Project FIRE21 - Internal workshop on recommendations

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Introduction

As part of the project FIRE21, a workshop was organised in Trondheim on September 8, 2023, inviting all project partners (Lund University, Research Institutes of Sweden, the Technical University of Denmark and the Norwegian University of Science and Technology) to brainstorm on potential problems for the fire and rescue services (FRS) in the 21st century, and recommendations on how to improve the handling of these problems. This aspect is part of work package 4 in FIRE21, which has an overall aim to develop project recommendations to support the development of resilient problem-solving networks. Some of these recommendations will be focused on the FRS, whereas others will be aimed at FRS collaboration actors.

The purpose of the workshop was for all the project partners to collectively delve into the core of the project's findings so far and provide recommendations from the different work packages. Here, each partner should consider how well the existing FRS problem-solving networks in the country support the present risk landscape and what changes might be necessary to support the development of appropriate networks for the future. This means that all participants draw upon their findings, ideas, experience, and the like to suggest recommendations for how the FRS handling of problems today and in the future can be improved. The scope of the workshop was intentionally broad to be able to capture all ideas, that would later be categorised and prioritised.

This report aims to describe and summarise the workshop and the perspectives drawn from it regarding problem solving in the Nordic FRS. The report is divided into four sections. It begins with a summary of the workshop and its activities, then moves on to discuss the main thematic clusters that emerged during the different phases and proceeds to analyse the four main outcomes regarding problems and their corresponding recommendations. Finally, the last section of the report focuses on the prioritisation of the recommendations that participants brought about.

Workshop description

In total, the workshop consisted of 8 participants from the above institutions. The goal was to identify problems using the report from work package 3 as a point of departure and provide recommendations for addressing them as well as capabilities that are needed, and the level of evidence for recommendations. The level of evidence, as seen in Figure 1 (will be translated in English), refers to the different strength of the sources of information. Levels of evidence can be higher in the "ladder" such as in the case of meta-analyses or lower, representing an opinion or "gut feeling".

Figure 1: Ladder of the "Level of Evidence"

The methodology followed for the workshop was based on an interdisciplinary approach, deriving from the diverse backgrounds of the project partners and their institutions. Following this principle, the aim was to initially create mixed rotating groups from the different institutions that would try to identify problems in fire rescue in the Nordic context.

The workshop consisted of three main parts. In the first part of the workshop, participants were divided initially into two main groups that discussed potential problems for the Nordic FRS. The aim for this first part was that the groups would be as diversified as possible with participants from the different institutions with the aim of bringing about more perspectives. Then the initial groups rotated so that more ideas would be generated through the discussion in a new group of participants. In this first phase, the participants came up with several categories of problems or clusters of problems.

In the second part of the workshop, participants were called to provide recommendations for addressing the different problems or clusters of problems identified in the first part. Simultaneously, for each recommendation, the aim was to note existing capabilities, level of evidence and methods for validating each recommendation. Figure 2 is a visualization of the aim of the second part of the workshop. Finally, the third part of the workshop was a broader unstructured discussion of the outcomes of the second part and a prioritisation of the recommendations provided by participants, which was done on a later time remotely. At this latter stage, two participants prioritised recommendations from the second part of the workshop justifying their choice.

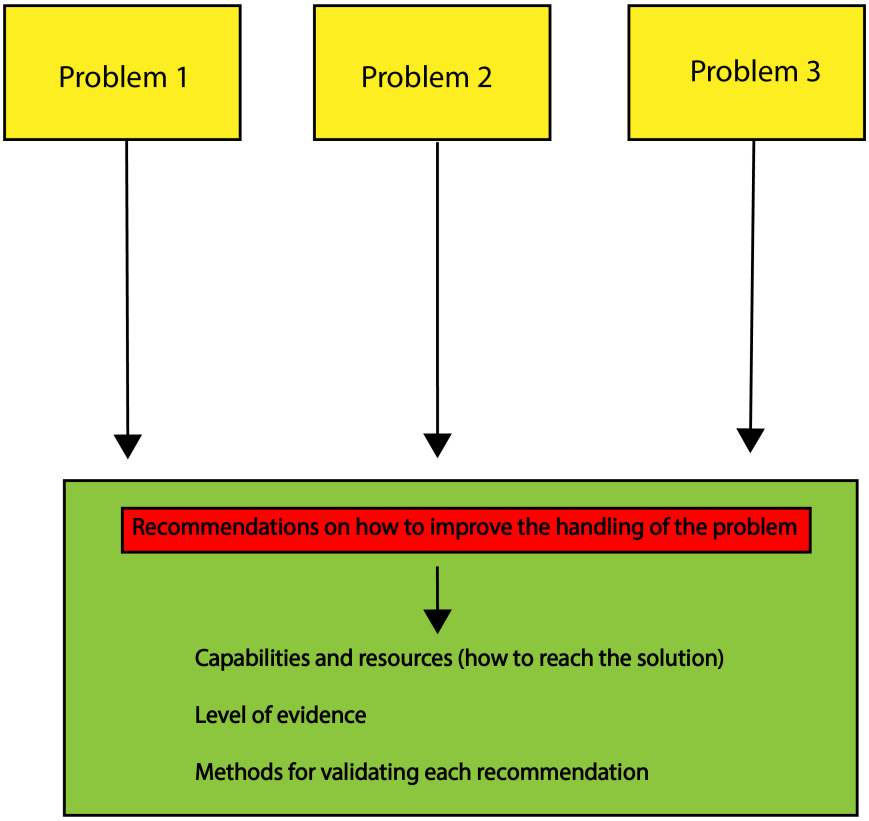

Figure 2: A visualization of the second part of the workshop

Clusters of Problems

During the first part of the workshop, seven different clusters of problems were identified. During the second part, corresponding to each cluster, the participants provided recommendations for addressing the cluster identified in the first part of the workshop. A general observation is that there is a variety of scope in the clusters, with some being quite general while others more specific:

1) Understanding, identifying, solving problems

   This cluster of problems refers to the challenges related to the conceptualization or the "grasping of a problem". Many problems that the FRS need to solve are considered complex, which can be difficult to understand and solve. Nevertheless, especially when facing complex situations, current literature supports that it is important to identify and define the problem before trying to solve it.

   Developing taxonomies for understanding problems was a recommendation that aimed to address the complex landscape of defining contemporary problems. Such taxonomies can be validated/tested with FRS service professionals. This recommendation will (partly) be an outcome of FIRE21.

More practical solutions to help the FRS understand the problems were also suggested. First, to develop checklists to be used in the emergency call centres (110/112) could improve the problem understanding and facilitate the knowledge of which actor to involve. Second, drones are suggested to be used by the FRS to gain an understanding of what is going on (see also later suggestions on IT/drones). These recommendations are suggestions for the FRS and partners to develop.

2) Managing tunnel fires

Managing tunnel fires was a more specific problem that was discussed during the first part of the workshop. The main issue with this type of events for FRS is that there is a variety of vehicle types involved which also implies a variety of fuel types, creating an uncertainty regarding how FRS should intervene and how to respond to tunnel fires. It is currently not known to the FRS which vehicles are in a tunnel at a certain point of time.

A recommendation for dealing with this problem focused on the prevention on such types of occurrences by using the toll road system to monitor the type of fuel and, where possible, hazardous cargo, entering the tunnel. Real time control systems are seen as a means for the prevention of tunnel fires. The solution could also be used for the same type of problem in parking houses or on bridges. However, a monitoring system like this could also create integrity issues or be a source for antagonistic attacks. This recommendation is a suggestion for the FRS or other relevant actors to develop.

3) Geographic scope

This problem cluster refers to the increased area for response especially when it comes to hazards such as floods, landslides, and forest fires. Events like these, which are also often of long time-duration, have the tendency to require an abundance of resources needed for response efforts, thus stressing FRS to their operational limits, and presenting a significant logistical challenge. Having many organisations and resources involved will challenge the coordination of teams and communication across FRS. During these types of events, it will also be difficult for the FRS to get an overview of the situation.

Regarding the capabilities needed, a high reliance on “big machines” such as helicopters and planes were mentioned, both for creating an overview of the problems but also handle logistical challenges of blocked roads etc. Early warning systems are a necessity but come with challenges for development for a large geographic area.

Information technology has a central role in the recommendations for addressing this cluster of problems especially when it comes to planning and distributing resources. Looking into the fields of humanitarian logistics or

military logistics could be a source of possible solutions. Drone technology can be further utilized for acquiring an improved overview of an operation area when it is challenging to get the full picture from the ground. Connected to this, literature on distributed decision-making/problem-solving could be useful. Connected to the need for achieving an overview and sharing that overview, a suggestion was to look into literature for situation awareness and common operational pictures.

The development of individuals' communication skills is also considered important for involved persons/firefighters to explain the situation as accurate as possible. Also, setting up experiments to test different ways to present information could be a way forward.

4) Information problems

This category refers to issues related to sorting and validating information, the quality of information, the lack of information and cases of information overload. AI machines and IT systems and software were suggested as possible solutions. There is however a common confusion between AI and IT that ought to be clarified. Information technology is limited to the transmission and manipulation of data while AI can enhance IT operations by learning and adapting. IT can assist in the collection and presentation of data. Systematic collection and analysis of data can be used as an input for AI to perform analysis of big data-related problems and generate pathways for decision making based on the input data but also for the validation of data. At the same time AI can enhance data security.

However, using AI would require increased knowledge and training. Also, acknowledging and addressing the ethical implications connected to decision-making by systems should be considered, such as the morality of decision-making through AI. As a result, further education is required on information handling.

Furthermore, what was pointed out was that an overreliance on IT and AI could become a problem itself and alternative analogue means cannot be discarded, especially in the case of loss of critical communication channels. This is something that has been mentioned in FIRE21 cases. It was further suggested to look into research in the fields of information handling and AI. The opportunity to introduce experiments to develop systems/AI tools was also described to improve the level of evidence on what works or not.

5) Antagonistic threats

This problem cluster refers to events such as war, and cyber or terrorist attacks and the problems related to these highly disruptive events. A main recommendation for dealing with these challenges is acquiring more

knowledge about the nature of such antagonistic threats. Furthermore, what was suggested was a better knowledge and overview of the actors involved with a necessity of developing capabilities for grasping and conceptualising such threats. This knowledge can then better inform the development of more relevant education for the FRS.

The issue of secrecy between actors is mentioned as a problem, where information will be more difficult to share and obtain, which will lead to difficulties in achieving a collective understanding of the problems at hand.

Other participants focused on the threats of riots and aggressive behaviour towards the FRS, suggesting that further collaboration with the Police is needed. In addition, information exchange between involved response actors and training are described as crucial for being able to handle these problems. Here, FRS in Sweden and Norway are already developing processes/strategies and training for their role in "pågående dödligt våld" (PDV/PLIVO).

6) Technological challenges

The cluster of technological challenges was one of the most discussed clusters of problems related to the FRS. Here, the main discussion revolved around the fact that technological solutions can be seen as both benefits and the cause of sub-problems or vulnerabilities. For example, drones and IT/AI can be used to improve the handling of FRS problems, as mentioned in other clusters. On the other hand, technological solutions can create challenges to the FRS, either by technological aids not functioning or caused by the technology itself. There is a possible overreliance on technological means and vulnerabilities related to disruption where FRS would have to rely on more analogue means. This means that capabilities to handle problems without technology could be important in the future. Such capabilities could be gained by training of such circumstances, learn analogue or "low-tech" tools.

A concrete example mentioned was an increasing variety in technological solutions in new buildings. Here, it could be that a building's doors and windows are controlled by technology and are difficult to override, resulting in difficulties of entering the building. A solution to this could be to introduce a "fire mode" where doors would be unlocked, windows closed etc.

Another concrete issue is to have knowledge about cell phone coverage, which has been brought forward in the project's interview study. In Norway, there is already ongoing work in improving coverage maps.

Improving digital competence was also a recommendation for addressing technological challenges. Digital competence is vital and can be defined as involving the "*confident, critical and responsible use of, and engagement with,*

digital technologies for learning, at work, and for participation in society. It is defined as a combination of knowledge, skills, and attitudes." (Council Recommendation on Key Competences for Life- long Learning, 2018). A more comprehensive framework for analysing digital competence provided by the EU Science Hub distinguishes five components as seen in Figure 1. These are: Problem Solving, Information and Data Literacy, Communication and Collaboration, Digital content creation and safety. The below framework can be used as part of the recommendations for addressing technology-related problems.

Figure 3: A framework for digital competence. source: EU Science Hub

7) Structural problems

The category structural problems was the problem cluster with the largest amount of input by the workshop participants and several problem themes were distinguished. The structural problems can be divided into material/physical and immaterial/non-physical.

Beginning with the physical structural problems, participants brought up the dense urban fabric of populated places as a significant obstacle for FRS, as trucks and other heavy machinery are difficult to manoeuvre here, with lack of information and training being significant sub-problems. One recommendation that was provided for this was the closer cooperation between FRS and city planning departments.

Building Information Modelling (BIM) and accessibility to related software in operations was suggested as a means to address the challenge of the variety of materials and response needs in an urban context. The accessibility to such software was mentioned in regard to translating what the models mean in a fire context and to educate FRS in how to use such modelling systems and their information.

When it comes to immaterial structural problems, the co-location of response actors such as Fire Departments, the Police, or health-related respondents was discussed. This comes with opportunities for rapid action and perhaps improved coordination but also creates vulnerabilities in case of antagonistic threats, making FRS an easy target.

Professionalisation/specialisation of firefighters was also described as a potential problem. For example, the general curriculum in Norway is described as now focusing more on theory and less on practical knowledge. Here, professionalising/specialising the FRS could lead to less practical, varied, knowledge, potentially making the FRS more vulnerable. More practice-oriented education was a suggestion. It was specifically mentioned that FRS ought to be able to respond to difficult situations and thus practical education and the development of skills is important. However, acknowledging that it is not logistically easy, and it is time-consuming, to practice for every scenario, so a prioritisation of key scenarios should be made.

Centralisation/standardisation of organisational structures was also described as a potential problem (something already ongoing in Norway and Sweden). On the one hand standardisation might be beneficial to organisational challenges of the FRS but on the other, it might impact unique competences and other important elements such as motivation and trust. What was proposed as a recommendation for the latter is the careful and bottom-up oriented approach to structural changes. When it comes to merging of FRS into greater networks/clusters, performing a practice-informed SWOT analysis was suggested.

8) <u>Working under “disturbed” conditions</u>

This final problem cluster, which can also be part of several others, was created to describe operations under conditions of disruption, such as lack of electricity (due to antagonistic threats or hazards such as storms). This is a concern that is related to the problem of overreliance to big infrastructure and technological systems, as well as communicating through cell phones or radio. A main recommendation to address this was enhancing the ability to operate “low tech” or through more analogue means of communication. More specifically, two main recommendations were given: To begin with, introducing nodes of experts or volunteers who can operate low tech (an example was morse code) and educating parts of the FRS on analogue or more “low tech” communication means, although this as pointed out would require significant resources and come with considerable time constraints.

Summary of recommendations

Table 1 below summarises the recommendations, per problem cluster. Also, a potential organisation that could develop the recommendation is suggested, where found relevant.

Table 1. Summary of project recommendations.

Problem cluster	**Recommendations**	**Potential organisation to develop recommendations**
Understanding, identifying, solving problems	Developing taxonomies, validate/test with FRS. Develop checklists to be used in emergency call centres, e.g. on which actors to involve.	Research institution in collaboration with FRS FRS
Managing tunnel fires	Use the toll system to monitor type of fuel and cargo entering the tunnel.	
Geographic scope	Develop information technology for early warning systems, and for planning/distributing resources Use drone technology for overview. Look into literature on distributed decision-making/problem-solving, situation awareness, common operational pictures. Develop individuals' communication skills. Test different ways to present information.	Research institutions, private companies, agencies, FRS FRS Research institution in collaboration with FRS FRS Research institutions
Information problems	Look into IT tools/systems for collecting and presenting data, and AI tools for analysing data. Include education on ethical aspects of using such tools. Develop alternative analogue means for data handling.	Research institution in collaboration with FRS FRS in collaboration with volunteers/amateur radio groups
Antagonistic threats	Acquire knowledge of antagonistic threats. Develop capabilities for grasping and conceptualising antagonistic threats. Increased collaboration with the Police.	FRS, assisted by research institution and/or security agencies Research institution in collaboration with FRS FRS
Technological challenges	Increase knowledge and training on analogue or "low-tech" communication tools. Introduce "fire mode" in buildings to unlock doors, windows in case of fires.	FRS in collaboration with volunteers/amateur radio groups

	Have knowledge of cell phone coverage. Improve digital competence.	FRS FRS
Structural problems	Closer cooperation between the FRS and city planning departments. Accessibility to building Information Modelling (BIM) and related software in operations. Co-location of response actors. More practice-oriented education for the FRS. Train for key scenarios. Use careful and bottom-up-oriented approach to structural changes. Use a practice-informed SWOT analysis for investigating effects of structural changes.	FRS and city planning departments FRS and local authorities Relevant response actors FRS FRS National emergency management agencies (DSB, DEMA, MSB)
Working under "disturbed" conditions	Increase FRS knowledge and training on analogue or "low-tech" communication tools. Introduce nodes of experts/volunteers who can operate "low-tech" communication tools.	FRS in collaboration with volunteers/amateur radio groups FRS in collaboration with volunteers/amateur radio groups

Main Outcomes (prevalent themes)

This section of the report aims to uncover main themes that emerged from the discussions in the first two parts of the workshop and especially through the second part regarding the clustering of problems and the recommendations provided. The discussion led to the emergence of four main themes:

1) <u>Same typology of solutions for different problems</u>

   Several typologies of recommendations or solutions were proposed to address problems of different nature. This does not mean that these solutions can be seen as panacea for dealing with challenging issues, however, they seem to hold potential for FRS problem-solving.

   IT solutions were a common typology of recommendations that dominated the discussion in the second part of the workshop. IT oriented solutions were brought up frequently and aimed to address different problem clusters such as technological challenges, information challenges, problems related to the geographical scope of events and managing tunnel fires. Education and training were also a common recommendation for different problem clusters, such as

structural problems, working under disturbed conditions, technological challenges, and antagonistic threats. Knowledge enhancement is seen to present with a valuable key to unlocking problem-solving potential of FRSs.

2) Solutions create sub-problems

An interesting outcome of the discussion during the second part of the workshop concerned the generation of sub-problems because of proposed solutions, creating a complex problem-solving landscape. More specifically, IT solutions became a prevalent recommendation for various types of problems. However, the overreliance on IT solutions can itself be seen as a source of problems, such as vulnerabilities in relation to antagonistic threats or in disturbed conditions such as the lack of electricity or network coverage. On the other hand, training for more "low tech" means can generate resource-related problems.

Recommendations for "Structural problems" also tended to create a variety of sub-problems. Co-locating FRS and partner organisations could be efficient when it comes to coordination and collaboration, however, also comes with various vulnerability related to the concentration of critical resources and personnel in case of antagonistic threats.

To visualise such sub-problems, Figure 4 illustrates this with the example of fires. The concept of this "hierarchy of problems" is important to keep in mind in problem-solving activities when trying to come up with solutions for a primary problem and the sub-problems that might be created as an outcome of solutions to that problem or to the solutions to sub-problems.

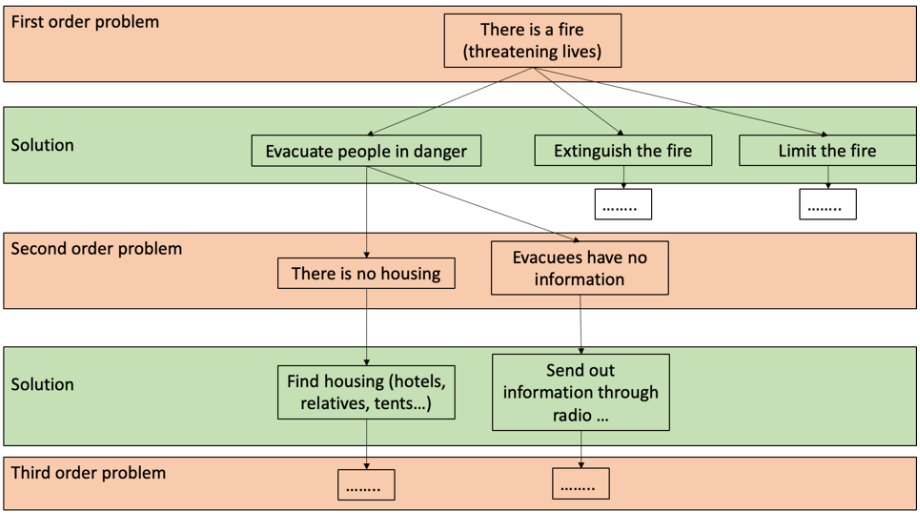

Figure 4: The hierarchy of problems and the generation of sub-problems and solutions.

3) Conceptual skills vs technical skills

A common debate in both the risk management and response management landscape is the need to develop conceptual skills vs the need to develop more technical skills. There are various reasons why both kinds of skills ought to be developed in a balanced manner, as both are interconnected. Conceptual skills are necessary to address the problem cluster of “Understanding, identifying and solving problems”, but also to be able to visualise and understand problems related to the cluster of "Geographical scope". Problems that the FRS need to handle are often complex and a basic contributor to complexity is ambiguity. Here, conceptual skills are of great significance to be able to understand and define a problem in the first place.

Technical skills are at the same time necessary to implement solutions. This type of knowledge is prevalent in the recommendations for different clusters, in relation to the need to enhance education.

4) Methodologies for clustering

There is no right or wrong way for clustering problems and recommendations. However, clustering can be useful to navigate the complex landscape of problem solving for FRSs in the 21st century. In the present workshop the clustering of problems and recommendations became a more spontaneous process without following a specific methodology as the aim was to think broadly. As a result, some of the clusters created were broad while others very specific.

A useful way of clustering recommendations from FIRE21 can be to look at the below framework (to be translated in English). Developed in MSB's development project concerning the Swedish policy for multi-actor management of emergencies and disasters, this framework shows different development outputs. It consists of four levels, each with different outputs. The conceptual basis and ways of thinking (förhållningssätt) should be at the basis for developing methods and/or more specific checklists, and all development should be made with certain prerequisites (utgångspunkter) in mind, such as legislation or specific responsibilities. This kind of framework can be scalable and adaptable to problem-solving processes.

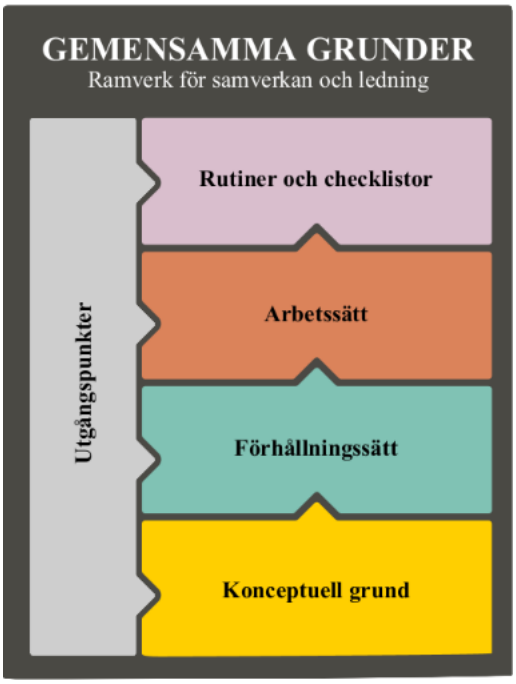

Figure 5: One way to cluster recommendations, according to the framework for development output for the Swedish policy for multi-actor management of emergencies and disasters (Figure from MSB)

Although the above framework is not specifically designed for problem-solving, it provides a starting point on how to think about recommendations from FIRE21. Here, recommendations can be described in a similar way as the abovementioned outputs. For example, the conceptual foundation for problem-solving that is described in the project or a taxonomy for clustering problems are found in the conceptual basis. From these, methods and checklists for, among else, working with the understanding, identifying and solving of problems can be developed.

Prioritising recommendations

This part of the report summarises the prioritisation of recommendations provided by two participants after the completion of the workshop. The prioritised recommendations were centred around the importance of information related parameters and the technological potentials for improving various aspects of FRS practices and associated challenges.

One prioritised recommendation was the efficient sorting and validation of information as it is of outmost importance for the FRS to have knowledge of the quality of information, cases of lack of information and to prevent and address information overload. As mentioned, information is vital for improving how we identify, understand, and solve problems. Without any information, it is not possible to solve problems. IT and AI developments are useful for assisting in decision-making; however, all these applications depend on different sources of information and thus validation and filtering is important to prevent misinformation or conflicting information.

Therefore, knowing the type of information is of importance. At the same time, conceptual materials can be developed to improve individual problem-solving skills.

A more specific recommendation that was prioritised, again technology-oriented, was the suggestion for the wider use of drones as a standardised equipment for FRS. FRS personnel can be further trained in the use of drones and in analysing data and imagery.

Another prioritised recommendation is more training on "low tech" means of communication. As pointed out, new technologies do allow for richer and more comprehensive data transfer, however, they are also more dependent on functioning power grid and satellite systems. However, satellite systems and power grids can both be subject to failure and when this worst-case scenario occurs, there needs to be a backup solution in place. Back up tech-systems can be a solution; however, they are also faced with the same threats during for instance an antagonistic event such as war. Analogue communication back-up alternatives and the relevant skill development can provide with a safer means of communicating during the worst-case failure scenario.

Developing actor maps was also a prioritised suggestion. The changing risk picture and the operational differences between urban and rural areas imply a difference in the way FRS respond to different types of incidents. An interactive actor map can help navigate a complex landscape of actors involved and the relevant responsibilities and tasks during an incident.

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