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Assembling Collaboration Space: Maps in Practice During Search and Rescue Efforts In Northern Norway

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ABSTRACT

Rescue services in Norway are based on collaboration between private, public, and volunteer sectors. Digital mapping platforms serve as a support tool for those involved in a search and rescue (SAR) operation. However, they lack interoperability and pose practical challenges to the responders.

This research is situated in New Materialism, which focuses on interactions between heterogenous material-semiotic actors. Therefore, I analyze digital maps as assemblages constituted through practices. I deconstruct the "black box" of maps: investigate how maps are assembled for SAR operations, zooming in on what these assemblages can offer for efficiency of collaboration during an effort, especially when (dis-)connecting different localities. By doing so, I trace the interactions contributing to or disrupting cross-organizational capacity for collaboration during a SAR effort. The database for this study is formed from 15 semi-structured interviews with 13 people who are related to volunteer services, police, JRCC, and map modeling in Northern Norway, and supplemented by informal conversations, observations, and complementary documents analysis.

Findings reveal that digital maps can function as assembling or disassembling platforms for a coordinated rescue action while contributing to information sharing, decision making and situational awareness. This article demonstrates that maps are intrinsic to cross-organizational collaboration, and are interlinked with available infrastructure, training procedures, funding, regulations, and other socio-material aspects. Change in one of these nodes can have inadvertent consequences for the operational capacity of rescue services. Having mapped-out constellations can help trace how they are affected when implementing a change in the use of maps during SAR operations.

1. Introduction

1.1. *"Everyone is just waiting for the new search and rescue tool to be launched, so we can just leave the whole SARTopo mess behind."*

(Interview with V7, 2022).

One of the rippling effects sent by the fatal landslide at the end of 2020 in Gjerdrum, Southern Norway, was attention to action support tools, namely, digital mapping platforms. The incident exposed the unavailability of a common mapping solution, a vulnerability of the one used by volunteers, and spurred the development of a mapping tool for land rescue services. A report revealed that a lack of accessible ready-to-use mapping solutions hindered the rescue effort (Evaluation Report 2021, 67). Responders experienced challenges with accessing, logging, and sharing information via digital tools (ibid.), thus hampering communication. To overcome this, participant rescuers plugged into the SARTopo mapping platform used by volunteer services, resolving some challenges, yet posing a threat to personal information security (ibid., 68). The latter spurred discussions resulting in the National Police Directorate in Norway announcing a ban in June 2022 on using it within Rescue Services (Joint Rescue Coordination Centre 2022, June 17). The basis for the decision was its incompliance with the General Data Protection Regulation (GDPR). Voluntary Rescue Services were suggested to use another mapping tool called BaseCamp instead (Kroksæter 2022). The landslide response also spurred the development of a shared mapping solution for Rescue Services on land in Norway. The Joint Rescue and Coordination Centre (JRCC), in collaboration with police, volunteers, and mapping developers, began producing a new common mapping tool (Johnsen 2022, March 22). The attention generated by the fatal landslide stirred already rippling waters of mapping practices within Rescue Services leading to the confusion quoted above.

The use of digital mapping platforms within emergency response has

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amassed attention for their role in establishing a common operational picture (Steen-Tveit 2020; Opach et al. 2020; Steen-Tveit and Munkvold 2021; Opach and Rød 2022). When paired with additional means for message exchange, digital maps can enhance the common operational picture and the common situational understanding (Steen-Tveit and Munkvold 2021, 10). However, the emergency responders in Norway currently do not have a shared mapping platform available for all resources (Steen-Tveit 2020, 261). The solutions used by the services do not cross-communicate – a feature caused by organizational formalities, rather than technical issues (Opach et al. 2020, 514). In addition, available maps do not share the symbol library, thus complicating the information sharing and retrieval, leading to a need for a standardized outlay (Opach and Rød 2022, 139). When it comes to specifically the context of SAR, maps with an integrated live tracking feature can help with a good information flow and timely decision making (Hanssen 2018). Yet, with limited broadband coverage track logs can be skewed, needing an algorithmic intervention to restore or generate the missing data (Hanssen 2021). Avalanche terrain maps can be modeled with a help with an algorithm (Larsen et al. 2020), and are becoming increasingly accessible with catering for the people with color-vision deficiency (Engeset et al. 2022).

Inquiries into the use of maps within the wider field of emergency preparedness focused on cartographic layout and accessibility of information, computing strategies, and the needs of the first responders. Technical tracking integration was discussed specifically in the SAR context. Some of the studies linked the capacity of the digital mapping platforms to wider issues, such as procedural inaccessibility to shared information (Opach et al. 2020), questioning the traffic-light color-coding principle to ensure accessibility (Engeset et al 2022), or tracking challenges due to complex operational landscape (Hanssen 2021). Despite these links, the studies are focused on the human–computer interface, excluding other factors affecting the technical capacity of maps.

There is a long tradition to study maps as representations (see Dodge, Kitchin, and Perkins, 2011; Winther 2020). However, in past several decades discussion about maps has moved towards rethinking the role of maps while paying attention to how they are practiced (Kitchin and Dodge 2007; Cosgrove 2008, Crampton 2011), and how they interact with other nonhuman actors (Rossetto 2019). Maps have been analyzed through the perspective of enacting power relations, such as biopolitics (Barua 2014), geopolitics (Wood 2012), or urban power dynamics (Awan 2016). They have also been explored as propositions (Wood, Fels, and Krygier 2010), and for their role in navigation (November et al. 2010). Studies emphasize the active role of maps in co-constituting experienced realities. This angle was partially applied in the aforementioned studies, analyzing how maps are used by the first responders with a focus on needs. However, the processual aspect of maps was not fully explored. I argue that it is necessary to look beyond the human–computer interface by maintaining a holistic overview to understand how maps are assembled and in turn contribute to a response capacity. Thereby, with this article, I aim to explore how digital mapping platforms contribute to the operational capacity of SAR efforts with a focus on cross-organizational collaboration. I do so by investigating the "black box" of maps: how they are assembled for SAR operations and what these assemblages can offer for collaboration, especially when it comes to connecting different localities or occurring misalignments**.** Mapping out interlinked factors helps in understanding how a change in one nod can affect the functionalities of m

I first provide an overview of Norwegian Rescue Services. I further inquire about how the use of maps for SAR operations appears "on paper" (a handbook for rescue services, guidelines, reports), followed by a description of a theoretical framework used for analysis, a presentation of the methods for data collection and finally, a discussion of the findings, and conclusions. The aforementioned developments regarding mapping platforms shape and inform my analysis, by alerting me that there are more layers to the use of maps, and they need to be explored thoroughly. Therefore, in the presentation and discussion of the results, I analyze the three mapping tools: BaseCamp, SARTopo, and the one in the works, initially called Felle SAR (FSAR). The first two platforms have been in use by volunteers in Northern Norway. I conclude with what my chosen theoretical angle – assemblage-thinking – reveals about the use of maps during SAR efforts, their participation in cross-organizational collaboration, and how this mode of inquiry can contribute to the research on (human) safety issues with a focus on emergency response.

2. Rescue services in Norway

The Norwegian model for rescue services calls for cooperation between the public, private, and volunteer sectors, under the leadership and coordination of the Joint Rescue coordination center (JRCC) or a Local Rescue Center (LRC) (Organization Plan 2019, 1-3). Therefore, the core operational premise of rescue services is cross-organizational collaboration. Participating parties should have information sharing capabilities of a SAR operation, specifically when it comes to a geographical location of an incident. As an interlocutor from the JRCC expressed, "[e]very search and rescue operation has a location" (Interview with JRCC2, 2022). This citation illustrates and underpins my argument that maps and mapping platforms should be investigated as an integral part of rescue services.

When an incident occurs, a response is coordinated either by Local Rescue Centers (LRC), led by a district's chief of police, or by two main rescue centers – JRCCs (Mandate for LRC 2022). There are two JRCCs in Norway, one in the South, Sola, and one in the North, Bodø, dividing the area of responsibility by the 65° N degrees line (SAR cooperation plan 2022, 3.2). The JRCC in the North assumes responsibility for about 80 percent of Norway's Search and Rescue region (Andreassen et al. 2019, 17). However, according to yearly statistics, in 2021 it registered fewer incidents than its southern counterpart (HRS 2022)[2]. In addition to the JRCC in Bodø, there are four Local Rescue Centers in Northern Norway – Nordland, Troms, Finnmark, and Svalbard (Police Directorate 2020, 100). While JRCC deals with incidents in sea and air, LRC coordinates land SAR efforts (Andreassen et al. 2019, 15). Operational capacity in Norwegian rescue services is divided into three parts: strategic level (JRCC involvement), operational (police involvement), and tactical (on-scene coordination and involvement) (Handbook for Rescue Services 2018, 13).

Depending on the incidents and locations, different organizations are called in for assistance. JRCC can involve all available public and private resources and cooperate with fire, health, map, meteorological, and volunteer services, as well as Civil defense, Armed forces, Coastal Administration, Police, and Coastal Radio (Organization Plan 2019, 2.3). Each of the participating parties is responsible for the development of rescue services in their organizations and for sharing knowledge between them (Mandate for LRC 2022, 3). The JRCC should also participate in the development of common digital tools for promoting the efficiency of rescue service and collaboration (Main Instructions 2020, 3). With many participants and preparedness practices, coordinating centers have to be capable of pooling resources and information about their actions.

In this article, I focus on land responders who are operating on the tactical level, more specifically, volunteers. There are several reasons for this. First, during interviews study participants (volunteers and professionals) pointed out that the situation with available mapping tools for land operations is challenging, as one participant put it, "and it's on-scene we have this problem with no tool" (Interview with JRCC2, 2022). While the police, fire and rescue, and health services have mapping solutions catered for their daily use, volunteer organizations do not. Secondly, data availability dictated my focus on certain organizations, due to the unavailability of professionals (police) at the operational

[2] Respectively 2795 (943 in the sea) and 5359 in 2021.

level. Therefore, I analyze the use of maps within volunteer Rescue Services. While there can be organized and unorganized volunteers (Skar 2016, Tengesdal and Kruke 2018), my study focuses on organized resources – members of volunteer Rescue Services. Their involvement in SAR operations is planned (Aasland and Braut 2019, 7), and they participate in relevant training (Handbook for Rescue Services, 2018, 52).

3. Maps in rescue services

Until recently maps have not been given much recognition, the scarcity of which can be seen in documents related to SAR response. With more reports and studies naming similar shortcomings of maps and their uses the situation has been gradually changing. While the first guidelines for conducting a search effort on land (Guidelines 2015) lacked attention to a variety of maps and practices, the revised guidelines (Revised Guidelines 2022) included detailed suggestions for the uses of maps, responding to diverse mapping practices. Below I provide a short overview of how the use of maps is depicted in SAR response-related documents and studies.

As described in the aforementioned guidelines, maps are an integral part of rescue operations (Guidelines 2015, Revised Guidelines 2022). In the first guidelines for Norwegian Rescue Services detailing a search for missing persons on land, published in 2015, maps are mentioned in several ways, including as a tool for navigation (Guidelines 2015, 30), for planning a search (ibid., 49), and for providing an after-action overview (ibid., 67). The map used during the search should contain information about the last known place, the starting point for the search, places of interest, other critical intelligence, and tactical choices for further search (ibid., 66). Guidelines draw attention to using maps for the concentration of information and as a visual help for planning a search (ibid., 66). Yet, the delivery of the information, such as color coding or abbreviations – is not discussed. In conclusion, the assumed role of maps in these guidelines is quite static, thus excluding varying practices of using maps.

Attention to the use of maps on a practical level is brought up in the 2018 report about the role of voluntary rescue services in society (Report on Volunteer organizations 2018). The report emphasizes the lack of digital solutions for volunteers, which would allow common access to information, mapping, and decision making, and that the ones in use only partially cover the needs, and cause duplication of information (ibid., 72). The 2018 Handbook for Norwegian Rescue Services states that they have no maps specifically developed for SAR operations, therefore, there could be many variations in local uses of maps (Handbook for Rescue Services 2018, 89–90). Thus, the issue of lacking maps was documents related to the activity of the Rescue Services.

Revised guidelines for searching for a missing person on land (Revised Guidelines 2022) address the issue of varying practices of using maps among the collaborating organizations. The goal of these guidelines is to standardize knowledge-based search practices (ibid., 8). They provide detailed suggestions on how information should be shared via mapping, with the use of terms, abbreviations, and colors. I discuss these guidelines in more detail in section 6.5. The elaborated discussion on the content of mapping signifies that the role of maps has been acknowledged in a more dynamic setting, with emphasis on their practical handling.

4. Theoretical framework

My study is inspired by New Materialism, a theoretical approach that emphasizes relationality between heterogeneous actors. There is a variety of New Materialist perspectives and classifications (see Gamble et al. 2019; Shomura 2017), where the common denominators are attention to processes, decentralization of humans, and a flattened ontology – where processes happen on the same ontological level (Fox & Alldred 2016, 8). Instead of looking for an explanation in structures outside of the interacting network, New Materialisms looks into these interactions and builds up an explanation from within, for "matter is self-organising" (ibid., 56). This article draws on Actor-Network Theory (ANT), an influential approach overlapping with New Materialism. The self-organizing principle in ANT is attributed to assemblages, where "the social" is flowing from interactions (Latour 2005, 247–250), instead of being restricted to only a few participants (people). Networks create the relational space between actors while being in the same "flat" dimension as the actors themselves (ibid., 180). Thus, they co-produce with each other. Actors can be anything, provided they act or gain activity granted by others (Latour 1996, 373). This approach allows for embracing the processual part of maps and focusing on their emergent characteristics (see Kitchin and Dodge 2007).

Assemblages serve as the theoretical anchoring in this article. Here, the term "assemblage" is based on Müller's combination of ANT and assemblage-thinking: "a mode of ordering heterogeneous entities so that they work together for a certain time" (Müller 2015, 28). Assemblages are exterior relations between actors and provide new territorializations, expressions, behaviors, or even realities (ibid., 28–9). They provide a stage for emerging characteristics and agency, which cannot be easily ascribed to human or more-than-human entities. While actors act through networks, obtaining either stable, or fluid forms of association (Mol 2010, 260), assemblages assemble, reassemble, and disassemble themselves, suggesting a wider temporal scope than networks (Müller 2015, 35).

An example of assemblage-thinking in risk studies can be seen in one of November et al.'s studies, which analyzes crisis management as "an assemblage resulting from the agency of several spatialities that are specific to the various elements involved in a risk situation" (November et al. 2016, 3). Therefore, they analyze everyday practices and the spatio-temporal involvement of control rooms (ibid., 7). The inquiry recognizes risk monitoring as "one aspect of larger socio-technical monitoring devices", instead of the control rooms being the prime "source of action" (ibid.). The research extends outside the control rooms with attention to how they are assembled, and how they connect to the monitored sites. Therefore, this mode of analysis allows exploring the monitoring of risks and crisis avoidance through everyday practices – assemblages.

For this study, assemblage-thinking means looking into maps as processes, where they are constituted through practices, within assemblages of material-semiotic actors of various natures, from regulations to data sets, and to humans. Maps are dynamic, therefore, their functionalities, such as performativity or representation, instead of being understood as pre-described features, are analyzed as an outcome of interactions. Thus, different uses of maps reveal the diversification of functionalities and failures to function in a certain way. When I engage with study participants or observe mapping practices, I pay attention to what is necessary for the maps to become maps. This spans from various infrastructural features to funding, regulations, and various uses of maps by the rescuers, such as plotting, tracking, navigation, shared situation awareness, or a shared operational picture. With this angle of analysis, I reveal a variety of functionalities arising from interactions: maps delineate movement (as in marking search area), track the responders (live tracking and track logging), and are involved in decision making (navigation, planning) and information communication (shared situation awareness, shared operational picture). They are enacted and are "becoming" (as in Haraway, 2016, 12–13) in different ways due to specific situations and needs of responders and map makers. Maps as processes entail numerous interactions with heterogenous more-than-human actors, including hardware, landscape, regulations, and people. Therefore, in this study expressions "practices of maps", "use of maps" and "mapping practices" are used interchangeably, with an emphasis on a map as an ongoing process. By invoking assemblages, I do not contest the potency of maps as representations or their performative capabilities, this perspective rather allows me to study what is happening as maps gain such characteristics.

5. Data and method

Data sets for this article are developed from interviews, observations, and document analysis. I have conducted 15 semi-structured interviews with 13 people (two of them are follow-up) who are related to volunteer services (7), police (2), JRCC (2), and map modeling (2), with a focus on Northern Norway. Due to the pandemic restrictions and geographical dispersion, most of the interviews were conducted online, between 2021 March and 2022 October. Interlocutors were recruited through snowball (Geddes et al. 2018, 348–350) and purposive (Gentles et al. 2015, 1778) sampling. Additionally, data were collected through unstructured conversations, emails with follow-up questions, and observations of volunteers' training with maps.

Due to the increasing use of digital solutions, this study is focused on digital maps. During interviews, interlocutors were asked about mapping practices: when, where, and how they would use a map, what maps they prefer, and if they use any additional tools for (reading) maps or navigation. Professionals related to map modeling were asked about how the data sets are collected, sifted through, and prepared for the users. The interviews were transcribed and coded through the NVivo program. The themes for coding emerged from the data, while the focus on what assembles a map is inspired by the theoretical approach. The analyzed documents included those related to the management of rescue services (as stated in the Mandate for the JRCC 2022, 7.1) and other documents, such as reports, guidelines for conducting searches, police guidelines, and other documents related to search and rescue incidents and their management.

Changes regarding mapping tools affected my angle of analysis. My initial intention was to investigate spatially dispersed mapping practices, with defined localities, where maps are either used in SAR operations or are modeled. However, the changes mentioned in section 1 led me to focus on the three mapping platforms – BaseCamp, SARTopo, and the one in the making – and their practices in Northern Norway. Notably, volunteers here used BaseCamp as a tool before all volunteer rescue services started using a singular platform – SARTopo – in 2021 Autumn.

6. Results

6.1. Practices of maps

The study participants emphasized the abundance of maps, thus it is the most noteworthy aspect of the use of maps during SAR operations. The interlocutors have mentioned at least 5 different forms of hardware for maps employed in operations. These can be paper maps, mobile phones, tablets, computers, and handheld GPS, the selection of which mostly depend on responding units and the availability of technology. In addition, when it comes to digital maps, at least 13 mapping platforms, databases, or maps were mentioned, supplemented by aerial photos when necessary. Identified digital platforms mostly do not communicate with each other. This leads to an uncoordinated movement of resources over the search area and hinders the rescue effort: "[b]ecause when you are wasting energy or the time to search on the same place, where already two different resources already have searched, you miss search on the other parts, which is really important." (Anonymous, 2021). This detail alone reveals a fractured landscape in which land responders operate with implications for shared situational awareness and collaboration during a SAR effort.

For a better overview of how maps participate in SAR operations, I start by presenting overall mapping practices for SAR-related incidents on land in Northern Norway and related challenges. I continue by investigating the use of the three mapping platforms, where I analyze how maps are assembled through practice. While presenting nodes identified by voluntary and police responders, I inquire into how these constellations interlink with the collaboration capacity. I also look into misalignments of the interactions - transpiring complications of these assemblages as noted by the study participants.

6.2. Practicing mapping in SAR operations

Responders rely on maps, whether paper or digital. As interlocutors from different organizations consistently pointed out, one of the basic skills covered by the basic training for voluntary SAR groups is to be able to orient themselves in the surroundings with a paper map and a compass (Interviews with volunteers). These tools are also necessary items in one's backpack, as a backup, if other means of navigation fail. However, responders are increasingly using digital maps. As study participants explained, it is because they are easier to operate in low visibility – darkness, storms, or fog. "We do search in fog, we do search in dark <…> then we have to use the map more than in daylight because the only thing we can trust there is a map. If we don't see far, we have to trust the map completely" (Interview with V1, 2021). In these conditions, the rescuers have to trust their navigation to digital maps. With the growing use of technology, the functions and technical capabilities of maps are more dependent on available assemblages.

Digital maps can have a variety of roles. They depend on the needs of the responding personnel, and localities where maps are practiced – the field response or the command post, the voluntary services, or the professional response – the police and the JRCC. Mapping practices identified by the participants are mostly related to information gathering, sharing, and decision making – maps are the "decision making tool" (Interview with JRCC1, 2021). Among these practices are plotting out search areas and resources, navigating through the surroundings, live tracking the movement of responders, and track logging for immediate and later use. The latter has different uses. Logged tracks are used in long-lasting searches to keep track of area coverage or for learning purposes. As well, logged tracks are used for navigation when units need to move out and respond to an incident during poor visibility, for example, snowstorms. When it comes to local voluntary resources on land, they are mostly using maps for collecting information and keeping track of their progress, instead of navigation. This is because volunteers rely heavily on communities and their local knowledge of the surroundings.

Live tracking provides the possibility for an overview of the situation, and better control over decision making. For example, a leader in the command post can assess the movements of the volunteers in the field in real-time and change a search plan if necessary (Interview with V7, 2022). As well, when connected to the same mapping layer, rescuers can consult with people who can be far away from the rescue effort (Interview with V3, 2021). Therefore, with live tracking, a digital mapping platform can connect resources from different spatialities – localities – such as the command post, the field rescuers, and people contributing remotely. This feature can save time – a factor that can be fatal. Thus, live tracking contributes to decision making while providing a synchronous situation overview.

Maps used by responders on foot have to be self-sufficient. A notable difference in mapping assemblages is that maps used in marine and air rescue efforts are assembled with mechanisms onboard – radars, gyroscopes, other receivers and transmitters, and energy sources. Snowmobiles provide energy and heating when it comes to maps, whilst responders on foot have to rely on what they can carry. Ensuring working trackers means responders on foot have to bring additional sets of batteries. For power-saving purposes, they can also disable the device's backlight and use headlights instead. Trackers can stop working, leaving a rescuer without a track log or navigational means. Thus, the maps available for the rescuers on foot have to be portable and sufficient enough when facing cold, darkness, moisture, and a lack of connection.

The use of digital maps comes with obstacles, which can significantly hinder a SAR effort. Further, I briefly describe the ones identified by the study participants operating on land. While challenges are intertwined, they can be divided into the following segments:

Data access and management. Not all mapping platforms allows to manage entered data. As well, volunteers have less access to action-related information, thus rendering their situational awareness incomplete.

Capability to coordinate actions. This includes the lack of inter-operability between different mapping platforms, thus leading to the lack of shared situational awareness.

Infrastructure availability. It includes challenges with coverage zone and availability of technical support at the command post.

Funding. Volunteers depend on external funding for acquiring tracking devices, mapping software, and hardware.

Portability and (inter-)operability of maps are important factors for responders on foot, yet they present challenges. With more technical capabilities, maps are more interlinked with various spatio-temporalities, and are used in different ways. Therefore, it is important to investigate how maps are assembled when practiced and how (dis-)connected localities interplay with collaboration capacity during a response.

6.3. BaseCamp

The first mapping tool in this analysis is BaseCamp. The software was considered an alternative for SARTopo after banning its use and is also among the many non-compatible mapping platforms used by volunteers in Northern Norway. It is provided by the Garmin company and is freely accessible for its hardware users, while certain mapping layers have to be purchased. The software allows importing the track logs and drawing straight onto a map, thus making it suitable for planning and action coordination. It is less automatized than its counterpart, SARTopo, yet its users have control over data management.

Responders in the field use several devices for information collection and sharing. Volunteers have trackers, which can also be mounted on dogs. Rescuers use Global Positioning System (GPS) devices with small screens for maps. There they can check their tracks for uncovered areas in a search section or steer clear of another unit's supposed area of responsibility. Due to the size of the display, it can be tricky to navigate with it or get a broader overview of the landscape. The maps might also lack detail for certain terrains. There is a possibility to link several GPS trackers so responders could see each other's whereabouts, however, this is not practiced avoiding overcrowding the maps. In addition to GPS devices, responders can use their smart mobile phones with access to other maps. For example, police use Telus mapping solution, tailored and reserved for police's need (yet not for SAR operations) and can be used for getting intelligence related to the rescue operation.

The rescuers use radio for field communication, especially for sightings. However, this takes time – responders have to dictate their location in numbers and have it confirmed. As one participant expressed, this process can take time, which is unaffordable if the located person is injured – „And if you're in the woods with a wounded person that needs first aid, you don't want to spend a whole minute communicating with the operative leader just to give him or her the information about where you are. You want to be located instantly." (Interview with V2, 2021). Rescuers use a single channel for communicating information, thus there is a risk of clogging radio communication with unnecessary information if used excessively. Nonetheless, it is a helpful tool when live tracking is unavailable and participating organizations use different mapping platforms.

When working with BaseCamp, maps at the command post have to be assembled with manual input. Track logs have to be delivered back to the operative leader at the headquarters and uploaded into a computer. Leaders then have to combine these logs to see the overall coverage of search sections. Physical data delivery means the coordinator cannot process movement trajectories and have the full situation overview with responders still in the field. Sometimes responders can send a screenshot with a map layout while in the field, however, retracing someone's tracks on the mapping solution is time-consuming and inaccurate. Furthermore, when the rescuers in the field are unaware of each other's progress, they can search in the same area, or stumble into each other, resulting in lost time (Anonymous, V2, 2021). When an operation is finished, track logs are transferred to a central database and deleted locally. Thus, for maps to work as a coordination tool, they require manual assemblage, the efficacy of which depends on one's experience with the mapping software. Dependency on physical track log delivery also means that the headquarters have to be established before starting the search in reasonable proximity to the search area.

The operative leader can use additional maps for action planning. Maps provided by BaseCamp lack information about the terrain, such as contours or steepness – important details when looking at where a missing person could have gone. For more details, the leader can look into 3D terrain models provided by an international company or maps produced by a local initiative. The latter is provided by the Norwegian orienteering community and supplies extremely detailed information about rivers and streams, steep terrain, and drops, with data sourced from the Norwegian Mapping Authority (NMA). These maps are the outcome of the open data policy by the NMA, which is responsible for collecting geographical information for national maps, sifting through them, and creating data sets (Interview with MM6, 2021). While BaseCamp is an offline software, additional mapping sources are online platforms requiring an internet connection.

Assembling maps through BaseCamp reveals two misalignments. First, when assembled, the map lacks immediacy. To be used as a planning tool for action coordination, the mapping platform needs continuous input from responders in the field. Coordinators cannot see real-time movement of the rescuers on the mapping platform, and it takes time to compile a full overview of the search situation. Therefore, the situational awareness provided by BaseCamp is disconnected from the synchronous events in the search area. Furthermore, the use of BaseCamp must be situated near the search area, therefore, a command post must be established, delaying the time of response.

Another misalignment lies between the headquarters and the responders in the field. Action coordination is limited to initial instructions and assessments of the results. The use of radios can bring the localities together, as rescuers can communicate their whereabouts and observations. However, to exchange the information to a full extent, rescuers in the field have to go back to the command post. A similar detachment occurs between units in the field. Because they do not have oversight of who is where, they lack cross-coordination in terms of movement in the field, thus hindering the search effort. In this case, the mapping platform provides space for cross-organizational collaboration with latency – a factor that can act as a disassembling factor in a coordinated search effort.

6.4. Sartopo

In Autumn 2021 volunteer organizations in Northern Norway conducted exercises to get acquainted with the SARTopo mapping tool. It is catered for SAR operations, allows one to draw and mark things directly onto a map, and has integrated live tracking. This mapping platform has already been tested and preferred by several Norwegian volunteer organizations. Therefore, the umbrella organization for voluntary rescuers, the Volunteer Organizations Rescue Professionals' Forum (FORF) initiated and funded the move onto a single mapping platform. As stated in the Organization plan, whilst volunteers can get reimbursement for direct expenses for participation in a SAR operation, they are responsible for their preparedness level (Organization Plan 2019, 3.2, 4.3). Thus, volunteer organizations have to rely on external funding. FORF provided tablets containing pre-installed programs to ensure that the organizations are on the same page.

SARTopo caters to portability and flexibility needs. It is available in two different settings – as desktop software and as an application for mobile devices or tablets – both easily portable devices. Volunteers

mentioned they have been in communication with SARTopo developers and have asked for specific map layers to be incorporated into the platform, thus gaining access to diverse map layers through one digital mapping system. According to one interviewee, portability and connectivity allow starting the initial phase of the search without waiting for establishing a command post (Interview with V7, 2022). As another interviewee explains, it allows the people to start planning the search effort already in the car underway to the scene, saving time upon arrival (Interview with V3, 2021). They also mentioned that depending on phone coverage in the search area, there is a possibility to include expert responders remotely, who can see the same map layers and provide input (Interview with V3, 2021). This option is relevant in scarcely populated areas, or when the establishment of a command post can be too difficult.

Live tracking capability contributes to shared situational awareness and interlinks with overall motivation. As I have observed, the mapping platform offers a minimum delay in information updates, and responders, both in the field and the headquarters, can see them almost immediately. Therefore, an operative leader can monitor the progress of search teams and change the search plan if necessary. One interlocutor conveyed that "respect for the terrain and how it affects the search is important for me as a leader. Because it directly affects how motivated the crews are and the quality of the search." (Interview with V7, 2022). Live tracking proves to be also important for responders in the field. Volunteers participating in searches mentioned that accessing the same information as the people in the headquarters provides openness, which creates a level of trust (Informal communication with V8 2022, V9, 2022). Moreover, seeing the progress of a search effort is motivating, as they can see themselves as a part of a larger effort (Informal communication with V8 2022; V9, 2022). These are the great pillars of volunteering work – trust, motivation, and a sense of belonging. Therefore, it is important to acknowledge that through live tracking, the mapping practices interlink with the organizational capacity of a SAR effort. The immediacy of connected localities allows for synchronized situational awareness and decision making. Consequently, SARTopo maps enhance cross-organizational collaboration, affecting not only common operational picture, but also motivation of the units in the field.

The main misalignment in this mapping assemblage that needs to be addressed is the controversy over the use of SARTopo due to the GDPR. The software is provided by a private company outside Europe, which does not abide by the same data security rules as in Norway, complicating the treatment of personal information. Because entered data is stored in a cloud, the main issue with using these maps is ensuring secure and proper data management, especially when it comes to GDPR. FORF urges volunteers to delete any personal data after a search operation but cannot guarantee that the protocol is always followed. According to several interviewees, concerns over GDPR were first raised during the search effort at the fatal Gjerdrum landslide (Interviews with V3, 2021; Anonymous, 2022; JRCC2, 2022). Consequently, these concerns instigated the production of the new mapping platform (Interview with JRCC2, 2022). Despite its impact, the connectivity of SARTopo is superfluous, rendering its use insecure from a legislative perspective.

Another misalignment is accessibility. SARTopo is not free to use. Therefore, volunteer organizations have to secure a structure of funding, which is currently overseen by the FORF, and ensure its viability. In addition, SARTopo is yet another mapping platform requiring time for reaching desirable operating skills. There are no formal instructors, however, more proficient users can help other responders to understand how to utilize the mapping solution. Due to some organizations having accumulated more experience with this mapping platform than others, knowledge sharing can be cross-organizational and cross-spatial, involving organizations from different locations, which I had the privilege to observe. Dispersed and asymmetrical experiences of using SARTopo complicate access to its functionality, while simultaneously it can also enhance routine cross-organizational collaboration.

6.5. Platform in the works

The third case analyzes the mapping solution in development overseen by the JRCC. One study participant from the JRCC explained that the reasoning behind this is that the tactical level lacks a support tool catered specifically for SAR operations, which can be interoperable with mapping solutions at the police and the JRCC (Interview with JRCC2, 2022). Another important reason is data management, "we are obliged to have full control over every data we use" (Interview with JRCC2, 2022). This platform is a product of cooperation between the JRCC, volunteers, and the police (Johnsen 2022, March 22). Along with participating in the development consortium, volunteers have contributed with partial funding. After the 2020 Gjerdrum landslide, FORF received significant funding for improving emergency response and channeled a part of it, 5 million Norwegian Krones, to stimulate the development of the new common mapping platform (Interviews with JRCC2, 2022; Anonymous, 2022).

The goal is to have a flexible mapping solution, connecting different rescue services and response levels (Interview with JRCC2, 2022). The main premise of the platform is that developers are in close contact with volunteers and the police to develop a tool which is based on the needs and acquired knowledge of the responders. The possibility of multiple map layers should ensure its applicability in various geographical locations and terrain. The question of flexibility and portability is tackled by addressing track logging within and outside of the coverage zone. This platform is projected to be free of charge for involved responders, and will initially be available to the JRCC, police, and volunteers. The project crosscuts localities by assembling funds, expertise, and local knowledge from different rescue response levels to raise the efficacy of collaboration on the tactical level through a mapping platform.

The JRCC assumes the main responsibility for the development and maintenance of the mapping platform, making this tool under direct control by a governmental institution. This way, issues related to data access, storage, and security can be addressed and resolved centrally and locally. An interlocutor mentioned plans to regulate access to shared information by filtering out what each level of response (tactical, operational, strategic) needs to know (Interview with JRCC2, 2022). Developers are also in close communication with lawyers who manage matters related to compliance with the GDPR, or information security such as storage, access, and control. Due to sensitive data which can be entered into the maps, regulations for data accessibility play a significant role, interlinking legislation with the accessibility and the use of maps. Thus, implementing a direct involvement of a governmental institution can resolve arising issues.

The development of the mapping platform comes along with another important change in information availability and communication for Rescue Services. In June 2022 revised guidelines for searching for missing persons on land were published. An interlocutor said the release is regarded in connection to the development of the common mapping platform (Informal communication with JRCC2, 2022). A consortium of responders (from police, volunteer organizations, Civil Defense, JRCC, health services, and others) is responsible for the new edition. Among other information, the revised guidelines provide detailed instructions on how to plot on maps during and after the search. The book includes suggestions on color-coding (trail logs, search sections, search plan, and results), and details terminology and abbreviation for mapping purposes (Revised Guidelines 2022, 67, 70–71). Standardization of color-coding corresponds to what the study participants have called for. It is noted that some mapping platforms in use might not have the technical capabilities to fully adapt suggested ways of mapping (ibid., 66–67). Mapping limitations and possible risks related to mapping practices are also laid out. Among those, attention is drawn to technology use – some screens might limit the overview of a probable search area, map layers might lack important details, and drawing capabilities can impact how fast the search is started (it can be delayed until after the initial plotting) or its reflexivity (insufficient flexibility due to sticking to drawn

sections) (ibid., 52–53).

In the future, the adaptability of the mapping solution should be explored. The platform is on course to be managed centrally, with unified processes for generating a map and implemented access control. Following the revised guidelines, mapping practices during a SAR effort are to be standardized on the tactical level. Thus, together with the guidelines, the mapping tool aims to solve the challenges of information duplication, lack of coordination between units and search areas, and flexibility in search planning. In the future, it is important to analyze how this mapping platform will reassemble through mapping practices, with attention to local variations and its adaptive capacity.

7. Concluding discussion

With this article, I aimed to analyze how digital mapping platforms contribute to cross-organizational collaboration in a SAR effort. Previous studies have shown that maps take part in decision making, information communication, and shared situational awareness. My findings reinforce these statements and further reveal the variety of roles the maps play, and their relation to collaboration capacity. Furthermore, my mode of inquiry reveals challenges outside of a SAR effort that voluntary rescue services face when using certain mapping platforms. Various participating organizations have to be able to coordinate their actions, and they do so with the help of maps. For maps to efficiently participate in situational awareness and decision making support, the mapping process has to include a continuous flow of information through the vertical (the command post – field response) and horizontal (field response) axis. The BaseCamp mapping platform is capable of doing so with a delay, therefore leading to a fragmented situation overview, slowing down decision making and coordination. SARTopo is capable of enhancing synchronous collaboration between organizations and different roles during a search. However, it is not an open-access application, requires a structure for funding, and exposes personal data, therefore is not favored by the police, leaving communication fragmented on the police-volunteers axis. It is too early to analyze the implementation of the mapping platform in development. However, it should be analyzed following what gets interlinked when it is employed, and what challenges are resolved.

Inquiry into the "black box" of maps – applying assemblage-thinking – allows the further exploration of what interactions hinder or enhance certain functionalities of maps. Because organizations have an individual responsibility to maintain a certain preparedness level, volunteers have to acquire funding to have access to certain map layers of BaseCamp, or SARTopo, and to have working hardware. Infrastructure needs differ accordingly to which mapping platform is used. Furthermore, organizational practices define how maps are used in a SAR effort, and, along with training and availability of required skills affect how sufficient maps can become. Utilizing mapping solutions requires knowledge sharing, therefore creating the potential for new ways of collaboration. As the cases reveal, maps can have an effect on coordination efficiency, motivation in the field, and the pace of a SAR effort. When all units can access the same timely information, a search plan can be changed immediately, thus providing flexibility, and enhancing coordination and communication. As well, regulations affect the way maps can be used or not. These aspects interlink the employment of maps and can be decisive factors for maps' capacity to function as a collaboration space.

Analyzed cases make it obvious that maps are interlinked with sociomaterial processes and should not be studied in a vacuum. The use of digital mapping platforms in SAR efforts is not only about human–computer interface. Training responders to work with one platform and producing guidelines for unifying mapping practices can resolve issues related to divergent organizational routines, but it will not solve access issues. The landslide in Gjerdrum provided a painfully obvious insight, that mapping platforms have to be ready before an incident happens. Amidst the immediacy of a SAR response, an accessible and catered specifically for Rescue Services mapping platform can provide a virtual space for collaboration before a command post is established. However, Rescue Services have unequal access to maps, therefore hindering action coordination support through maps. Unclear regulations regarding the use of SARTopo create a messy situation for volunteers. Therefore, when analyzing the use of maps in rescue services it is important to maintain a holistic perspective to see what interactions take place for maps to act the way they do during SAR efforts. Furthermore, with mapped-out nodes and interlinks it is possible to see the strengths and shortcomings of mapping assemblages. This knowledge is useful when implementing changes to mapping practices.

Digital mapping platforms can enhance cross-organizational collaboration during a SAR effort and beyond. They provide space for coordinating the movement of units in the field and can even motivate them. As shown in analyzed cases, the challenges of using maps bring Rescue Services together outside of incident response. For example, the need to learn how to use the mapping tool, the necessity for funding to access the maps, or the development of the new digital solution prompts the organizations to cooperate. Therefore, digital mapping platforms are interlinked with cross-organizational collaboration on different levels and have the potential to enhance the operational capacity of Norwegian Rescue Services throughout and beyond a SAR effort.

CRediT authorship contribution statement

Virginija Popovaitė: Writing – original draft, Project administration, Methodology, Investigation, Data curation, Conceptualization.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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