Trouble at Sea: Data and digital technology challenges for maritime human rights concerns

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ABSTRACT

Recent years have revealed the severity and scale of human rights abuses at sea. Yet maritime human rights investigations remain challenging due to an array of difficulties, including physical inaccessibility and a complex legal environment. Improving the availability of data has been framed as a solution that will enhance transparency in marine-related activities and improve accountability for rights violations. Such enthusiasm has fuelled the development of technological solutions promising to identify abuses and safeguard vulnerable individuals. However, these efforts clash with concerns over the use of data and technology in human rights practice. In the context of such tensions, this paper studies how data and technology have been integrated within investigations into rights abuses at sea. We examine the challenges posed for transparency, accountability, and fairness regarding communities affected by rights violations. We ask: do data and digital technologies offer effective means for helping to expose rights abuses and hold malicious actors accountable? Or do they introduce new threats to autonomy, privacy, and dignity? We present empirical research based on qualitative engagements with expert practitioners. We find: 1) an increased availability of datasets did not necessarily prevent harm or improve safeguarding for vulnerable people; 2) many tech solutions were detached from affected individuals' lived experiences and appeared not to meet communities' needs; 3) uses of data and technology could introduce or aggravate risks to fairness and accountability within human rights investigations. We contribute a much-needed reflection on the actual implications of the use of data and technological tools for communities affected by human rights violations. Regarding maritime human rights, we argue that prioritising large-scale, top-down monitoring to collect larger datasets or market more tech solutions is not the best way for data and technology to contribute to transparency and accountability. Instead, we advocate for deeper engagement with affected communities.

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CCS CONCEPTS

• **Applied computing** → **Law**; Sociology; • **Social and professional topics** → **Codes of ethics**; • **Information systems** → **Data analytics**; **Geographic information systems**; **Global positioning systems**; Open source software.

KEYWORDS

Data, technology, remote sensing, open-source intelligence (OSINT), human rights, human rights practice, investigation, seas, fishing, maritime, ethics, fairness, transparency, accountability

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1 INTRODUCTION

Recent years have seen rapid growth in data and data-driven tools aimed to illuminate activities at sea. There is increased enthusiasm about potential technical solutions and examples of their real-world applications within human rights investigations. From detecting human trafficking using vessels' global positioning data [59, 67, 86, 114], to locating forced labour using satellite image analysis [2, 94, 135], to documenting the mistreatment of migrants and asylum seekers in small boats using social media data [37, 52, 144], such developments promise to increase transparency and promote accountability in an otherwise obscure space. Yet there also exist criticisms and concerns – especially about how practitioners' newfounded, technologically-mediated gaze could replace direct engagement with people impacted by rights abuses. The datafication of human rights practice carries risks that include privacy violations [53, 76], creeping surveillance [53, 76], marginalisation of situated and contextual knowledge [7, 27, 101], ignorance of structural issues [27, 101], and the perpetuation of global power imbalances [7, 53, 76, 148]. All of these possibilities can cause further harm to affected communities. Such concerns have proven divisive amongst the human rights profession [97].

By situating human rights abuses at sea in the context of the increased availability of data and tools, we examine the effectiveness of data and tool adoption by human rights investigators in practice. We aim to contribute to the field's awareness of challenges

relating to transparency, accountability, and fairness that can arise when maritime rights investigators adopt data and technology. We explore the question: *do data and digital technologies offer an effective solution for identifying potential abuses, holding abusers to account, and empowering those impacted by rights violations? Or, as the critical literature suggests, do they introduce new threats to individuals' autonomy, privacy and dignity*? Here, we do not focus one any one data source or tech solution (e.g. a single app, algorithm, or database). Rather, we examine complex interactions across a *socio-technical* ecosystem of actors which collect, share, process and interpret data. This emerging ecosystem spans 'old' technologies like WiFi routers and novel ones such as deep-learning algorithms.

To provide answers, we engaged with practitioners working on human rights investigations at sea via workshops and interviews. Based on a thematic analysis of the transcripts, we examine the issues and needs our participants raised through the lens of fairness, accountability and transparency (FAccT). Our main findings are: 1) Despite rapid developments heralded by remote sensing data, the transparency of many aspects of marine-related activities remains low. Practitioners still do not know enough from data traces to prevent harm and safeguard vulnerable individuals. 2) There is a large market for 'high tech' solutions, many of which seem detached from affected people's lived experiences and appear not to meet community needs. 3) Uses of data and technology can introduce and/or aggravate risks to fairness and accountability within investigations – through bias, misinterpretations, or data privacy problems. Amid a rush to exploit ever-larger datasets and offer cutting-edge solutions, this paper contributes a much-needed reflection on their actual implications for affected communities, informed by domain experts occupying different investigative roles. We offer a way forward for data and technology to contribute to FAccT at sea: rather than prioritising large-scale, top-down monitoring to collect larger datasets or to market more 'tech solutions', practitioners can adopt deep, localised kinds of engagement that support communities to exercise their own agency.

2 BACKGROUND

This section provides background and context on (1) our approach to FAccT principles concerning technology for human rights; (2) the role of data and technology in human rights work; (3) data and technology used in the human rights sea context; and (4) the challenges, risks and ethical considerations relevant to the use of data and tools in maritime human rights investigations.

2.1 Fairness, accountability, and transparency (FAccT) in technology for human rights

We approach fairness, accountability, and transparency from a perspective rooted in Science and Technology Studies (STS) and Critical Data Studies (CDS). We view both technology development and data-driven investigations as relational, socio-technical practices: they are the situated product of myriad interactions between humans, non-human objects, and the larger assemblages they form together ([12, 77, 83]). Socio-technical systems are simultaneously technical, cultural, political, and economic. Hence, FAccT principles cannot be reduced to merely social or technical problems [127]. The meaning and moral valence of what is 'fair', 'accountable', or 'transparent' for a given implementation of technology depends on the context and actors involved [127]. Per Laufer et al's discussion of 'optimisation', 'normative choices and assumptions' are inevitable whenever frames like these are operationalised to shape technologies [78].

'Fairness' has acquired multiple meanings across studies of social interactions with technology [79], from the legally-oriented definitions emphasising equity in decision-making to technical definitions seeking to quantify the fairness of algorithmic systems [21, 127, 143]. We approach fairness holistically across four interconnected areas: (1) fairness regarding who is able to exercise their human rights; (2) fairness in the course of human rights investigations and their outcomes; (3) fairness within the technical systems and processes used by practitioners; (4) fairness in the distribution of resources and investment across the technology development ecosystem which focuses on the seas. We follow Boven's concept of "accountability as a mechanism": "an institutional relation or arrangement by which an actor can be held to account by a forum" [11]. Accountability mechanisms may be comprised of, for example, community practices, organisational procedures, and technical systems [19, 20, 131] such as secure reporting platforms for witnesses of rights violations (e.g. [47, 149]). Finally, we understand 'transparency' in terms of "information *visibility*" (original emphasis), defined by Turilli and Floridi as "the possibility of accessing information, intentions or behaviours that have been intentionally revealed through a process of disclosure" [137]. Transparency therefore describes circumstances wherein an actor discloses complete and accurate knowledge about their status, actions, or history to other actors. It "depends on factors such as the availability of information, the conditions of its accessibility and how the information, which has been made transparent, may pragmatically or epistemically support the user's decision-making process" [137]. In each instance, transparency is situated, context-dependent, and relational: it relies on *how* information is disclosed and *to whom*. We examine transparency across three overlapping domains: (1) transparency within technical systems and their surroundings, as has been studied extensively by technology and privacy researchers (e.g. [19, 28, 51, 65]); (2) transparency within markets and supply chains for data and related tech (e.g. regarding suppliers, product specifications, pricing, and quality) [20, 103, 140]; (3) transparency within maritime activities and ocean governance [48, 100, 108]. These categories reflect the ways our participants themselves referred to transparency.

In our discussion of how FAccT principles relate to uses of data and tech in human rights practice, we highlight problems that can arise in so-called 'tech for good' initiatives [84, 85]. Our case highlights how technology markets which prioritise 'cutting-edge' tools to aid human rights may fuel what Morozov, Selbst, and others have called 'techno-solutionism' [50, 105, 127]: the assumption technology can answer social or political challenges by reducing them to engineering problems [105]. This may come at the expense of investment in vital 'low-tech' needs of the communities most affected by rights violations. When transparency around their true capabilities is lacking, novel tech products such as AI may turn out to be marketing devices rather than effective answers to real-world problems [107].

2.2 Data and technology in human rights practice

Recent literature indicates that there has been a significant turn towards leveraging digital data in the course of human rights work [3, 70, 72, 95, 113]. Data and information technologies, as McPherson writes, have "creat[ed] a wealth of new opportunities as well as a variety of new risks for human rights practice" [95].

Our review identified at least six use-cases for data and data-driven tools. They included: (1) gathering and analysing data during research, investigations, and fact-finding [24, 63, 70–72]; (2) developing aggregate statistics to observe trends, identify risks, and construct 'indicators' of rights violations [6, 41, 74, 99, 139]; (3) presenting data as evidence during court cases [40, 54, 146]; (4) communicating about human rights issues through data visualisation and other techniques [13, 30, 116]; (5) performing administrative activities, such as data archival and case management [8, 22, 26, 88]; (6) and developing policy and legal proposals [4]. Because this paper focuses on the investigative process, it primarily explores the first two of these use-cases: (1) data within research, investigations, and fact-finding; (2) data for trend and risk analysis. Our participants were selected based on their expertise in these domains (§3.1).

2.3 Human rights abuses at sea

Globally, systematic abuses of human rights at sea have received increasing attention in recent years, leading to the Geneva Declaration on Human Rights at Sea (GDHRS) in March 2022 [56]. As the Declaration states, human rights "apply at sea as they do on land" and provide "protections for all persons living, working, and transiting bodies of water globally". Common types of human rights violations that occur at sea include labour exploitation, modern slavery, human trafficking, denial of access to legal remedy, arbitrary detention, and the use of excessive force [56]. The majority of people at sea are fishers [56]. Labour exploitation on fishing vessels—involving deception, wage deduction, forced confinement, excessive working hours, physical and psychological abuses, and even murder—has been exposed by research and media (e.g. [31, 32, 45, 55, 87, 133]. Offending vessels frequently also engage in illegal, unregulated, or undetected (IUU) fishing [128], which jeopardises the security of ocean ecosystems and the income of coastal communities. Furthermore, sea routes are taken by international migrants, refugees, and human traffickers. Violence against migrants and refugees at sea is well documented, and is often a result of attempts to enforce border controls [52, 90, 144]. Human trafficking is a human rights violation under the Universal Declaration of Human Rights' prohibition against slavery and servitude (UDHR, Article 4 [138]).

Activities in maritime spaces have historically been more difficult to monitor given their geographic isolation from land, lack of distinct borders, and vast scales. Scholars have noted how these attributes have created a complex legal environment which renders maritime human rights work especially challenging [68]. As Klein details, the legal regimes that govern activities at sea are difficult to navigate: events often transpire across multiple jurisdictions—each with their own legal specificities—whilst international laws governing maritime activity (e.g. the United Nations Convention on the Law of the Sea [141]) may not cohere with those governing human rights (e.g. the UDHR [138]). Practitioners seeking to hold abuses at sea to account may struggle to pinpoint which legal regimes apply or which authorities hold responsibility for upholding justice and supporting affected communities. Compounding with such legal issues, the physical isolation and hard-to-observe nature of events that transpire on the deep oceans pose additional challenges. As the GDHRS states, there is "a perception of 'sea blindness' reflecting the often-cited misconception that what happens at sea is out of sight and therefore out of mind [...] *This fosters conditions of impunity exploited by abusers within weak enforcement systems based upon a lack of public transparency and accountability*" [56] (emphasis ours).

The growing availability and variety of data has been proposed as a solution to some of these challenges – especially regarding a lack of direct access. Much literature appears to be centred on remote sensing data that reveal the location of vessels across time. These data types include (but are not limited to): (1) Automatic Identification System (AIS) data transmitted by vessels [17, 18, 25, 36, 75, 81, 94]; (2) radar and Synthetic-aperture radar (SAR) data [16, 114]; (3) imagery captured by satellites [25, 89, 118, 134] or unmanned aerial vehicles [69]. Additionally, user generated data (e.g. witness recorded data; social media data) [86] and Open Source Intelligence (OSINT) [123] have been used to connect remote investigators with affected individuals and communities via the internet. Other studies have made use of state-level indices on fishery, trade and governance [35, 82, 111], vessel registry data [109], Port State Control inspection records [111, 150], past offences on IUU fishing lists [82], and the distribution and catch record of marine species [39, 91, 125]. Such work reflects the broader regulatory, economic, and ecological landscape around marine activities.

A variety of data analytics techniques, from descriptive statistics to graphical models and machine learning algorithms, have been proposed and/or applied to analyse said data [15, 16, 60, 129, 151]. Examples of applications cited in the literature include automated anomaly detection [81, 121], assessments of vessel and worker behaviours [64], and risk scoring [36, 73, 106]. Most of the studies to date, however, represent proofs-of-concept. It is unclear to what extent these proposals have been adopted by frontline practitioners, or how they are being used if so.

2.4 Risks, harms, and ethical challenges

Some authors have raised concerns over the use of such data sources, methods, and technologies within human rights practice at sea and on land. Although its transfer to the civic space holds the promise to empower non-state actors [110], the military origin and embedded surveillance gaze of satellite imagery have fuelled criticisms that practitioners may become detached from local knowledge and local needs, enable coercive interventions, and perpetuate a neo-colonial gaze upon the Global South [7, 53, 80]. Many of concerns raised centre on surveillance and the potential for involvement by actors who do not prioritise or respect human rights. In a maritime context, Heller et al. have noted the tension inherent in the fact that remote sensing data such as AIS can both be used by border forces to target boats carrying migrants and by organisations seeking to ensure migrants' safety (see [52]; also [61, 112]). Regarding digital Open Source Investigations (OSI) using openly available digital data (also known as OSINT), Rahman and Ivens have noted the dangers inherent when rights investigators adopt "the same [digital

surveillance] methods that can be used by malicious actors" [115]. These methods can risk exposing bystanders' personal information in reporting and put survivors of abuses at risk of additional harms by revealing their identities [23]. In the extreme, improper data collection, problematic data disclosures, and similar malpractices can contribute to further rights violations – as in cases where data shared by investigators or humanitarian workers is used to further target vulnerable people (e.g. [23, 57]). Furthermore, like remote sensing, these investigative techniques enable a kind of mediated surveillant 'gaze' over the subjects of digital media. The field is dominated by experts from Global Northern countries, whilst much of the human rights research that goes on focuses on the Global South [29]. Finally, technologies developed in the civic space to aid human rights practitioners risk being repurposed for use by the states or business actors for surveillance [148].

Such concerns about the observers' gaze are compounded by the physical isolation of events that occur in the deep ocean – far away from shore, often in international waters. Data-driven investigators are frequently geographically removed from the regions they study and rely on data which is either gathered at a distance, extracted from technical systems, or relayed by human sources closer to events. In the context of digital human rights investigations focused on land, Gray has theorised such 'remoteness' as a form of "data witnessing": a practice wherein digital media allow for "the involvement of remote, non-present and unanticipated actors" that observe and pass judgement [44]. The mediation afforded by data allows for people involved in the production of data to be (re)defined as 'local' or 'on-the-ground', whilst those observing remotely can emerge as 'global'. In a sense, events that are physically and/or socially distant from observers *become* 'remote' through the process of investigation at a distance[1].

Hence, remote data-driven investigations raise the possibility of bias and misinterpretation, whether on the part of the tools used or the humans using them (e.g. [92]). As raised by Swartz et al. in response to a study using AIS data to identify vessels involved in labour abuse [93, 94, 135], inaccuracies and biases throughout the analytics pipeline risk amplifying the dangers of flawed human interpretations and misleading framing.

These compounding concerns prompted us to examine how data and digital technology are used in human rights investigations at sea. Do they help bring exploitation and abuses to light and holding malicious actors to account? Or, as some critical literature suggests, do they introduce new threats to individuals' autonomy, privacy and dignity? The marine context represents an excellent case study of how explosive growth in data and tech can interact with fields featuring complex social, political, and informational dynamics. As the coverage of data continues to increase, our findings will be useful to inform thinking at the intersection of technology and human rights – both at sea and on land.

3 METHODOLOGY

Based on our insights gained from our initial exploration of the literature, we sought to identify practitioners' experiences with data and digital technologies. To do so, we engaged with ten domain experts in summer 2023. Afterwards, we applied thematic analysis to the transcripts using NVivo, a qualitative analysis platform.

3.1 Practitioner engagements

We sought to engage with experts from a diverse range of backgrounds and skill sets. We recruited ten participants using a combination of purposive and snowball sampling strategies [117, 126]. Purposive sampling involves seeking out participants based on predefined selection criteria [117, 126], which assisted in recruiting participants who appeared to be particularly knowledgeable and/or prominent in the field. Snowball sampling involves participants providing referrals to other potential participants, and is useful as it utilises participants' existing networks to access to new sources and establish trust [117, 126]. Our selection criteria required participants to have relevant domain expertise (e.g. automated vessel identification) and practical experience contributing to maritime human rights investigation and documentation projects. We sought experts from a wide range of relevant professions (e.g. journalism; NGOs; companies), irrespective of the type of human rights violation they researched, andaimed was to give equal representation to the different backgrounds across the field. In total, we attempted to contact 36 individuals and 11 organisations, resulting in 10 individual participants (see Table 1). When asked, all participants described their organisations as being based in Global Northern countries with a 'global' focus, though some specialised in specific regions within this wide remit.

Codename	Role	Organisation type	Attended
Participant 1	Researcher/investigator	Research NGO	Workshop 1
Participant 2	Researcher/investigator and data scientist	Investigative NGO	Workshop 1
Participant 3	Researcher/investigator	Research organisation	Interview
Participant 4	Campaigner, advocate, and investigator/researcher	Trade union	Workshop 2
Participant 5	Campaigner and advocate	Campaigning NGO	Workshop 1
Participant 6	Technologist and researcher	Tool provider	Workshop 1
Participant 7	Technologist	Tool provider	Workshop 2
Participant 8	Researcher and consultant	Consultancy	Workshop 2
Participant 9	Investigative journalist	Freelance	Interview
Participant 10	Researcher/investigator and data scientist	Research organisation	Workshop 2

Table 1: Codenames and details for study participants

We ran two workshops with each with four participants lasting around 90 minutes. We later performed two semi-structured interviews with two individuals who for scheduling issues could not participate in the workshop. We recognise that different dynamics may arise between focus group discussions, which can feature an imbalance of participation [62, 104], versus individual interviews where a more controlled environment inhibits emergent interactions [14, 104]. We sought to mitigate concerns by: (1) following the same protocol of prompts for both formats; (2) as moderators, seeking to ensure each workshop attendee had the opportunity to contribute as much as they wished; (3) endeavouring to give equal attention to all participants in our analysis, regardless of how they engaged in the research.

3.2 Qualitative analysis

We analysed our results via thematic analysis [124, 136, 147]. Thematic analysis involves annotating qualitative data according to thematic "codes" which "symbolically assig[n] summative, salient,

[1]See [34] and [119] for similar discussions of the organising role of spatial metaphors within humanitarian work.

essence-capturing, and/or evocative attribute[s]" [124]. Our analysis was based on an open-coding approach [120] and had four stages. (1) A team member coded the workshop and interview transcripts inductively, generating a list of individual codes without reference to a pre-existing codebook. (2) The same researcher organised these codes into a nested hierarchy of top-level codes and lower-level codes. (3) Another researcher independently reviewed the transcripts and codebook to check for consistency, accuracy, and reliability. (4) The team used an updated codebook to conduct further analyses, such as comparisons between subsets of participants (e.g. investigative journalists vs. data scientists). The coding process resulted in a hierarchy featuring 19 top-level codes that contained a total of 1123 lower-level codes (see Table 2).

4 FINDINGS

This section presents our results. Table 2 details the top-level themes that emerged from our analysis, based on the frequency with which they were used for coding. Our discussion centres on themes relating to 'data and information' and 'tools and technologies'. We do so because: (1) these were the most directly relevant themes for our study's focus: the use of data and tools in the investigative process; (2) they comprised two of the most frequent thematic categories. We also touch upon most other prominent thematic areas; these will be discussed in more detail in future work.

We begin by summarising how our participants perceived data in terms of quality, coverage, and accessibility. We detail how practitioners were said to actually incorporate data and data-driven tools into their everyday work. Finally, we present the needs and concerns our participants voiced: firstly by focusing on the specific tech available; secondly, by expanding to examine what broader social risks such tools raise when applied. Table 3 summarises our findings.

4.1 Data: scarcity and a lack of transparency

Our participants described a vast variety of data being used (see Table 4 in Appendix A). Types of data mentioned included remote sensing data (e.g. AIS, VMS, satellite imagery), state-level statistics and indicators (e.g. economic data), and data from digital open source investigations (e.g. user-generated content, messaging data). However, our interlocutors described problems ranging from data not being collected and low data quality, to difficulties they faced when trying to access or share the data. The seas were "a data poor environment", in P1's words. This was "despite everything that [had] happened over the last decade" regarding technical developments. P2 echoed the sentiment: "data sparseness [was] always an issue with these kinds of vessel investigations." The limited transparency over the seafood supply chain was also mentioned by several participants. Thus, the quality and quantity of existing data was said to be insufficient for remote investigators in their efforts to gain an overview of marine-related events. As a consequence, participants framed transparency in the marine environment as an ongoing problem. A number of factors seemed to have contributed to the situation: the most useful information for investigation often came not from remote, large-scale monitoring (e.g. satellite imagery), but from affected individuals and frontline organisations who might not have received sufficient support. Even when data existed, their utility was limited if they were incomplete or inaccurate.

4.1.1 Individuals: gaining access and building trust. The challenges in accessing and acquiring data from human sources had many dimensions. First came physical access. P3 found this "very challenging": "how do you interview workers aboard distant water fishing vessels?" Potential sources could also face coercive situations which prevented them from providing data – if, for instance, they had their communication devices removed by a captain. In addition, people with lived experiences could be distrustful and/or unwilling to relate their stories due to trauma. "There are plenty of people who don't want to share their experience [because] it's too traumatising" (P9).

4.1.2 Organisations: internal capacity building. The potential and importance of empowering the communities were emphasised by several participants. Yet community- or victim-led monitoring also faced obstacles: frontline organisations often did not have the appropriate tools or expertise to record and share information in a standardised way; "There are so many actors involved and so many steps [are required] that I think [we need to expand] the act of registering data to make sure that that data is actually useful" (P5).

4.1.3 Incomplete and inaccurate data. The poor quality of data was said to severely restricts its value. It can also feed into biases if the analysts are not aware (§4.4). For example, there was a danger for investigators who depended on AIS to "miss non-AIS enabled vessels" (P10). "This [was] particularly an issue in developing countries [...] on small vessels that we can't capture using our current tools". P1 said that incomplete data led to "default high risk for practically everything" when they initially tried to incorporate quantitative data sources. They had to remodel by "doing assessments that are entirely descriptive" instead to make the tool informative.

4.1.4 Institutional and political obstacles. Finally, institutional or political imperatives might not support data sharing. For example, VMS data were gatekept by state actors. P3 mentioned an occasion when "the [Peruvian] government actively denied us [VMS] data because they didn't want us to [...] link any kind of satellite data to labour exploitation." P1 also remarked on some governments' reluctance to acknowledge problems: "It can be quite uphill to actually get to a point where you can even get to work because it's [such] an embarrassment [for governments]."

4.2 A plurality of uses for tools

When examining the methods and tools used by practitioners, we identified a diverse array of investigative activities. Below we first distinguish four types in terms of the degree of manual investigative work involved, the tools utilised, and the kinds of research outputs produced (see Table 6 in Appendix A).

4.2.1 'Traditional' manual investigations: These were case-based, primarily offline, built using sources and witness testimony, and involving careful verification work. This methodology was termed a "bottom-up" approach by P9, an investigative journalist. Based on her and others' testimonies, the approach seemed mostly manual and often centred on analogue data, such as handwritten notes and paper-based records. The tools and technologies mentioned

Top-level theme	No. lower-level themes	Examples of lower-level themes	Coding frequency
Data and information	182	Data access, gathering, and visibility	352
Events and issues on the ground	139	Background issues (e.g. economic factors)	252
Practices, methods and approaches	154	Work process; Roles and goals; Collaborations; Privacy, security, and risk	251
Problems and challenges	186	Gaps and lacks; Issues with tools and technology; Problems regarding data; Bias	245
Locations	46	Countries; Regions; Oceans	131
Actors	56	Named individuals; Named organisations	130
Tools and technologies	61	Current state of tools for field; Types of tools	122
Indicators and signs	53	Indicator sets; Kinds of indicator	105
Engaging with survivors and communities	32	Reasons to engage; issues when engaging; building trust	71
Outcomes	43	Improving services; working with law enforcement	70
Abuse types	16	Modern slavery; trafficking; labour exploitation; child abuse; migrant pushbacks	62
Knowledge and perspectives	30	Standpoints; lived experience; expertise	47
Ethics and norms	24	Ethical challenges; law versus ethics; minimising harm	31
Risk	13	Risk assessment; forms of risk; risk of tool misuse	28
Needs, aspirations, and future developments	28	Improving accuracy; need for standardisation; need for map of existing tools	27
Organisation, collaboration, and coordination	8	Collaborations and partnerships; bottom up response	22
State of the field	22	Standards; editorial control; unwritten norms; trust	20

Table 2: Top-level themes identified by thematic analysis

Topic	Findings
Challenges with data	• Gaining access • Building trust with individuals • Building capacity for organisations • Incomplete and inaccurate data • Organisational and political obstacles
Type of investigation	• 'Traditional' manual investigations • Digital open-source investigations • Large-scale, automated case detection • Trend analysis and synthesis
Problems with tools	• Tools detached from contexts and needs • Optimism and solutionism • Crowded and misaligned market
Risks to fairness and accountability	• Geographical bias • Misinterpretation • Surveillance and data misuse • A need for empowerment and agency

Table 3: Summary of findings

in relation to these 'bottom-up', offline investigations tended to be comparatively 'low-tech'. They often related to data collection, storage, and sharing: mobile phones for contacting sources; WiFi for witnesses to create and share evidence; encrypted chat apps to share said evidence; and satellite phones for communication if these were available. In one case, P3 told us, a fishing worker had "sent literally a message in a bottle" to seek help. A short list of tools were mentioned for analysing data, such as qualitative analysis software (e.g. NVivo, Max QDA). This did not exclude digital data or automated tools in the investigation: practitioners mentioned consulting vessel tracking platforms and OSINT as part of verification, but usually in a later stage after targets had been identified.

4.2.2 Digital open-source investigations: These were manual digital investigations conducted using digital open-source data. OSI/OSINT work had been popularised within the human rights field by NGOs like Amnesty International [5], Human Rights Watch [58], and Forensic Architecture [38]. Its usage in maritime contexts was fairly niche but growing. The tools and techniques used in this field were developed primarily for investigations on land. For example, they used data archival software, prominent satellite imagery platforms like Google Earth, and sought user-generated content if available. Other sources included social media groups for communities (e.g. fishers and trade unions). Practitioners also consulted resources specialised for the marine environment, including open-source databases of vessel images and registration details such as ShipSpotting [130] alongside AIS trackers like Global Fishing Watch [43]. Like 'traditional' investigations, "corroboration" and "triangulation" were key: rather than relying on one item, it was vital to connect many pieces of data to test how much each supported the others. In one case, P2 described investigating incidents of migrant

pushbacks using photographs taken from shore by activists "using telephoto lenses", which they integrated with satellite imagery and other data.

4.2.3 Large-scale, automated case detection: These involved automated data analysis using large-scale, remotely collected sources. If traditional investigations were 'bottom-up', these could be said to be 'top-down'. They would collate satellite imagery, data from remote vessel sensing, and signals data in large datasets, which can be monitored continuously. There were two approaches that could be taken within this: (i) an organisation's system could generate automated flags for vessels displaying unusual or suspicious behaviour, which could be passed on to relevant authorities; or (ii) the organisation could select data on a specific vessel based on an external tipoff. This information could then be used through a process of "filtering" to home in on potential cases. Organisations mentioned that fit this pattern included Global Fishing Watch, which was co-founded by Google [42], and Stella Maris [132].

4.2.4 Trend analysis and synthesis. These collated material produced by the other investigations to distil further insights. They drew on both data published about individual cases and aggregated data that captured trends. Some synthesised these high-level insights into reports for public consumption – occasionally integrating their own on-the-ground investigations as well (e.g. [31, 32, 45, 46]). Others used them to calibrate statistically driven decision-making and risk-assessment tools (e.g. [73, 82]). They would occasionally feed into more direct investigations, for example, to help identify hotspots for future investigations or to determine if known risk factors were present in a particular case.

4.3 Problems with technical tools: solutionism, a lack of contextual specificity, and market crowding

Though each kind of investigation used technical tools, our participants described an array of problems. For some, especially more traditional investigators, these issues prevented them from working with technology to a greater extent.

4.3.1 Tools detached from contexts and needs. We heard complaints about tools that were unfit for purpose and did not solve the problems people faced. This was said to often result when developers from outside of the field entered the space with proposals lacking enough contextual specificity for maritime human rights work. Participants were especially concerned about tools that did overlooked the vulnerability and diverse needs of communities affected by rights violations. P3 provided the example of cameras on vessels. These could not "detect" the "more nuanced [problems], like social issues that are happening on the vessels". The approach would pick up "only the vessels that are willing to install cameras on their ships [which were] not going be the ones committing the most severe infractions". Tools could also be detached from affected individuals' lived experience. P9 commented on how campaigns to make Wi-Fi mandatory on fishing vessels were "contingent on the workers being able to access that Wi-Fi for a minimum number of hours per week." P3 was also mindful about technological solutions' accessibility: mobile apps, for example, were of limited use as "a lot of fishers don't have access to very advanced phones".

4.3.2 Optimism and techno-solutionism. A rush to provide high-tech solutions seems to have widened the gap between developers' efforts and communities' needs. In P3's phrasing, widespread "techno-optimism" assumed technologies were beneficial regardless of the circumstances. They illustrated this via plans to use "blockchain technology" to track exploitation: people did not seem to "understand[d] what [blockchain is] good for". "Transparency around the seafood product itself doesn't mean that there's going to be transparency around the other things that are happening on the vessel." P9 expressed similar concerns: "We don't need another tech tool that's divorced from people's experience and reality. [...] It['s] not like the technology doesn't exist or that we need something new necessarily. [...] We just need to get over [existing] obstacles" involving financial access, communication, and exploitative systems.

4.3.3 A crowded, mismatched market. The number of new tools being offered for investigations and vessel identification was itself said to be problematic. Take this statement by P7: "I would posit as a tool provider that more tools are absolutely not what's needed and it would make matters worse". The level of crowding in the for-profit and not-for-profit market meant there were "lots and lots of other [technology] organisations doing very similar things to us and to other organisations sort of in the general field". "Hundreds if not thousands of organisations" were engaged in the space. P4 agreed, pointing to confusion caused by the "a bewildering array of NGOs active", with increasing numbers moving into human rights adjacent work. The crowded field was said to have contributed to a general lack of communication or knowledge about what data and tools existed in the first place. As P7 put it, the problem was that "what's out there is not fully known and the full set of potential requirements [for practitioners] are not circulating". There appeared to be an overall feeling of dissatisfaction with the level of dialogue between tool developers and users.

4.4 Risks relating to fairness, accountability, and transparency

Our participants' overall desire was to minimise harm and support communities affected by abuses. All felt data and technology could play a part in advancing this. Yet throughout their accounts, we identified ways that same data and technology could introduce or aggravate human rights problems. We detail these below, before discussing how participants imagined an alternative path forward where technology played a greater role in empowering survivors.

4.4.1 Geographical and technical bias. Location surfaced as an important axis of potential bias within the data and tech being adopted. Investigators' pre-existing expectations and assumptions already come into play when they decided where to look. P1 cautioned that the 'hot spot' model left "a lot of blind spots [...] places where we don't go or places where we assume that things are probably better than they are in Thailand, Taiwan, Indonesia, Philippines". She brought up potential issues in the North Sea as an example: "... where you know where people tend to assume it's great, but once you start scratching the surface, [...] really unsavoury things in the cod fleet there". Uncritical reliance on the output of tools can

reinforce biases in understandings and research efforts. More generally, participants expressed concerns that errors, inaccuracies, and statistically non-representative data could lead to biases becoming ingrained in technical systems in ways which went unnoticed. In P3's words, detection tools could "create this false sense of bright spots, where we say: 'the technology is not detecting anything bad and therefore it must be OK'".

Biases in data access, collection, distribution, and technical functioning therefore represent a threat to fairness: they risk giving some affected groups privileged access to justice. Given constraints in resources, bias in investigations and reporting could lead to unfair disparities in who receives attention, support and is held accountable. These biases risked being reified when the data and tools are used by practitioners, who might interpret the results as objective and neutral.

4.4.2 Misinterpretation and loss of context. Many participants agreed that context and human expertise were indispensable for interpreting investigative findings accurately. Yet such supporting qualitative information was the most difficult for remote investigators to obtain. Practitioners associated misinterpretations of structured data and algorithmic outputs with poor outcomes, which in turn could jeopardise the fairness of downstream interventions. In particular, the mediated distance afforded by remote sensing and observation technologies was said to enable misunderstandings. For example, the difference between fishing, maintenance, and a medical emergency was said to be difficult to tell without human expertise. For digital open-source investigations, P2 told us that being "online researchers looking at data [found] on the internet" meant it was "very easy to either miss context or misinterpret" the results. Hence, "one of the most important things" for their teams was to "hav[e] a local partner organisation in the region to co-publish with or to provide contextual support". Not having a partner was "oftentimes a reason [not to] investigate something".

4.4.3 Surveillance and data misuse. Our participants raised concerns about the ethics of data collection and use within maritime investigations. Disquiet was often directed at areas where investigations intersected with surveillance. For instance, half spoke explicitly about a need to better elicit informed consent for data collection and use. Communication and framing were understood to be crucial for this. P8 described having been "reliant" on translators and intermediaries when gathering testimonies from fishers in Southeast Asia. They worried that the ethical "rules of engagement" for their data collection—"how [fishers'] data was being used, where it was shared, whether it was anonymised"—"may have been lost in translation". Surveillance and consent were also raised as problems for data from remote and online sources. Consider the following quotation from P2 on using location data from digital advertisers: "there are potentially quite useful data sources that come from mobile phone locations [which are] collected primarily by advertising companies and then resold [...] But by purchasing that data, we're participating in the very surveillance economy that is collecting information, often without people's knowledge, about their precise locations. That has been used for a number of very unpleasant things as well." P2's words echoed critiques made by Zuboff [152, 153] and others of the presence of a market for personal data. P2's comment implies that, by taking advantage of this market his team would undermine their moral standing. Taken together, participants' concerns surrounding surveillance and data collection hinged on the implication that non-consensual data gathering threatened people affected by rights violations.

4.4.4 Opportunities: empowerment and agency. Participants highlighted how technology could play a positive role, especially with regard to community empowerment. For P9, it was vital to prioritise the empowerment and agency of people affected by rights abuses. This was about ensuring they were in "control": able to access resources, understand their situation, and hold others to account. "They know what they need. [...] I'm more interested in how the fishers and communities themselves can be made more connected, more transparent and safer through technology." "Long-term change" would not come from "top-down" impositions, in P9's view. Echoing her sentiments, P3 advocated for "use of technology" that would enhance workers' and other affected communities' "voices".

5 DISCUSSION

Our study indicates that maritime human rights investigations comprise a large, diverse, and dynamic field. Rapid changes in data, tools, and methodologies appear to have contributed to shifts over time – characterised by growing datafication, automation, and the entry of technologists into the field. Practitioners are aware of these new developments; most have taken advantage of them to different extents. Yet the contribution of data and technologies to fairness, transparency, and accountability regarding events threatening human rights at sea appear to have been limited.

Risks around the use of data and technology led to concrete trade-offs that practitioners had to navigate. Those involved in working with survivors and affected communities were concerned with imbalances of power and resources across the field. They spoke of the dangers of investigators and NGOs misrepresenting people's lived experiences in their reporting, as well as of risk of abstracting those experiences beyond recognition in the final outputs of investigative work. The process of data collection, aggregation, and analysis seems to have raised worries that forms of tacit and situated knowledge from people's lived experience was being elided. STS scholars have previously highlighted how datafication and digitisation often devalue situated knowledges in favour of a decontextualised machine's-eye view [66, 142]. In these processes, knowledge which cannot be easily made digital is rendered invisible, marginal, or otherwise of less value [49]. As such, in the case of maritime human rights investigations, it would seemed the perspectives and inputs of affected communities were vulnerable to being discarded in the pursuit of 'high tech' solutions.

The high seas' geographic isolation appears to have encouraged investigators to adopt 'data witnessing' (§2.4). The separation was simultaneously spatial, temporal, social, and technological, defined materially by a vast socio-technical network. Via a chain of technological intermediaries, this practice established the events being studied as 'remote' in the sense of being difficult to access. Meanwhile, investigators became 'remote' insofar as they were physically removed. Yet whilst data and data-driven tools afforded an unprecedented ability to observe the oceans without being physically present or interacting with survivors in person, they also

put investigators at risk of lacking 'ground-truth'. Participants who used OSI/OSINT were especially aware of this limitation. Hence, the seas' physical and social isolation appeared to have a contradictory relationship with how practitioners pursued transparency and accountability.

Affected communities appeared to lack representation when decisions about priorities for investigations, resource allocation, and technical developments were made. The neglect of capacity development at local community levels was a prominent theme throughout the our participants discussions about the scarcity of useful data, misplaced efforts by tool developers, and risks to fairness and agency. Local organisations often generated the most useful information, thanks to possibility of direct access and ongoing monitoring; affected communities were best placed to express their needs and desires, equipped with a holistic understanding of their own experience; and community-led monitoring and actions could effectively avoid the risk of top-down surveillance. But by its nature, community-level reporting is generally not amenable to large-scale automated datafication. And although our participants brought up some examples, the involvement of technologists at the local community level had been rare. Instead, people on the ground were left comparatively under-resourced and their 'low tech' needs went unmet. Therefore, again, we argue the complexity and interconnectedness of the marine space underscores the importance of situated knowledge [49] for any socio-technical intervention to function effectively. In HCI, participatory approaches [1] have become increasingly prominent especially when designing interventions to social issues [10, 33]. Participatory Action Research [98] could also provide guidance for technologists to advance social change through collaboration with affected communities.

In contrast, there appears to have been significant investment in actors seeking to offer 'high tech' solutions on a global scale. This dynamic appeared to have created a crowded, opaque market in which products and efforts were duplicated without properly meeting users' needs. On a technical level, it was unclear to what extent innovations in making technical systems transparent were being adopted. For example, whilst transparent, explainable artificial intelligence systems (XAI) are a dynamic area of research [102, 122], it was not apparent that explainable techniques were being implemented within existing workflows (or, indeed, the degree to which such is useful [19]. This is significant given that decisions and classifications made during investigations into human rights incidents—at sea and on land—can have serious downstream impacts. Additionally, there appears to have been mutual dissatisfaction over a lack of communication between frontline practitioners and tool developers: the former complained about tools detached from people's lived experience, whilst the latter were frustrated the available tools were unknown or underused. 'Techno-optimism' is likely to have contributed to this misalignment between users' needs and developers' efforts.

These findings are supported by a growing literature on exaggerated claims about data analytics, AI, and other technological development [50, 105, 107, 127]. A common failure of such systems is to overlook the context-sensitive assumptions embedded within computational abstractions [78, 127]. In our case, the complexity of the marine environment for human rights—its vastness; physical isolation; myriad interactions between legal, economical, and ecological systems; and the hidden nature of human rights abuses—poses a severe challenge for technological solutions' efficacy.

We suggest there is a uniting factor present in our participants' concerns: the political-economy shaping how maritime human rights work operates as a socio-technical ecosystem. The technical development environment appears to lack transparency or accountability, whilst those most directly affected by rights violations seem the least well resourced. Instead, there is a focus on developing advanced—and *marketable*—technical solutions. These attract attention and investment, possibly to the detriment of survivors and community-level organisations. Such a political-economic environment appears to have shaped the data and data-driven tools available to investigators, as well as the structural conditions they worked within (following [9, 83, 142, 145]).

6 CONCLUSION

Oceans are a critical arena in global efforts to promote human rights. Increasing attention paid to maritime human rights issues has exposed the scale of the problems at hand. These discoveries have been driven, in part, by advances in data and the technology used to analyse it. Like other areas of human rights practice [96, 97], datafication appears to have introduced new skill-sets, new epistemologies, and new professions into the space.

But despite the degree of interest in the academic literature in leveraging various data sources and developing technical solutions to the problem of challenge human rights abuses at sea, our research indicates these have not necessarily made marine spaces more transparent, increased the accountability of malicious actors, or improved safeguarding for vulnerable individuals. Meanwhile, we observed a familiar series of concerns regarding data-driven technical interventions: they were said to introduce errors, contribute to biases, and lead to misinterpretations, which could all reduce investigations' efficacy and feed unfair disparities in outcomes. They could encourage technological solutionism, crowd the market for tools, and divert resources from where they were most needed. This misalignment—between affected communities' needs and technology developers' efforts—was spurred by a socio-technical environment where investments in 'high tech' solutions and their providers have been privileged.

We argue the path for data and technology to contribute to fairness, transparency, and accountability within efforts to challenge maritime human rights abuses is not through further investment in large-scale, top-down monitoring to collect larger datasets. Nor is it through pursuing more sophisticated tech solutions in a crowded market where existing products may not be meeting users' needs. Instead, the field demands deep, localised engagement that supports affected communities to exercise their own agency. In a resource-constrained environment battling against severe harms to individuals and communities, the stakes of under-utilising or misplacing resources are high.

Our findings (Table 3) are likely to be echoed in other human rights fields and in the broader 'tech for good' sector. In particular, we suggest the needs, difficulties, and concerns that practitioners raised about investigating maritime incidents will be relevant to human rights investigative work in contexts where data is scarce and/or of low quality. These might include work to identify labour

exploitation on land; investigations in areas with limited internet access or available data; and initiatives seeking to document events during armed conflict.

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A ADDITIONAL TABLES

Data type	Examples	Typical sources
Analogue records	Paper-based documents	Vessels, government records
Qualitative text data	Interview transcripts, verbal testimony	Survivors, affected communities
User-generated content	Social media posts	Social media platforms, public databases
Remote sensing	AIS, VMS	Aggregators (e.g. Global Fishing Watch), governments
Satellite imagery	High-resolution satellite images, infrared spectrum imaging	Google Earth, Maxar
Surveys	Population surveys	Affected communities
Technical data	System logs, internet traffic	Technical devices, public databases (e.g. Shodan)
Geolocation data	GPS, co-ordinates	Vessels, mobile devices
Signals data	Radio, WiFi, mobile phone signals	Vessels, mobile devices

Table 4: Types of data mentioned

Issue	Example
Gaining access	Difficulty accessing witnesses on distant water vessels
Building trust with individuals	Survivors reluctant to trust investigators
Organisational capacities	Organisations lacking the appropriate tools, funding, or expertise to gather and analyse data
Incomplete and inaccurate data	Sparse and inaccurate AIS data
Organisational and political obstacles	Governments gatekeeping data

Table 5: Challenges with data

Type of investigation	Characteristics	Example
'Traditional' manual investigations	Case-based, primarily offline, manual, 'bottom-up'	Interviewing survivors of labour exploitation on vessels
Digital open-source investigations	Case-based, primarily online using open sources, manual, 'bottom-up'	Investigating incidents of migrant pushbacks using satellite imagery and photographs taken from shore
Large-scale, automated case detection	Large-scale, aggregated, automated, conducted remotely, 'top-down'	Detecting illegal fishing using AIS signals
Trend analysis and synthesis	Large-scale, manual and automated, synthesising existing reports	Risk modelling for labour abuses on vessels

Table 6: Uses for data and tools

Problem	Example
Tools detached from contexts and needs	Tools that require witnesses to access WiFi, which is often not available on vessels
Optimism and solutionism	Using blockchain in supply chains assuming this will reveal exploitation
Saturated market	Lots of tools with little oversight or clarity about their efficacy

Table 7: Problems with tools

Issue	Example
Geographical bias	'Blind spots' not covered by data
Misinterpretation	Remote researchers lacking local context to interpret data
Surveillance and data misuse	Encouraging use of data from mass surveillance
A need for empowerment and agency	Data subjects lack control over their data

Table 8: Risks relating to fairness, accountability, and transparency