilized here, the years from 2018 to 2021, there are a few areas with *repeated near constant occupation by stationarity ships*: one is outside the harbour limits of Houston (close to Galveston) another small one around the Los Angeles area on the west coast and around Delaware and Norfolk on the east coast. The AIS analysis shows the ships do not overall tend to remain stationary for very prolonged periods and they have a constant likelihood of becoming mobile each day of 45%. In addition, a distinct difference with the AIS data can be made between the different *types* of commercial ships. Almost all of those on longer periods on layup were tanker vessels. This is likely due to the different patterns of movement. Dry cargo ships, in general, move on a more regular schedule, leading to a steady pace of transport while tankers are more opportunistic actors as a result of the entry and destination ports for their goods being more specialized.

But what does adding this knowledge mean for a human geography of the sea? First, it alerts us to the *behaviours* of vessels and to certain types of vessels that are more prone to layups. Also, it is not only that quantitative analysis offers an overview, and qualitative data deepens it—the AIS findings may also us deepen the questions we ask about water worlds (Anderson & Peters, 2014). For example, when we identified that it is tankers most at risk of layup we can begin to ask additional questions of this kind of shipping, its economic dynamics, geographical drivers, its linkages to environmental concerns and policy, and the labour rights of workers in operating in this field of shipping. In other words, AIS doesn't just present positions, it positions new possibilities in terms of the questions we may ask by presenting us with the shape of, in this case, what is moving or not, in the ocean.

5 | OUTLOOK/LOOK-OUT: CONCLUSIONS

Closing loops, the main goal of this paper has been to reflect on the interests of human geographies of the sea. If this field is interested in sea-society-space relations questions of those relations may also be posed by approaches that go beyond those currently framing the questions asked. Whilst shipping is just one area of concern under the banner of 'human geographies of the sea' it is a very important one (Borovnik, 2012; Cresswell & Martin, 2012; Peters, 2014; Squire, 2016). It is thus a useful area to demonstrate where there could be a benefit of widening the scope of study. This is also vital because as transport geographies of shipping have showed (see Ducruet, 2020) there is great potential in quantifying analysis of shipping. Yet the fields—qualitative human geographies of seas and quantitative analysis of shipping—whilst both examining the fluidity of the ocean, its mobilities and networks—are divided and separated in practical academic work. Drawing inspiration from Sibilia's qualitative analysis of layups, Ducruet's quantitative analysis of the worlds of shipping and ports (2020), and human geography's lacuna of work that takes seriously broader patterns and trends at sea (Peters et al., 2022), we have showcased AIS as a tool for deepening analysis and raising further questions for the field to explore. In our own study, in identifying the areas and prevalence of the praxis of layup we were able to open up more quantitative exploration of these spaces. We asked what their common features are in order to open the door to more qualitative questions: how do these conditions impact the lived experiences of the layup crews? We may also ask environmental questions: are ships that are revived from layup possibly bigger vectors for the invasion of species and how likely is it that they will be revived at all?

Moreover, using AIS has other potentials in bringing wider methods to the core concerns of human geographies of the seas. For example, much work is currently taking seriously the workings of empire and colonialism in the present moment, as it stretches to contemporary seascapes (see Belhabib, 2021; Davies, 2022; Fawcett et al., 2022). But, how are those power dynamics actually enacted? An AIS analysis of port development in Global South countries, for example, may add to the work that considers the shadow economies of neocolonism, and also allow it to be possible to see how greater shipping trends impact local, indigenous communities. Where policy-related action relies often on quantifiable data, this could assist in demonstrating visually, the influence increased shipping has on traditional livelihoods to make the case for change. In another, quite different example, AIS may allow us to contribute to conceptual debates about the ocean and its place in contemporary thought. Whereas the ocean is often placed on the margins (see Lambert et al., 2006 to Urbina, 2019) our own research has used AIS to create 'countermaps' that subvert this understanding (Müller et al., 2023). Following the above example, our AIS-created maps, where ships produce the outline of the world "support a logic that pushes back against, and subverts, the landed dominance of maps, and also the land-sea binary" (Müller et al., 2023). It does so to challenge "logics are embedded in world views that are western, and bear the imprints of colonial mind-sets, and activities, of expansion and territorial gain" (Müller et al., 2023).

We close our discussion by noting, importantly, that an emphasis on quantitative methods, or the use of AIS, is not meant as a way to replace the current ideas circulating in work defined under the umbrella of human geographies of the sea. The gain is in engaging the methods in dialog. Describing a qualitative phenomenon then trying to identify its spread and positions out on the ocean, has the goal to give back this information to the qualitative side, supporting the shared quest to illuminate worlds out at sea. In our own case we hope more work on layups could identify global areas where most layup takes place, identifying companies, and people on board and how these quasi permanent residents of ocean spaces conceptualize their environ.

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ENDNOTES

[1] AIS is a requirement for all vessels of "300 gross tonnage and upwards engaged on international voyages, cargo ships of 500 gross tonnage and upwards not engaged on international voyages and all passenger ships irrespective of size" (IMO, 2019)

[2] The measurement of a "nautical mile is based on the circumference of the earth, and is equal to 1 minute of latitude. It is slightly more than a statute (land measured) mile (1 nautical mile = 1.1508 statute miles). Nautical miles are used for charting and navigating" (NOAA, 2021).

[3] Indeed, the author collective operate their own AIS receiver station as part of research on their ongoing projects concerned with data-driven approaches to understanding complex systems and maritime worlds.

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