RISK AND RESILIENCE REPORT

Trend Analysis Civil Protection 2035
Uncertainties, Challenges and Opportunities

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1. Executive Summary

1.1 Objective

This report is the third reiteration in an ongoing series dedicated to identifying and examining evolving trends relevant for civil protection. It offers an overview of relevant trends that are expected to have a substantial impact on Switzerland and its civil protection system over the next five to ten years. The report is part of the Federal Office of Civil Protection's (FOCP) initiative to strengthen horizon scanning capabilities in the field of civil protection, which is a dynamic field that requires continuous adjustment. It underscores the importance of early detection and assessment of emerging challenges and opportunities, particularly for policymakers and other stakeholders.

The primary objective of this report is to provide a solid basis for adapting and enhancing civil protection strategies on the three levels of government (federal, cantonal, communal). It aims to be a valuable tool to identify key areas for investment, improvement, and strategic prioritization. Additionally, this report supplements the existing research done by the FOCP, in particular the National Risk Analysis process.[1]

The methodology used for this report has been instrumental in bringing together relevant stakeholders from across the entire spectrum of the Swiss civil protection system. It offered an opportunity to gather insights from practitioners at the communal and cantonal level through to federal authorities involved in strategic civil protection planning. This collaboration is key to developing a cohesive and evidence-based approach to civil protection and it ensures that Switzerland stays ahead in terms of effective risk management and opportunity harvesting. The authors would like to express their gratitude to the participants of the workshop and survey for their valuable contributions to this report.

1.2 Structure and Methodology

The report is structured in two closely linked parts. The first part is a systematic analysis of 12 selected trends, focusing on the uncertainties, challenges, opportunities, and potential policy implications for the Swiss civil protection system. The second part examines the implications of these trends on civil protection, viewed through the lenses of *Impact, Adaptability,* and *Knowledge*.

The evaluation of trends in this report is inspired by the Delphi method, an anticipatory method that leverages panels of experts to generate insights in areas with limited information, or to anticipate future scenarios and better prepare for change. The strength of the Delphi method for this report lies in the comprehensive examination of the civil protection system, in which the knowledge from a variety of experts is compiled and then reflected in the conclusions. The method is structured into a four-step process, as detailed in Figure 1, and based on techniques successfully used in previous editions of this series.

Step 1 consisted of extensive desktop research in order to obtain up-to-date knowledge about developments and future trends in the field of civil protection. This phase involved examining previous trend reports, academic studies, and recent changes in the Swiss civil protection system. At the end of this phase, 12 key trends were selected for further examination. The authors conducted a comprehensive analysis of these trends, focusing on four key aspects: uncertainties, challenges, opportunities, and policy implications. When examining the challenges and opportunities, these were evaluated based on their impact on civil protection in all stages of disaster risk management, in accordance with the Integrated Risk Management Cycle used by the FOCP.[2]

In Step 2, the objective was to collect expert opinions on the 12 trends in terms of *Impact, Adaptability,* and *Knowledge* from three key expert groups: (1) representatives from the FOCP and the wider federal administration, (2) representatives from cantonal civil protection authorities, and (3) professionals from the private sector and academia. Participants were given a survey, in which they were asked to rank the trends in the three dimensions of *Impact, Adaptability* and *Knowledge* in order of importance from 1 to 12, with one being the most important and twelve the least important. A definition of these three dimensions is given in Substitute with: in Chapter 4. In the subsequent analysis of the results, qualitative insights were combined with descriptive statistics such as mode and average.

In Step 3, an expert workshop was convened on September 27 2023 to discuss the trends and review the aggregated survey results. The workshop began with an overview of the individual trends to ensure a common understanding. The experts then discussed potential challenges and opportunities associated with the trends and evaluated their impact on the Swiss civil protection system. An important aim of the discussion was to identify ongoing projects, best practices, and flagship initiatives in Switzerland relevant for each trend.

Step 4 involved revisiting the potential uncertainties, challenges, opportunities, and policy implications of each trend, informed by the outcomes of Step 3. The authors collected expert opinions and integrated them into the report to create a thorough and reliable analysis of the trends and their relevance for the Swiss civil protection system. The results of this process are presented in this report.

Figure 1 Methodology of the study

Step 1

Prepare

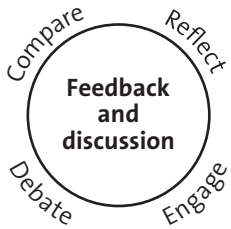
- Desk research
- Review of previous reports
- Identification of changes and selection of 12 relevant trends to be investigated
- Composition of a questionnaire to collect stakeholder opinions

Step 2

Conduct

- Ranking of trends by mean of importance score
- Collection of answers, summary of qualitative comments, performance of descriptive statistics
- Trend summary in the domains Uncertainties, Challenges, Opportunities and Policy Implications
- Expert selection for Step 3

Step 3



- Discussion and assessment of the selected trends
- Perspective sharing and discussion of ongoing projects, best practices, and flagship initiatives
- Presentation of responses in Step 2 and reflection on results

Step 4

Trend Analysis

- Revise Step 2 conclusions based on group feedback and discussion in Step 3
- Illustrate the results in the form of a report and derive overarching findings

1.3 Results

This report examines 12 trends that are relevant to the Swiss civil protection system. These trends impact various aspects of the system, resulting in a wide range of possible actions for affected institutions. In many cases, the ability to directly influence these trends is limited, which underlines the need for their early detection. Foresight and horizon scanning exercises are vital and should consider scenarios that cover all stages of disaster risk management. To this end, it is not always necessary to develop new methods, but existing tools, such as the Integrated Risk Management Cycle, can be used effectively to identify both challenges and opportunities arising from the respective trends.

The report outlines five strategic areas for strengthening the resilience of the civil protection system. First, civil protection should go beyond the role of a mere emergency response service that it has played in recent decades. It has the potential to transform into a versatile and well-coordinated platform that involves a variety of different actors, including spontaneous volunteers. It can become a comprehensive system that not only supports collaboration between different actors, but also promotes solidarity and provides additional benefits to society.

Second, the interconnected and multidimensional nature of the trends discussed in this report show that the Swiss civil protection system needs to evolve to cope with the complex disasters and emergencies in the future. This evolution requires the integration of people with a wide variety of expertise, spanning from technological to social disciplines. Another important aspect is the institutionalization of knowledge exchange between all civil protection stakeholders to effectively manage the complexity of current and future disasters and emergencies.

Third, in situations where resources are limited or investments in new assets are substantial, pooling resources through international platforms, either multilaterally or bilaterally, becomes crucial. Such an approach not only helps to manage resources efficiently, but can also improve cooperation in cross-border crises. At the same time, there should be a strong focus on promoting individual preparedness and involvement. Continuous individual and community involvement emphasizes personal responsibility and collective action within the framework of civil protection strategies.

Fourth, navigating the ever-growing technological landscape requires sound legislation and regulation to ensure its safe and responsible use while encouraging innovation. Such legal frameworks would strengthen the confidence of civil protection authorities and the general public in technological solutions and provide efficient tools for crisis management. Effective policy frameworks should also include the training of civil protection personnel and promote the exchange of knowledge.

Lastly, for civil protection to truly evolve and achieve these ambitious goals, support at all levels of government is essential. Political will is needed to legitimize and prioritize civil protection initiatives, especially in the face of competing national interests and budgetary constraints. Persistent political advocacy facilitates the development and implementation of effective policies, regulations, and strategies to meet the evolving requirements of civil protection.

2 Introduction

2.1 Civil Protection in Switzerland

Swiss civil protection is an integrated system designed to protect the population and their livelihoods in the event of major incidents, disasters, emergencies and armed conflicts, to contribute to limiting and coping with incidents and to take appropriate precautionary measures.[3] The system brings together five main partner organizations: police, fire service, healthcare, technical services, civil defense *(Zivilschutz).* Responsibility for these organizations lies with the 26 cantons, each of which operates in its own municipal, regional, and cantonal area of responsibility. The cantons are responsible for the training, management, and leadership of civil protection activities and ensure that responses are carried out in a timely and appropriate manner. They oversee the deployment of the partner organization within the framework of civil protection and manage intercantonal cooperation. At the federal level, the Federal Office for Civil Protection (FOCP) plays a coordinative and supportive role, assisting the cantons, municipalities, and partner organizations in their civil protection duties. The FOCP may take on the responsibility for coordinating and managing incidents that impact multiple cantons, the entire country, and neighboring countries. It is in charge for the systems for warning, alerting, and informing the authorities and the population in the event of imminent dangers and incidents.

The operational scope of Swiss civil protection is expected to expand in the coming years. This expansion is being driven by the increasing frequency and severity of extreme weather events associated with climate change, as well as societal and technological shifts that bring new risks that could jeopardize the security of Swiss society. The FOCP's *National Risk Analysis of Disasters and Emergencies in Switzerland* serves as guideline for strategic civil protection measures over the next decade.[4] It forms the cornerstone for proactive planning and event preparedness at all levels of government. The hazard catalogue provides a comprehensive list of hazards relevant for civil protection to which Switzerland is exposed, including those that could have serious consequences for the country.[5] Due to the increasing complexity of crises and the influence of trends outlined in this report, it is likely that the catalog will evolve to include emerging threats beyond Switzerland's historical risk profile.

The role of Swiss civil protection authorities is also evolving and going to extend beyond traditional disaster response and reconstruction related to natural hazards. The *2021 Swiss Security Policy Report*[6] and the 2022 *Supplementary Report*[7] highlight the need to safeguard critical infrastructure and address historical maintenance issues. In 2023, the Federal Council approved the updated *National Strategy for Critical Infrastructure Protection*[8] (CIP). The strategy lays the foundation for future efforts to improve national resilience with regard to critical infrastructure by implementing eight measures. The FOCP has committed to periodically reviewing this strategy to ensure it remains in line with the evolving security landscape.

Technological advancement is expected to modernize Swiss Civil Protection, for example with the integration of new communication systems. The current POLYCOM secure radio network for rescue and security authorities and organizations, which serves more than 55,000 users, is set to be replaced by a more advanced, secured and broadband mobile system by 2035. The new System for the Secure Exchange of Data is to be gradually introduced from 2027 and will fill gaps in broadband telecommunication systems in the event of technical failures, cyberattacks, or natural and human-caused disasters. These two communication channels will form the basis for the organization of civil protection and offer new possibilities for future developments.

The potential participation of Switzerland in the EU Civil Protection Mechanism (UCPM) promises to enhance the effectiveness of the Swiss civil protection system. This collaboration could facilitate mutual assistance among member and participating states in crisis situations by leveraging the transnational expertise, networks, and resources of the UCPM. Such a partnership would significantly support cantonal and federal authorities in their efforts to prepare for, respond to, and adapt to the future risk landscape.

Increased cross-sector collaboration will become ever more important in Switzerland. Greater cooperation between federal, cantonal, and municipal authorities has proven crucial for efficient crisis management in various scenarios. The COVID-19 pandemic has demonstrated how important cooperation is for a unified response to complex crisis situations. To facilitate this increased cooperation, clearly defined roles, responsibilities, and competencies are expected for both the Confederation and the cantons, particularly in case of intercantonal or transnational crises. The reform of national crisis management structures in the wake of the pandemic will create clarity in this area, which must then be put into practice in the event of a crisis. Planned regular exercises should also help to cultivate and reinforce collaboration between the Confederation, cantons, and municipalities. The integration of more scientific advice and expertise from outside the federal administration, including academic institutions and private sector entities, is expected to enhance the capabilities of federal crisis management. In situations where specialized resources are needed or are stretched, the military can be called upon more to supplement cantonal efforts, requiring continuous coordination among the different levels of authority to manage and allocate resources appropriately.

The new State Secretariat for Security Policy (SEPOS) in the Federal Department of Defense, Civil Protection and Sport will begin its work in 2024 and, among other things, strengthen the civil sector in security policy. SEPOS is intended to promote strategic leadership, particularly in times of crisis, and ensure a comprehensive and integrated approach to national security policy.

2.2 Trend Definition and Selection

In line with the two previous editions of this series, the term *trend* in this analysis refers to a significant and influential development of social, environmental, or technological nature that will affect the Swiss civil protection system in the coming years. These developments can already be observed today, but their impact on civil protection in terms of challenges and opportunities is likely to increase over the next five to ten years.

While there are numerous trends that can impact civil protection, this report focused on 12 key trends. These trends were selected based on comprehensive desktop research, consultations with FOCP experts, and review of previous reports, as outlined in Section 1.2. This approach ensures that the identified trends reflect the latest developments and shifts in the Swiss civil protection landscape.

The report covers trends in three interlinked domains: social, environmental, and technological. Each domain influences and is influenced by the other two. For example, effective adaptation to climate change not only requires technological innovations, but also involves significant social considerations. Taken together, the trends from these three domains have the potential to decisively shape the strategies, tasks, and objectives of civil protection in the coming years.

The report contains a mix of immediate and gradually emerging trends to provide a comprehensive spectrum of relevant issues. The analysis by the authors does not distinguish between trends and mega-trends, nor are the trends ranked in terms of importance. Instead, the focus of the analysis is on exploring broader patterns associated with these trends, with the aim of providing insights that can help inform decision-making. These broader patterns are categorized into four areas: *Uncertainties, Challenges, Opportunities,* and *Policy Implications*.

Uncertainties describe unpredictable elements that can alter the course of a trend and lead to unexpected outcomes or deviations. The challenges and opportunities arising from these trends result from various developments, innovations, and interactions. They were identified through desktop research and stakeholder engagement. Although the challenges and opportunities listed are not exhaustive, they are likely to have a significant impact on civil protection and should therefore be considered. Where possible, they were analyzed using the Integrated Risk Management Cycle tool, as described in Section 1.2. The policy implications were also derived from desktop research and stakeholder engagement. They offer key insights into how the findings of this report can inform and influence decision-making in the field of civil protection. The degree of uncertainty and expected outcomes associated with each trend can vary significantly. However, taking a comprehensive approach that takes into account the four patters *Uncertainties, Challenges, Opportunities,* and *Policy Implications* ensures that each trend is assessed not only in its current context, but also in terms of its potential future trajectory and impact.

Compared to the previous two reports in this series, the trends featured in this edition have undergone some evolution, reflecting not only the evolving landscape of civil protection in Switzerland, but also broader environmental, societal, and technological changes, as

Figure 2 Changes in selected trends compared to the previous reports

Trend Analysis Civil Protection 2025	Trend Analysis Civil Protection 2030	Trend Analysis Civil Protection 2035
Climate Change	Climate Change	Climate Change Adaptation
Metropolization	Urbanization and Metropolization	Urbanization and Metropolization
Demographic Change	Changing Demographics and Social Norms	Social and Demographic Changes
Changes in Norms and Values		
	Geopolitical Change	Geopolitical Polarization
Efficiency Pressures on Civil Protection Measures	Sharing Economy	Collaborative Approaches
New media	Social Media	Hyperconnectivity
Unmanned Systems	Unmanned Systems	Unmanned Systems and Autonomous Robotics
Big Data	Artificial Intelligence	Big Data and Artificial Intelligence
	Digitalization	Digitalization
	Convergent Technologies	Convergent Technologies
		Space-based Capabilities
Scarcity of raw materials		Growing Supply Dependency
Mobility	Mobility	
Privatization of Critical infrastructure	Governance of Critical Infrastructure	
Pandemics		

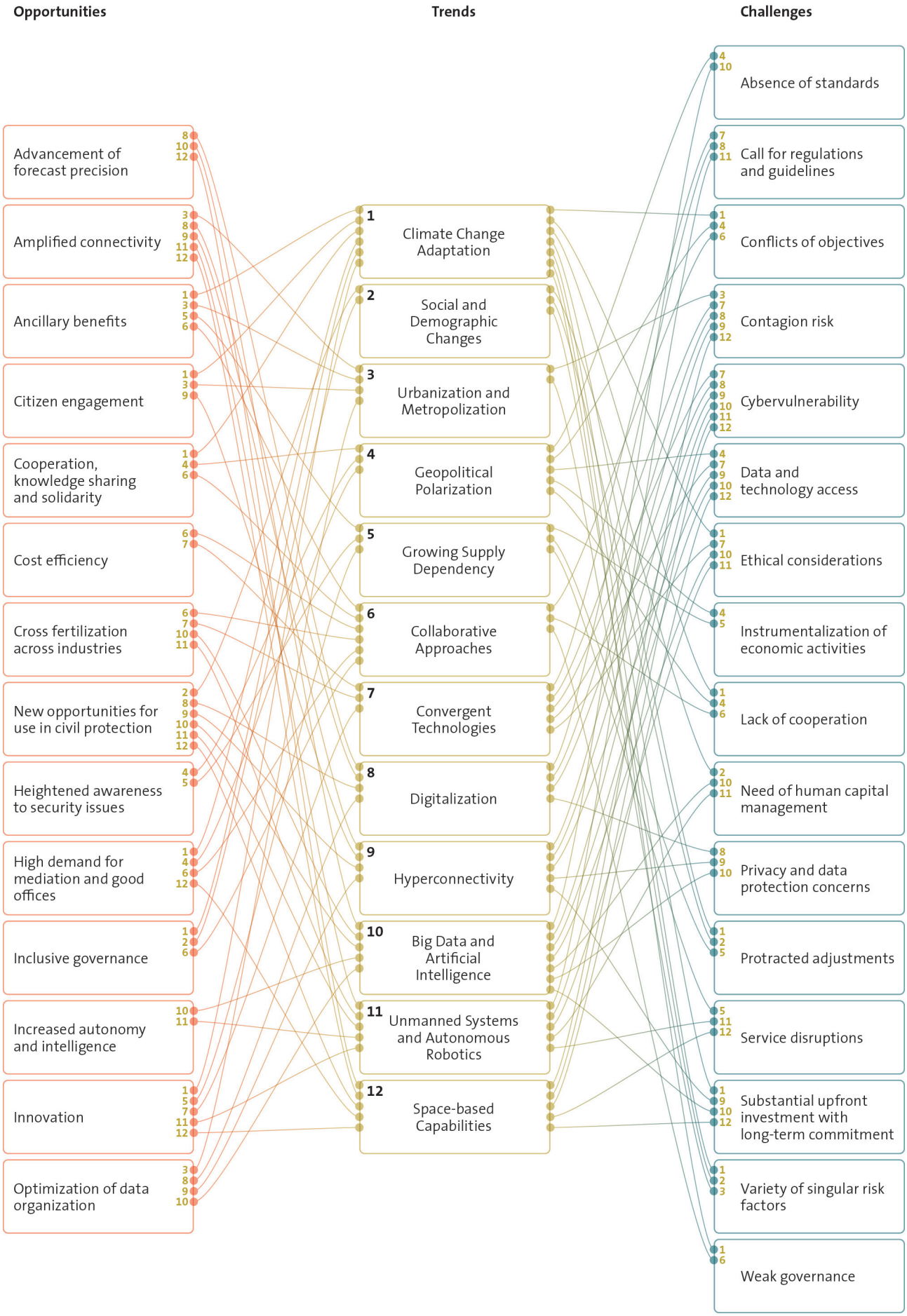
represented in Figure 2. Some trends were included in all three reports, such as Unmanned Systems. Others, like Digitalization and Convergent Technologies, were introduced in the second edition and continue to be relevant. Several trends have undergone significant changes and evolved or expanded to align more closely with current developments. For instance, Climate Change has evolved into Climate Change Adaptation. Similarly, Changes in Norms and Values and Demographic Change in the first report have been combined to Changing Demographics and Social Norms in the second and third report. Geopolitical Change in the second report evolved into Geopolitical Polarization in the current edition. Big Data in the first report and Artificial Intelligence in the second report were combined in the third report. New Media in the first edition, and Social Media in the second edition have been subsumed under the broader concept of Hyperconnectivity in the current report. Efficiency Pressures on Civil Protection Measures in the first edition transformed into Sharing Economy in the second edition and is included in this report as Collaborative Approaches.

Some trends have been excluded, as each edition only considers 12 trends. For example, Governance of Critical Infrastructure and Mobility are not featured in the current report. Their relevance has decreased comparatively, but this does not mean that they no longer have any impact. Some new trends have also been identified from report to report, such as Space-Based Capabilities in the current edition. These adjustments underline the dynamic nature of civil protection and reflect the need to periodically adapt to changing circumstances and new challenges.

In line with the findings of previous editions, this report underscores that all identified trends are interconnected, with each influencing and being influenced by the others. To illustrate these interconnections, the authors analyzed the challenges and opportunities associated with each trend and compared them to show how they intertwine and connect the trends. The outcome of is represented in Figure 3.

In terms of challenges, *Data and technology access* is the most interconnecting issue and is central to most of the trends in the technological sphere. Essentially, any prospective development or application of technologies in civil protection associated with these trends will be significantly hampered if access to data or innovation is either compromised or not well established. Another interconnecting issue is *Cybervulnerability,* which

Figure 3 Interconnections between trends



affects trends such as Unmanned Systems and Autonomous Robotics, Hyperconnectivity, Digitalization, Space-based Capabilities, and Big Data and Artificial Intelligence.

In terms of opportunities, *New opportunities for use in civil protection* emerges as the most interconnecting feature, particularly evident in trends like Unmanned Systems and Autonomous Robotics, Hyperconnectivity, Digitalization, Social and Demographic Changes, Space-based Capabilities, Big Data and Artificial Intelligence. This outcome is unsurprising, as these trends provide novel opportunities for Swiss civil protection to enhance its preparedness. These trends encompass opportunities that include both technological innovations and human qualities, applicable across all phases of the Integrated Risk Management Cycle.

Another strong interconnectivity that emerged is *Innovation,* found in trends such as Climate Change Adaptation, Growing Supply Dependency, Convergent Technologies, Space-based Capabilities, and Unmanned Systems and Autonomous Robotics. There are multiple areas in which these trends are offering innovative solutions designed to complement existing disaster risk reduction operations.

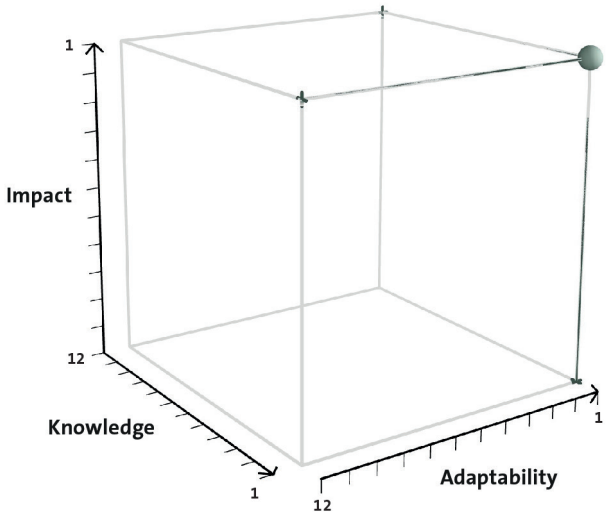
2.3 Report Structure

This introductory chapter is followed in Chapter 3 by a detailed analysis of 12 key trends that will have an impact on the Swiss civil protection system. The methodical analysis of each trend follows a consistent structure. It begins with an overview of the assessment of each trend by the experts surveyed in the dimensions Impact, Adaptability, and Knowledge. The ratings reflect the most frequently assigned values by the experts and are based on the stakeholder evaluations outlined in Section 1.2 of this report. General background information is then provided to ensure a common understanding and the uncertainties associated with each trend are highlighted. Next, potential challenges and opportunities for each trend are examined and their potential policy implications for the Swiss civil protection system are discussed. In Chapter 4, the findings from the stakeholder survey are presented and analyzed, and the perception of the trends by the stakeholders is summarized. The report concludes with Chapter 5, which covers topics that emerged across several trends, and are therefore particularly relevant for the future development and strategic adaptation of the Swiss civil protection system.

3 Trends

3.1 Climate Change Adaptation

Impact: **1**, Adaptability: **1**, Knowledge: **1**



3.1.1 Introduction

Climate change adaptation involves taking various measures and strategies across ecological, social, and economic domains to prepare for and adjust to the present and expected impacts of climate change. This process requires changing practices, processes, and infrastructures to reduce potential challenges and take advantage of opportunities that arise from climate-related changes. The nature of adaptation actions and strategies varies widely, tailored to the specific needs and circumstances of individual communities, businesses, organizations, or entire regions. Adaptation is a critical component of long-term global resilience against climate change, which is important for the protection of people, livelihoods, and ecosystems.

In Switzerland, the progress of cantonal efforts on climate change adaptation varies significantly.[9] Some cantons have pushed ahead with the practical implementation of measures and are actively engaging their municipalities, while others are in the strategy development phase, evaluating the need for action, or have yet to initiate any substantial efforts.[10] Following the adoption of the *Action Plan 2020–2025*[11] by the Federal Council, a renewed action plan for climate change adaptation is anticipated. In alignment with the Paris Agreement, Switzerland is committed to cutting its annual greenhouse gas (GHG) emissions by at least 50 per cent from 1990 levels by the year 2030, a target set independently of demographic or economic growth. The *Long-Term Climate Strategy*[12] sets the net zero emissions target for 2050.

3.1.2 Uncertainties

It is well established that human activities have led to an increase of more than 1°C in the Earth's climate since the late 19th century, and that the effects of climate change will continue to severely impact both the environment and social systems.[13] However, predicting the exact nature and extent of these impacts is challenging due to the complexity and cascading effects of climate-related changes. This leads to considerable uncertainties in the development of effective adaptation strategies.

For example, predicting the severity and duration of droughts and heatwaves is a challenging task that is subject to great uncertainty, even if these phenomena are expected to occur more frequently in certain regions. Such unpredictability can have direct consequences for water management, agriculture, and urban planning. Even as efforts are made to modify and re-engineer ecosystems to better cope with climate change through initiatives such as reforestation or the creation of artificial wetlands, their possible unintended environmental, social, and economic consequences remain largely unknown.

Adaptation measures play a pivotal role in building resilience, but it is worth noting that not all adaptation measures strengthen resilience equally.[14] Implementing large-scale and expensive adaptation projects can reduce response diversity, i.e., the number of effective options available to respond to a disaster. Additionally, increasing adaptability to a specific range of shocks may reduce overall resilience to new or unknown ones.

Describing and quantifying the uncertainties mentioned above holds significant weight in shaping decision-making. On the one hand, governments and institutions are the primary enablers of the climate change adaptation process. They can foster this process by implementing appropriate regulatory frameworks and collaborative strategies or hinder it by failing to enforce mandates and facilitate necessary change. On the other hand, how experts and policymakers communicate uncertainty about the effects of climate change can affect public trust and acceptance, which can determine the direction of adaptation efforts.

3.1.3 Challenges

There are multiple constraints that can significantly reduce the range of adaptation options and opportunities available to stakeholders and therefore fundamentally limit adaptation capacities.

- The options for adaptation to climate change can be limited by biological factors of humans, other species, and ecosystems. The biological characteristics of organisms determine their ability to cope with climatic stressors through acclimation, adaptation, or behavioral changes, as well as their ability to migrate to suitable regions. For species to fully develop their adaptation mechanisms, several generations must pass.

- The capacity of human and natural systems to adapt to a changing climate is linked to characteristics of the physical environment, including the climate itself. A variety of non-climatic physical factors also can constrain adaptation efforts of natural systems. This in turn influences the range of adaptation actions that can be effectively implemented to manage risk to water security and, subsequently, to agriculture and food security, and energy security. The 2023 planetary boundaries framework update finds that six of the nine boundaries are transgressed, suggesting that Earth is now well outside of the safe operating space for humanity.[15]

- The long-term and short-term economic trends can impact the ability of individuals and societies to adapt to climate change. The challenge lies in finding a balance between the immediate costs and the long-term benefits. Insurance can provide a buffer against the risks of climate change, but if it becomes too expensive and largely inaccessible, it may no longer be a viable adaptation tool. This creates an equity issue, as wealthier societies may have an advantage in adaptation, while less resource-rich communities are more vulnerable.

- Social and cultural factors can shape risk perception, influence which adaptation options are considered useful, and determine the distribution of vulnerability and adaptive capacity in society. Notably, the contribution of local or indigenous knowledge to understanding risk perception is often overlooked, and important aspects characterizing communities are not fully addressed. For example, there are certain elements that are unique to mountain communities, such as place attachment or the role of religion in determining risk perception, that are often neglected. Overlooking these aspects can hinder the successful implementation of climate adaptation strategies.[16]

3.1.4 Opportunities

There are various opportunities available for stakeholders in different regions and sectors to seize when planning and implementing adaptation strategies. In general, sustainable economic development is an overarching process that can support adaptation and represents a significant chance to reduce constraints and limitations on adaptation.

- Certain adaptation strategies can bring additional advantages or co-benefits by promoting sectors beyond the primary focus of reducing climate change

vulnerability. There is growing recognition that taking action to combat climate change can advance other policy goals as well. For example, halving GHG emissions would significantly reduce premature deaths caused by air pollution.[17]

- Prioritizing adaptation actions in vulnerable communities that are most affected by climate change can reduce social and economic inequalities. Additionally, involving local communities in the planning and implementation of adaptation measures can empower people and ensure that their needs are represented and addressed, promoting more inclusive governance.

- The need to adapt to the rapidly changing climatic conditions has prompted technological and social innovations to cope with rising temperatures, rising sea levels, and extreme weather events. This has led to advancements in various sectors, for example in agriculture, where drought-resistant crops[18] and efficient irrigation technologies are being developed, or in construction, where buildings are designed to be more energy-efficient and climate-resilient (see 3.3 Urbanization and Metropolization). In addition, adaptation to climate change can also lead to the creation of new economic opportunities and jobs.[19] As industries adjust to the changing climate, they can explore new markets, which creates economic incentives for entrepreneurs and businesses.

- Adaptation provides an opportunity for increased cooperation, knowledge sharing, and solidarity. Collective efforts (see 3.6 Collaborative Approaches) are essential for successful adaptation as they require a wide range of expertise, stakeholder engagement, and long-term planning. Useful collaboration for adaptation can occur within organizations such as small businesses and local municipalities, between administrations, and between associations and their stakeholders.

3.1.5 Policy Implications

The new Swiss climate change adaptation strategy must consider the need to act fast to implement climate adaptation strategies, focusing on local contexts and closing the gap between awareness and action. The development of local plans and collaboration with other countries to mitigate new challenges are essential in this regard.

Swiss municipal and cantonal authorities face an urgent need to develop and implement adaptation measures that mitigate the impact of climate-related disasters, taking into account the specific local context. An obstacle in this process lies in the time gap between the recognition of climatic trends and the implementation of appropriate adaptation strategies.[20] This gap is further widened by a lack of comprehensive assessments from civil protection bodies regarding the full implications of climate change on their operations. The urgency of climate change adaptation requires a streamlined process in which the recognition of risks is quickly followed by decisive action. This gap between awareness and response must be narrowed to ensure that local governments can safeguard communities against the accelerating pace of climate change.

Furthermore, the implementation of climate change adaptation strategies needs to move from a reactive to an anticipatory approach to avoid delays that can result in missed opportunities to strengthen the resilience of communities. The intersection of climate change adaptation and disaster risk reduction is most pronounced in the case of extreme weather events. Both require a focus on the entire integrated risk management cycle, including measures aimed at prevention, preparedness, and recovery.

Governance must ensure that adaptation efforts do not inadvertently accelerate the effects of climate change. For example, measures such as the widespread use of air conditioning, while providing immediate relief from heatwaves, may contribute to longer-term climatic challenges due to additional energy consumption. It is therefore crucial to follow the principle of sustainable adaptation that does not undermine the overall resilience of socio-ecological systems.

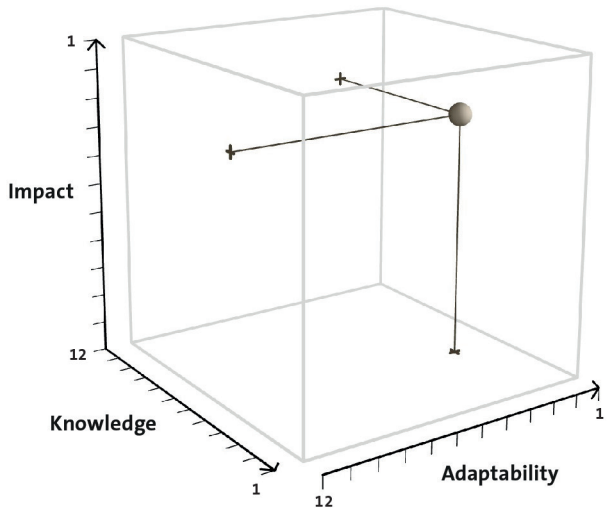
As global climate patterns shift, countries like Switzerland need to anticipate and prepare for unprecedented challenges that were previously outside a country's historical threat profile. One challenge that Swiss authorities have to address, for example, is the possibility that the warming of the North Atlantic waters could lead to hurricanes occurring more frequently in Western Europe.[21] Switzerland can draw on the experiences of other countries in improving preparedness for new natural hazards and improve local civil protection. To his end, robust international collaboration is essential for effective adaptation due to the global nature of climate change. Forming cross-border partnerships is not only beneficial for sharing best practices, but also for sharing financial resources and technological advancements that support the implementation, evaluation, and monitoring of adaptation plans.[22] All these considerations should be addressed by Swiss policymakers when drafting up the new action plan for climate change adaptation after 2025.

CLIMADA – Weather and Climate Risks

CLIMADA[23] stands for CLIMate ADAptation, a probabilistic damage model for natural hazards developed at ETH Zurich. This model calculates the benefits of adaptation measures, including grey to green infrastructure, behavioral changes, and more, by calculating the damage caused by disasters. CLIMADA is an open-source model that implements the Economics of Climate Adaptation methodology, which helps cities, regions, and countries to develop climate-resilient solutions.

3.2 Social and Demographic Changes

Impact: **3**, Adaptability: **3**, Knowledge: **5**



3.2.1 Introduction

The global population, including that of Switzerland, is projected to increase into the 2030s before peaking and then stabilizing.[24,25] In Switzerland, with the decline in birth rate per woman, the proportion of older people (aged 65 and above) is expected to rise steadily due to factors such as advances in healthcare, leading to an ageing society and slowly exerting pressure on the proportion of people in employment. Furthermore, social, economic, and environmental factors are expected to increase migration flows. As a result, future governments will have to deal with multi-ethnic, culturally diverse, and pluralistic societies that are more heterogenous in terms of religious, linguistic, political, and socio-economic characteristics.[24,25,26,27] With the ever-increasing digitalization of society and industry, the benefits and dependencies on technological solutions are transforming societal structures (Society 5.0).[28] In addition, the future society will be characterized by increasing mobility, diversity reflected in different forms of relationships and household structures, a divide between rural and urban dwellers due to out-migration, and different lifestyles and work-life arrangements (including the changing nature of work and education).[25,29,30]

3.2.2 Uncertainties

Social and demographic change will directly affect the civil protection system and its organizations, as these entities and institutions are designed and run by people for people. Civil protection organizations will need to address several issues, for example, how socio-demographic change affects society's preparedness places new demands on mitigation and preparedness for disasters and impacts the capacity to respond and recover depending on exposure and vulnerability.[31]

The uncertainty in this trend lies in the numerous elements that influence societies, which are themselves difficult to anticipate, but still act as push and pull factors that shape future societies. These factors can be of a technological, cultural, political, economic, or environmental nature.[32,33] With the changes in society and demographics, public service models are expected to adapt and evolve. However, it is still uncertain what these changes might look like. For civil protection and emergency organizations, these changes will potentially involve a shift towards a workforce that possesses more analytical and technological skills, while retaining essential human qualities such as creativity and interpersonal skills that cannot be replaced by technology.[34,35]

For the Swiss civil protection system, one of the most pressing uncertainties is staffing. Given the increase in the foreign population and the decline in the birth rate, it is uncertain whether sufficient personnel can be allocated to Swiss civil protection under the current constitutional and statutory frameworks. This is particularly critical when considering that Switzerland is approaching 9 million people, which inevitably raises the question of whether the Swiss civil protection system can cope with this population size.

3.2.3 Challenges

As socio-demographic change tends to occur gradually and is often not noticed immediately, the consequences are often overlooked or pushed aside. However, these developments pose a number of challenges for civil protection:

- The growing proportion of the elderly population, which is generally less mobile, less physically resilient, and more reliant on external and specialized support, poses numerous challenges. An increase in external

support for emergencies and recovery is also expected for smaller households that can rely less on family support.[36]

- Pluralistic and diverse societies create a level of heterogeneity that necessitates adaptations to civil protection service models. These models must account for socio-demographic vulnerabilities and regional or community contexts to guarantee equality and equity in service delivery. Such adaptations are critical to meet the rising expectations of civil protection services.[35,37]

- Finding the right balance to guide people during prolonged periods of crisis or new forms of crisis, increases the pressure to be transparent. Expectations for civil protection and emergency organizations will require increased public relations efforts as certain crises and emergencies, such as climate change exacerbated hazards, become more impactful and responses are quickly judged and amplified by a digitalized society.[32]

- Considering the numerous changes and uncertainties outlined, ensuring a sufficient number of well-trained and qualified civil protection personnel is crucial. Given the existing difficulties in recruiting and allocating sufficient staff to the various civil protection entities, changes in work-life arrangements (e.g., part-time work, home office, etc.) or new perspectives on what work and volunteering should contribute to may put further pressure on personnel issues.[33,34] Insufficient attention to and communication of preparedness in society could also further strain the capacities of civil protection personnel.

3.2.4 Opportunities

Involvement in civil protection operations and active monitoring of social and demographic changes before they have a negative impact in a crisis can create new opportunities, such as:

- Expanding the concept of demographic resilience[38], as promoted by the UN Population Fund, to civil protection can help to better anticipate and prepare for emergencies. In this context, demographic resilience involves a deep understanding in and forecasting of population dynamics and demographic trends that are crucial for maintaining stability and security, particularly in multicultural societies. For example, the demographic characteristics of age, gender, and economic circumstances were identified as useful predictors of the effects of the first wave of the COVID-19 pandemic.[39] Understanding demographic, societal, and social dynamics before and during a crisis will improve crisis communication, prevention, and intervention.

- As the digitalization of society progresses, it can be expected that this change will promote the integration of digital technologies into the civil protection infrastructure (see 3.8 Digitalization). With the number of people who have no digital affinity or access steadily decreasing, there is an opportunity for civil protection organizations to increasingly rely on digital communication channels, warning systems, and response mechanisms.

- Knowledge plays a crucial role in understanding challenges such as climate change, in supporting behavioral shifts, including risk-averse behavior, in providing self-reflection like individual preparedness, and in strengthening resilience for example through local knowledge. To enhance the level of knowledge, civil protection structures should find ways to leverage social and demographic streams to turn risk knowledge into mainstream knowledge. For example, the rise and range of continuing education for adults could serve as a platform for risk education in Switzerland.[40]

- Shared risk perceptions, disaster experiences, and crises situations create social cohesion, at least in the initial phases of crisis management, as the COVID-19 pandemic or the war in Ukraine show. One outcome of this process is the emergence of volunteers and volunteer organizations. These groups can provide a substantial workforce pool if they are included. They are also increasingly needed, especially to deal with major or prolonged crises. It is therefore essential to know how to coordinate, manage, train, and value their work.[41]

- While societal and demographic aspects are increasingly considered in mitigation, preparedness, and response, they tend to be neglected in the recovery phase. Here, however, integrative civil protection approaches (see 3.6 Collaborative Approaches) can ensure that vulnerabilities based on socio-demographic characteristics are reduced in the future.[42]

3.2.5 Policy Implications

Addressing social and demographic changes requires a multidimensional perspective for civil protection organizations. Demographic shifts, such as population growth, ageing, and changes in community composition, pose challenges that require workforce sustainability strategies, enhancing volunteer engagement, and the promotion of inclusivity in all civil protection activities.

Social and demographic changes often unfold slowly and sometimes go unnoticed or are suppressed until they prove to be significant factors in society's exposure and vulnerability. These evolving factors require a multidimensional approach from policymakers and civil protection organizations to address them effectively. This trend will impact both civil protection and emergency organizations as well as the communities they serve. One challenge will be to create a sustainable pipeline of staff and reserve personnel. The trend will also have an impact on the population, beneficiaries, or victims assisted by the civil protection systems. For example, ageing or more heterogenous communities can shift vulnerabilities and require adaptations to approaches and communication methods.

Demographic change is a pressing issue for Switzerland, as the population will to continue to grow and age throughout the 2030s. Nearly a quarter of the Swiss population consists of foreign nationals, which makes it difficult to recruit them for certain positions in civil protection and emergency services. At the same time, the number of willing and able candidates for civil protection organizations is declining. While the Federal Council is evaluating new service models,[43] civil protection organizations must continue to actively sustain their workforce, for example, through employer branding, expanding or broadening target audiences based on equality and inclusivity, etc.

An additional consideration in this context is the sustainable integration of volunteers. As social cohesion is often strengthened in times of crisis, it is crucial for civil protection systems to involve volunteers not only in the immediate aftermath of a disaster, but in all phases, including mitigation, preparation, and recovery. Therefore, recognizing, managing, and valuing volunteer efforts is of importance for the civil protection system. The Swiss Red Cross, for example, considers volunteering to be one of the pillars of its work, and therefore puts structures and processes in place to coordinate these engagements.[44]

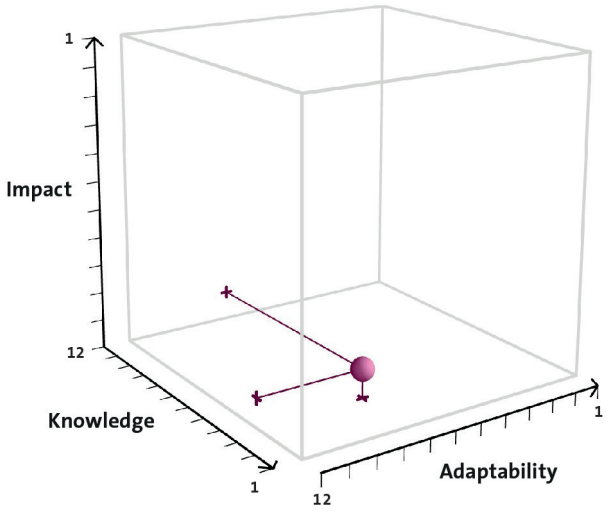
To reduce pressure on civil protection personnel and systems, a deeper understanding of the characteristics of the diverse landscape of communities, including exposure and vulnerability, could enable more targeted communication on mitigation efforts and increase preparedness in case of an event.

Mapping social capital for urban resilience

SOKAPI-R is a German research project aiming to spatially capture the social-capital in individual urban areas. By identifying social cohesion, and relevant changes in network connections within communities, this project fosters a better understanding of community resilience and social adaptation in crisis scenarios, or in situations where these capacities may be lacking.[45]

3.3 Urbanization and Metropolization

Impact: **11**, Adaptability: **8**, Knowledge: **3**



3.3.1 Introduction

Urbanization is the process by which more and more people live and work in cities instead of rural areas, leading to the growth and expansion of urban areas as a result. Metropolization is the process by which several already urbanized spaces expand further and merge to form a metropolis. In view of the predicted increase in the global population by 2050, this development seems unstoppable and is considered one of the most important and transformative trends of the 21st century.[46] The UN assumes that around 70 per cent of the world's population will live in cities by 2050.[47] Although this trend is particularly evident in developing countries, where 90 per cent of urban growth is taking place, it is also significant for industrialized countries.[48] While urbanization and metropolization often improve people's standard of living, these developments also amplify numerous existing risks and bring new challenges for authorities and civil protection.[49] Although Switzerland has no huge cities, it is one of the most densely populated countries in Europe and is in many parts de facto urbanized or metropolized throughout.[50]

3.3.2 Uncertainties

Although this trend is generally regarded as inevitable, its pace, characteristics, and associated consequences vary considerably from one urban space to another. The social, economic, and political context of a country influences how quickly or slowly the urbanization and metropolization of a region progresses. Numerous other factors such as geography or international developments, for example migratory movements, also play a role. This makes it difficult to predict exactly how and to what extent this trend

will affect specific cities, regions, and countries in the coming decades. The same applies to the challenges and opportunities intensified or newly created by this trend, as these depend heavily on the specific local characteristics of the trend.

However, this trend is a relatively slow and fundamentally not new development, which makes forecasting and planning easier. Regions do not urbanize overnight, especially not in industrialized countries. This gives policymakers and authorities the opportunity to influence the trend to a certain extent and steer it in a desired direction. In most cases, the necessary regulatory policies do not have to be newly invented, but can build on what already exists, allowing the authorities to draw on historical experience. The same applies to dealing with the challenges and opportunities arising from the trend. Here too, the responsible authorities can anticipate developments and intervene if necessary. Due to the diversity and complexity of urban spaces, there will be strong differences in how exactly a specific city will deal with this trend and the associated uncertainties.

3.3.3 Challenges

The concentration of people, industry and infrastructure in metropolitan areas poses several challenges for disaster control:

- The failure of critical infrastructure in urban areas affects more people and has significantly greater and longer-lasting consequences than in rural areas. Critical infrastructures are central to the functioning of urban life, which is why they are often concentrated in and around cities. Prolonged disruptions, for example to energy or water supplies, continue to affect the social and economic life in cities long after the direct impact has passed.

- Urban spaces have higher and more complex disaster risks than rural areas due to the concentration of people, infrastructure, and business activity.[51] More urban spaces in the future will mean more civil protection activities in cities to manage new and particular risk and disaster patterns. In addition to the specific physical and social vulnerabilities of city dwellers, it is also important for civil protection authorities to consider that the number of people in cities swells considerably during the day due to commuters, especially in countries with highly mobile populations such as Switzerland.[52]

- Urban areas are a major source of CO^2 emissions and are at the same time strongly affected by their consequences. Cities emit large amounts of CO^2 due to their high energy intensity, transportation, and economic activities.[53] The consequences of climate change act as a threat multiplier in cities, as they accelerate and exacerbate numerous existing risks of urban spaces, such as health issues, water scarcity or increased soil sealing and surface runoff.[54] They also impair the quality of life in urban spaces and increase operating costs, for example through repair or adaptation measures to the infrastructure.

- Low social cohesion in cities leads to a reduced resilience of their inhabitants. Despite their higher population density, life in cities has always been more anonymous than in smaller communities for a variety of reasons, resulting in a thinner social network of their residents. Current and future advances in communications technology are likely to exacerbate this tendency by allowing city dwellers to stay in touch with friends and relatives in far-flung locations, further reducing the incentive to connect with their immediate peers and neighbors.[55]

3.3.4 Opportunities

Urbanization and metropolization is a relatively slow-moving trend that allows civil protection to adapt and seize opportunities as they arise for all phases of the Integrated Risk Management Cycle:

- Nature-based solutions (NbS) offer cities the opportunity to reduce disaster risks through prevention and preparedness as an alternative or complement to traditional gray infrastructure or technological solutions, while improving the quality of life of residents. NbS in the urban context include green and blue infrastructures, such as public parks, green roofs and facades, artificial water bodies, but also non-anthropogenic or hybrid solutions, such as urban wetlands for flood control.[56] They also help to mitigate the negative effects of climate change, such as heat waves. For example, the city of Zurich has developed a heat reduction plan that includes NbS to prevent overheating, relieve vulnerable areas and preserve the city's existing cold air system.[57]

- Smart cities can increase urban resilience in all phases of the Integrated Risk Management Cycle by using information and communication technologies and related means. More than fifty Swiss cities and municipalities are already actively developing their own smart city concepts, albeit often with little consideration of civil protection aspects.[58] The possibilities of smart cities for civil protection are almost limitless and will only increase in the future: from smart growth strategies to reduce risk exposure, to critical infrastructure networked with

sensors, to smart traffic management for faster emergency response times, and IoT sensor networks to improve situational awareness (see 3.8 Digitalization).[59]

- Despite the greater anonymity, there are many informal social networks in cities such as friends, work colleagues, clubs or religious groups with resources and assets that can be mobilized during a crisis and improve the overall resilience of the community.[60] Implementing concepts that increase social cohesion within urban neighborhoods through small-scale development, such as the 15-Minute City that is being discussed in Zurich and elsewhere, can also significantly help with this.[61]

- Cities have the financial, political, and human capital to reduce risks and seize opportunities. From economies of scale to proximity to critical infrastructure, and professional emergency services, cities have better conditions and more resources than rural areas to deal with anything related to civil protection.[51] They also have the ability and capacity to act as independent entities that have relatively greater political autonomy to make and implement decisions compared to their rural counterparts.[62]

3.3.5 Policy Implications

Risk-optimized urbanization and metropolization incorporate existing experiences and give cities a stronger voice in civil protection matters. Innovative approaches such as NbS, Smart Cities and concepts for social resilience should be used extensively.

Although urbanization and metropolization is a relatively slow trend, the risks in urban spaces are dynamic and can change relatively quickly. To maintain the effectiveness and efficiency of risk reduction strategies in cities, it is important to continuously monitor the risk landscape through regular assessments, to communicate changes, and to identify and implement appropriate solutions as part of sound urban risk management and spatial planning.

The future growth and densification of Swiss cities should be based on risk-informed planning and development to prevent risks from occurring in the first place. Although each city is unique, they can learn from each other regarding the changing risk landscape and possible solutions, for which formal and informal forums for exchange are needed. At the political level, cities will become even more important in the future, which is why it could make sense to actively involve large cities in preparedness in civil protection in addition to the federal and cantonal levels. Cities have the financial and technological resources and know-how to integrate the latest lessons and options into their risk management. NbS should form the basis for dealing with the consequences of climate change in urban areas and receive the necessary financial and political support.

In the event of conflicts of objectives within city administrations, risk management aspects should be given greater weight in future. Civil protection aspects should also be considered more at the outset of new Smart City projects in Swiss cities. This does not necessarily have to involve purely civil protection-related projects, but it would be helpful to take greater account of the needs of civil protection in new or existing projects. For example, sensors could be used for multiple purposes or set up at locations that also suit the needs of partner organizations.

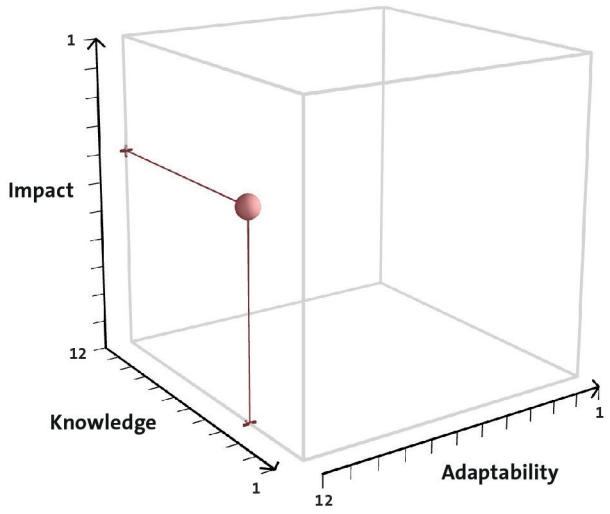
The greater resources of cities also represent an opportunity for the surrounding areas. The cities' professional emergency services offer a pool of experts whose skills and expertise could also be used outside the city limits. Finally, cities are also feeling the effects of the population's declining self-reliance and increasing dependence on critical infrastructure. They should therefore also be at the forefront of efforts to strengthen social resilience, for example through projects to increase the autonomy of neighborhoods or campaigns to increase the self-organization of the urban population in times of crisis. The concept of emergency meeting points, which has already been introduced in several cantons, is also relevant in this context. In the event of an incident, they can serve as a nucleus for neighborhood self-organization and should be perceived and used as such.[63]

Smart City potential for civil protection

In 2020, the city of Daegu in South Korea started a smart city project with a strong focus on disaster risk reduction.[64] It includes, amongst others, a slope collapse prediction service based on massive IoT networks, a sensor-based real-time heatwave information and risk mapping service for the inhabitants, a heat reduction system that automatically lowers the air temperature in the city through a cooling mist provided via streetlamps, an AI-supported smoke, fire and accident detection system based on video surveillance, and an ambulance dispatch support service that optimizes access routes based on real-time traffic information. The project is targeted for completion in 2025.

3.4 Geopolitical Polarization

Impact: **5**, Adaptability: **12**, Knowledge: **4**



3.4.1 Introduction

This trend refers to the growing tendency in geopolitics to form blocs of like-minded states regarding various political issues and the associated increased willingness to solve issues through confrontation rather than multilateral negotiations. The resulting fragmentation of international politics weakens the rules-based multilateral order and impairs international cooperation. One of the main reasons for this development is the selective exercise of leadership by the USA in recent years and the resulting increase in competition between great powers and emerging regional powers for spheres of influence.[65] To assert their claims, these states use leverage such as political, economic, and military influence and the control of technologies, resources, and supply routes. They are also more willing to operate in the gray zone between armed conflict and peace or to use blunt military force to pursue their interests. At the same time, international security organizations such as the UN are increasingly paralyzed in their efforts to find multilateral solutions due to the lack of consensus between the great powers. This trend has far-reaching consequences, particularly for small, neutral states such as Switzerland, which depend on a rules-based international order with functioning multilateral institutions.

3.4.2 Uncertainties

The phase of US dominance since the end of the Cold War seems to be gradually coming to an end. However, it is unclear what kind of stable international order will follow, which creates a phase of instability and uncertainty. Russia's invasion of Ukraine in February 2022 has brought some long-standing geopolitical tendencies to the fore and further reinforced them.[66] It has widened the gap between Western democracies and authoritarian states such as China and Russia, and extended bloc logic to trade relations in technology and energy. The war has led to an increase in US troops in Europe and made clear that the USA, via NATO, will continue to be central to the continent's security for the foreseeable future. However, given the long-term strategic focus of the USA on the Asia-Pacific region, it remains to be seen how long this commitment will persist.

The EU intends to take on more responsibility for European security but remains in large parts dependent on the USA. Although relations between the West and Russia will remain confrontational for some time, it is not certain how far the geopolitical polarization will go in the future on a global level, including in relation to other countries. Will Russia orient itself consequently towards Asia in the future or will it eventually become part of a new European security architecture? Will China and the USA drift further apart or find ways to coexist without military confrontations? Will geopolitical polarization turn into economic polarization, resulting in different blocs with their own trading systems, technological standards, and reserve currencies? The exact extent and depth of geopolitical polarization will ultimately determine the challenges and opportunities for Switzerland arising from this trend.

3.4.3 Challenges

Although there is considerable uncertainty regarding the development of this trend, some overarching challenges for Switzerland can be identified:

- In an increasingly fragmented, transactional, and confrontational international environment, multilateral cooperation on global challenges such as climate change, nuclear non-proliferation, or migration issues will become more difficult.[67] Binding commitments between governments and compliance with international rules by states and blocs will be harder to achieve if their perceived interests lie elsewhere. Everything becomes politicized, combined with the expectation that every country positions itself, which can be a challenge for neutral countries like Switzerland.

- The dwindling willingness to cooperate in international relations is leading to a less stable and more dangerous world, in which states and blocs are more likely to intimidate and coerce one another openly or covertly through hybrid, conventional, or nuclear means. The risk of not only more frequent but also simultaneous crises increases. This has an impact on the strategic orientation, the organization, and the necessary resources of Swiss civil protection.

- An increasingly polarized world increases the likelihood of the weaponization of economic and monetary systems by states and blocs in the form of export restrictions, sanctions, currency measures, etc.[68] Reduced trade flows and technology exchanges between blocs, as well as sudden supply disruption, lead to welfare loss, a slowdown in innovation, and more acute supply shortages, including for civil protection relevant goods (see 3.5 Growing Supply Dependency).[69]

- Geopolitical polarization will also likely affect access to critical and emerging technologies such as 5G/6G and AI, and the setting of technological standards for said technologies, as they become instrumentalized in competition between states and blocs. Technology access is needed for standard setting, and standards establish norms that guide future developments of technologies by transporting political and societal values, such as privacy and sustainability.[70] Diverging standards hamper compatibility, interoperability, and basic safety, and ultimately impact national security. The ultimate consequence could be a de facto technology decoupling between blocs.[71]

3.4.4 Opportunities

This trend offers some opportunities for Switzerland, but like the challenges, they are subject to numerous uncertainties and are heavily dependent on future developments:

- The increasing geopolitical polarization in the wake of the Russian attack on Ukraine has led to a newfound unity in transatlantic relations and revitalized the institutions central to Europe's security, such as NATO and the EU – at least for the time being.[72] Many European countries have increased their defense spending and new countries want to join NATO or have already done so. For Switzerland, this means greater security and may open up new or expanded opportunities for cooperation in the area of civil protection in the medium term, for example in cooperation with NATO.

- An increasing blockade of multilateral cooperation in international security organizations such as the UN increases the strategic autonomy of regional cooperation and can open up new opportunities in the form of bilateral, minilateral, or informal approaches. Regional, policy-specific cooperation between like-minded states that is flexible enough to accommodate different ambitions and willingness to yield sovereignty can provide an alternative to global treaties and enable faster progress. Regional approaches offer small countries like Switzerland more opportunities to exert influence and shape policy, including in civil protection.

- A lack of multilateral cooperation on global challenges in international fora and the tendency towards more bilateral negotiations may increase the demand for mediation, good offices, and meeting venues. Switzerland has extensive experience in these areas and may offer a neutral platform and conference location. The global challenges to be solved are manifold and range from the war in Ukraine and the future European security architecture to the global health order and the climate crisis. In 2025, the eighth session of the Global Platform for Disaster Risk Reduction, a multi-stakeholder forum to review progress in implementing the *Sendai Framework for Disaster Risk Reduction 2015–2030* and discuss the latest developments in disaster risk reduction, will take in Geneva, Switzerland.

- Numerous crises in recent years and an increasingly tense international security situation have heightened political and public awareness for security policy issues. For example, the war in Ukraine has greatly increased the interest of the Swiss population in topics such as alerting, protective shelters, and the supply situation.[73] Civil protection can use this attention to its own advantage.

3.4.5 Policy Implications

Geopolitical polarization places international cooperation and experience sharing at the heart of comprehensive civil protection that is more closely integrated into national defense. More and simultaneous crises require optimized early detection and crisis management structures.

Geopolitical polarization will make cooperation with European partners and security organizations even more important for Swiss civil protection in the future, for example in the areas of security of supply, NBC protection, adaptation to climate change and civil defense. The intention of Switzerland to participate in the UCPM is an important step in this direction.[74] Increased cooperation with NATO in the civil-military field would also be beneficial for civil protection but depends on the willingness of the Member States to cooperate.

Swiss civil protection should take advantage of the newfound attention to security issues in the wake of the pandemic and the war in Ukraine, both politically and socially. The *Supplementary Report* to the *2021 Security Policy Report* concludes that a stronger focus of civil protection on armed conflict should be examined.[75] Howev-

er, higher defense spending does not automatically lead to more resources for the civilian components of national defense. A situation in which the tasks of civil protection in an armed conflict should be given greater weight again, but the necessary financial and personnel resources are lacking, must be prevented. In a geopolitically polarized world, there is a need for a comprehensive approach to civil protection that repositions all elements of the integrated system as an integral part of national defense, similar to what was the case during the Cold War but adapted to current and future circumstances. In addition to its own historical experience, Swiss civil protection could also learn from Nordic countries, for example, where this is already the case today.[76]

Resilience of a society can also be considered a form of deterrence.[77] To this end, civil protection should not only focus on the primary risks of the last twenty years, but also take into account the new and increasing threats in a more unstable and insecure world. In this context, the integrated system, and the performance profile of civil defense should be reviewed.

Alongside armed conflict, issues such as hybrid threats, the protection of critical infrastructure, protective shelters, and security of supply will become increasingly important in the future. In addition to the international organizations in Geneva, the Spiez Laboratory is a potentially worthwhile target for malicious actors. The cyberattacks on various Swiss websites, including those of the parliamentary services, in the run-up to Ukrainian President Zelensky's address to the Swiss parliament in June 2023, show that Switzerland's political institutions can also be caught between the fronts and that civil protection must be even better prepared for such situations. The new strategy for the protection of critical infrastructure is an important component of this approach, whereby cross-border cooperation will also become increasingly important in this area, as Switzerland is also dependent on foreign critical infrastructure.

The early detection of crises is similarly becoming more important to anticipate developments in good time and identify emerging threat vectors. This requires systematic, continuous, and interdepartmental monitoring of international developments, in which all the resources and expertise available to the departments and possibly the cantons are brought together in a suitable form, for example in the National Emergency Operations Center. In future, this process and the evaluation could be supported by Artificial Intelligence (see 3.10 Big Data and Artificial Intelligence). In addition to smooth processes and interfaces, an early warning process also requires suitable structures and vessels for communication between the various levels of government. The adjustments to crisis cooperation between the federal government and the cantons introduced in the wake of the pandemic are important steps in the right direction.[78]

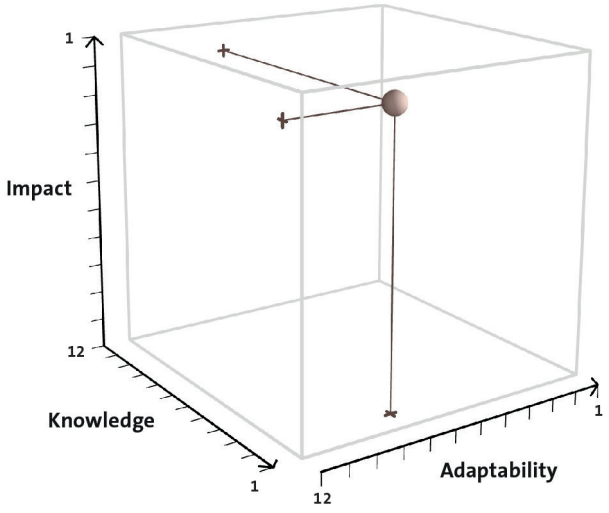
In a polarized world, there will be more crises. The crisis management structures at federal and cantonal level need to be strengthened so that they are ready and able to cope with rapidly and dynamically developing crises, which can also occur simultaneously. This primarily concerns the areas of training, resources, situational awareness, and round-the-clock availability.

New concept for protective shelters in Switzerland

After the end of the Cold War, Switzerland did not dismantle its shelters to the same extent as other European countries. There are around 370,000 personal shelters and 1,700 larger shelters like command and first aid posts across the country.[79] In 2023, the FOCP, together with the cantons, developed a new concept for protective shelters as a planning basis for the further development and value retention of shelters in the coming 20 years.[80] In addition to structural and technical aspects, the concept stipulates that every resident should have a shelter close to their place of residence. Small private shelters that are no longer operational are to be increasingly replaced by the construction of larger public shelters.

3.5 Growing Supply Dependency

Impact: **2**, Adaptability: **8**, Knowledge: **2**



3.5.1 Introduction

The globalization of value and supply chains is leading to a growing dependence on foreign suppliers for vital commodities, goods, and services. The experiences of recent years with supply shortages due to disruptions and crises

have highlighted the great vulnerability of globalized supply chains. Insufficient supply security can have direct and indirect effects on civil protection, for example in the form of shortages in medical supplies during a public health emergency, or energy shortages.

Thanks to technological advances and reliable logistics, the production of more and more goods and services has shifted abroad in the last thirty years.[81] Countries and regions have specialized in certain commodities, goods, or services, dominating the global market. This offers advantages such as lower costs, greater efficiency, and better quality.[82] In recent years, however, increasing geopolitical polarization, the COVID-19 pandemic, and the invasion of Ukraine have called into question the reasonability of these developments.[83] Many countries have imposed import tariffs, sanctions, and other trade barriers, while conflicts and other events have led to temporary disruptions in logistics, high transportation costs, and bottlenecks in just-in-time production. Efforts such as regionalization, on-, near- and friend-shoring have consequently gained momentum. However, this decades-long development can at best be reversed in a few selected, strategic areas, while globalization will likely continue to progress in most others.

3.5.2 Uncertainties

As a consequence of the numerous crises in recent years and their impact on the supply of many commodities, goods, and services, security of supply currently enjoys higher political and societal attention than it did a few years ago. However, it remains to be seen whether this attention will last and lead to concrete steps to significantly slow the trend, or whether the lessons learned will soon be forgotten, and globalization will continue to accelerate. This arguably depends to a large extent on future developments in geopolitics and logistics.

A further increase of the polarization in international relations (see 3.4 Geopolitical Polarization), especially between China and the USA or the West, would foster the bloc formation regarding global supply chains and severely impact free world trade. As a result, today's tendencies toward on-shoring, near-shoring, and friend-shoring would likely prove to be more than just short-term reactions to recent crises and disruptions before the economic benefits of globalization returned to the fore. Arguments against such a development, however, are that shorter supply chains and regionalized production are not necessarily more resilient to shocks, and that supplier diversification, re-location, and redundancy capacity outside of crises are likely to prove too expensive, inefficient, and impractical in many industries.[83,84]

Reliable and cost-efficient global logistics links, provided primarily by international shipping, are a prerequisite for international supply chains. They have been taken for granted over the last 40 years, but this is no longer the case. They too are vulnerable to disruptions, crises, and politicization, leading to price hikes, bottlenecks, and capacity constraints. In recent years, international maritime trade has been characterized by high freight rates, congested ports, chaos in container logistics, and a reduction in capacity on key sea routes such as the Suez and Panama Canals.[85] It is uncertain whether or not these challenges will become more accentuated in the coming years.

3.5.3 Challenges

Growing supply dependency for vital commodities, goods and services poses several challenges for the countries concerned:

- Import-dependent countries rely in vital areas on long and complex international supply chains, which are vulnerable to all kinds of disruptions and crises, and whose costs can vary widely. An incident along the supply chain can quickly impede or even prevent access to vital commodities and goods. This challenge is particularly pronounced for landlocked countries such as Switzerland, which also need to transport imports from seaports to the national border. For example, in recent years, logistical challenges in neighboring countries have repeatedly led to bottlenecks in the supply of petroleum products to Switzerland, even though the global market was sufficiently supplied.[86]

- The price pressure of global competition and just-in-time production set limits to the resilience of international supply chains. Precautionary measures by the private sector such as higher inventories, spare and surge capacity or redundancies increase the price tag of vital goods and services and can jeopardize the long-term survival of companies.

- The strong geographical concentration of worldwide production of certain commodities, goods, and services increases the likelihood of a lack of surge capacities and the instrumentalization of these industries for political purposes. This increases the vulnerability of import-dependent countries. For example, before the COVID-19 pandemic, China produced half of the world's supply of clinical masks and all mass-produced clinical gowns, which severely impacted global availability during the crisis.[87]

- Import dependency cannot be easily reduced in times of crisis. On-shoring takes time, if it can be done at all due to the loss of skilled labor, a lack of long-term economic viability etc. Partial on-shoring generally improves security of supply only slightly and entails

large upfront investments and/or higher production costs.[84] For example, Switzerland remained heavily dependent on imports for the supply of protective masks during the COVID-19 pandemic, despite government support to increase domestic production.[88]

3.5.4 Opportunities

Alongside challenges, the growing supply dependency also offers opportunities that are relevant to all phases of the Integrated Risk Management Cycle:

- The high level of attention the topic currently enjoys offers the opportunity to implement preparedness and emergency measures to strengthen national security of supply that would not have been politically acceptable a few years ago, such as on-shoring and additional stockpiling.[89] Civil protection organizations could use the current awareness to improve the overall resilience of the population, for example by promoting self-responsible preparedness through information campaigns, guides etc.[90]

- In many cases, supply dependency cannot and need not be prevented per se, but the underlying global supply chains must become more robust overall. Technological advances, such as digitalization or automation, and the high level of societal attention make it possible to implement appropriate measures, such as innovation or (partial) on-, near- and friend-shoring. For example, the United States, Australia, and other countries are working to break China's near-monopoly on rare earths, which are indispensable for advanced technologies, through policies, support packages and own mining projects.[91]

- Long-term on-, near-, and friend-shoring of strategically important and highly concentrated sectors brings additional benefits besides improving supply security, such as economic growth, re-industrialization, lower carbon emissions, and improved labor protection. This could also be used as political capital in international relations and trade to build closer relationships with strategically important partners. For example, Taiwan has positioned itself in the global semiconductor supply chain in such a way that the country is indispensable for both the USA and China, at least for the coming years.[92]

- Supply dependencies and feared bottlenecks in vital sectors can serve as an impetus for innovation and increased sustainability. Technological innovations can help to reduce supply dependency by making certain imports superfluous.[84] Depending on the criticality of the sector, the high investments and the lengthy technological shift required to implement them may be justified. An example of this is the energy transition towards renewable energies in many countries, which is at least partly motivated by the desire to reduce dependence on fossil fuel imports.

3.5.5 Policy Implications

The management of growing supply dependencies in critical sectors and any interventions in the economy require political will and farsightedness. Clear responsibilities, well-established processes and sufficient resources are necessary to avoid and overcome supply bottlenecks.

The 2020 *National Risk Analysis of Disasters and Emergencies in Switzerland* identifies an electricity shortage as the greatest technical risk and a pandemic as the greatest societal risk for Switzerland in terms of probability of occurrence and expected damage.[93] Switzerland is heavily dependent on imports for the prevention and management of both risks. This is why clear responsibilities and competencies are required that define exactly what precautions are to be taken and by whom, and how early or late and with what means the state may intervene should an event occur. The coordination required for this should be optimized so that the responsibilities and processes are known and well-rehearsed by all federal, cantonal, and private stakeholders involved. The topic should be the subject of regular trainings and exercises. When shaping structural and industrial policy, import dependency in sectors relevant to civil protection, such as energy supply or healthcare, should be considered and reduced where necessary. Technological progress offers increasing opportunities in this regard.

Measures to overcome acute shortages must be prepared with the necessary diligence and decisiveness. The responsible authorities must have adequate financial and human resources and receive the necessary political support to be able to prepare suitable and binding measures together with the cantons, the private sector, and the population. One of these measures is compulsory stockpiling. Switzerland already stockpiles a wide range of vital goods. The list of goods identified as essential and suitable for compulsory stockpiling must be regularly reviewed and, if necessary, expanded together with the relevant stakeholders from the administration and the private sector.[94] The first steps in this direction initiated by the Federal Council at the end of 2023 must be consistently pursued.[95] Binding obligations rather than voluntary recommendations on stockpiling must be supported politically and financially. For vital goods for which compulsory stockpiling is not possible, the political will and deci-

sions are needed to find alternative solutions, for example through infrastructure adjustments, long-term on-shoring, government solutions and cooperation with neighboring countries and the EU. Policies should promote agility for vital goods and services, e.g., through the standardization of inputs and regulatory flexibility in times of crisis. Critical infrastructures should have mandatory legal requirements to ensure that they can continue to provide their vital services in the event of a shortage. The intended hardening of the Swiss mobile phone networks through emergency power supply is a positive example for this.[96] However, precautionary measures should not be limited to the energy supply.

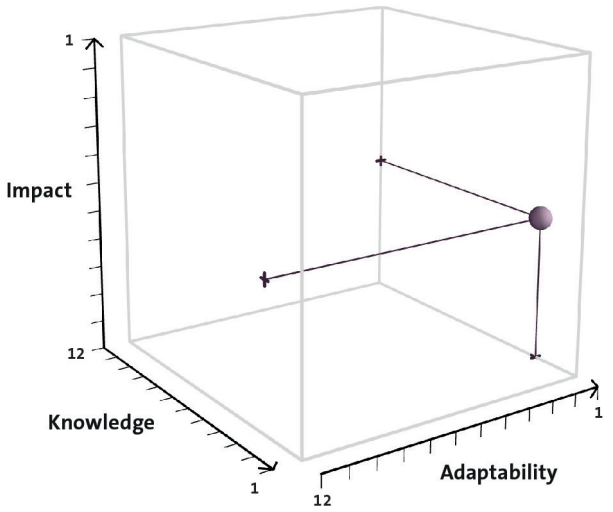
Civil protection and other relevant federal agencies should support critical infrastructure operators in identifying potential vulnerabilities and taking necessary industry-wide precautions in coordination with dependent sectors. The regular revision of the inventory of critical infrastructures and the strategy for the protection of critical infrastructures are important steps in this process[97]. In addition, civil protection should continue to help raise the population's awareness of this issue and support them with suitable means for self-help, for example in the form of guidebooks.

Reporting platform for shortages of therapeutic products

Switzerland's supply situation with vital medicines and vaccines has been steadily deteriorating for many years. Since 2015, the Swiss Federal Office for National Economic Supply operates a platform on which actors in the healthcare sector must report supply bottlenecks for certain vital medicines and vaccines.[98] The knowledge and foresight of market participants is thus used in a structured way to provide the authorities with a timely overview of relevant supply disruptions and to enable the implementation of measures such as compulsory stock releases or recommendations to medical staff.

3.6 Collaborative Approaches

Impact: **7**, Adaptability: **1**, Knowledge: **3**



3.6.1 Introduction

Collaborative approaches refer to the strategic partnership of various stakeholders, including citizens, national, cantonal and communal governments, federal authorities, private sector, and non-profit entities, aimed at strengthening the country's resilience in civil protection. This trend emphasizes the consolidation of resources, the exchange of expertise and best practices, and the promotion of cross-sectoral and cross-border partnerships. The concept goes beyond mere cooperation or sharing of resources and encompasses the collective efforts of independently operating entities to transcend organizational boundaries, levels of authority and sectoral divisions. The objective is to collaboratively prepare for, respond to, and recover from disruptive events. The adoption of collaborative approaches in Switzerland is particularly relevant due to the decentralized political system, which grants cantonal and local authorities considerable autonomy, as this creates a more nuanced and flexible collaborative framework.

3.6.2 Uncertainties

Collaborative approaches in civil protection can entail uncertainties that overshadow their benefits. Traditionally, vertical hierarchies have been at the forefront of command-and-control strategies. While centralized approaches ensure structured responses, they risk preempting or even excluding community involvement. These local entities often have to rely on themselves initially, as external assistance can be subject to delays.[99] Neglecting local insights and capacities could limit timely disaster response and hinder the community's ability to continue to respond to and recover from disasters. Achieving a bal-

ance between hierarchical control and community involvement is a challenging task.

Often, the distinction between coordination duties of emergency managers and the on-site duties of first responders is blurred. In smaller jurisdictions, such as municipalities, these roles often overlap, with officials such as fire or police chiefs serving as both emergency managers and first responders. This intertwining can further complicate the collaborative landscape.

Successful collaboration in these complex settings requires a balance between cultural awareness and a shared language. However, it is unrealistic to expect entirely conflict-free interactions. Organizations may be reluctant to collaborate due to internal politics, cultural differences, or past experiences. As an event grows and a wider range of parties become involved, the establishment of a unified command becomes necessary. While this unified structure promotes better information sharing and coordination, it limits inclusive decision-making, especially in large-scale emergency response operations. These scenarios create practical constraints to widespread participation, resulting in concerns and uncertainties about the representation of all stakeholders in the decision-making process.

Uncertainty is inherent in collaborative approaches, as there is not one predefined structure for such collaborations. These collaborations often emerge spontaneously during large-scale events and vary depending on the relationships between the stakeholders. The characteristics of collaboration, including objectives, conflicts of interest, power dynamics, level of involvement, and strategies, also influence how actors will collaborate.[100] The complex causal structures of disasters and their long-term effects add another layer of uncertainty when it comes to establishing the best collaborative relationships.

3.6.3 Challenges

The challenges inherent in collaborative approaches can be magnified in decentralized emergency systems like Switzerland's, potentially hindering response efforts during emergencies if not managed effectively.

- Challenges to effective collaboration arise from the inclusion of multiple actors in crisis management. While there are practical constraints to participation, especially when rapid decision-making is crucial, cultural and conventional barriers further complicate seamless collaboration.

- Collaborative approaches towards disaster response can be impeded by potential conflicts arising from different priorities of the actors involved. The operational focus of first responders, which primarily emphasizes immediate relief, can sometimes clash with the emergency managers who tend to prioritize long-term strategic planning. Conflicts can also arise due to the scarcity of resources when various local and wider interests are affected. The water management of Lago Maggiore, which is shared by Canton Ticino and Northern Italy, is a classic example of the friction between local and wider interests, with each jurisdiction having its unique priorities. The collaborative management of Swiss-Italian waters encounters obstacles due to competing interests like irrigation, fishery, tourism, and navigation. This issue is especially prevalent during summers when high temperature anomalies and low precipitation, worsened by climate change, result in low water reserves in the lake. Moreover, collaboration between trained professionals and lay volunteers can lead to disagreements in major crises due to differences in training and approach.

- Collaborative disaster management efforts can be hindered by communication challenges. Without optimized channels, the amount of information shared exchanged can become overwhelming, which can lead to potential confusion. Different entities may rely on different technological platforms, making communication challenging. Different languages and vocabularies across sectors and regions can pose another hurdle. For example, much of the disaster-related terminology is in English, and the translation into local languages is not always accurate. This can be a barrier for policymakers and practitioners who do not have a good command of the language.

- During collaborative disaster management, the involvement of multiple agencies and departments can lead to a fragmented administrative process. These entities may operate differently, which can cause misalignments and inefficiencies. Decision-making can be protracted, requiring numerous layers of approval and delaying emergency responses. When multiple organizations work together, it can be difficult to determine clear responsibilities.[101] Overlapping jurisdictions can lead to confusion in crisis situations, which underlines the need for well-defined collaborative frameworks.

- In the absence of effective coordination, overlapping services from multiple entities can lead to a waste of resources. This redundancy can confuse the affected population and create inefficiencies in relief efforts.

3.6.4 Opportunities

Collaborative approaches are particularly relevant for a decentralized emergency system. A careful analysis of the

opportunities offered by collective efforts will allow civil protection to proactively equip itself to address multi-hazard disasters and their cascading effects.

- Collaborative approaches are essential when dealing with complex emergencies, which often involve multifaceted challenges that cannot be overcome by a single entity alone. Disaster events do not recognize political borders, and often require a united and robust response. An efficient cooperative framework that spans across cantons, regions, and neighboring countries can enhance response capacities and address the limitations that often occur in centralized decision-making systems, such as delayed emergency response due to distance or lengthy bureaucratic processes. Collaborative approaches also help overcome limitations in local communities that may not have sufficient resources to respond to emergencies.

- Collaborative efforts enable the pooled management of resources and promote a joint share-and-care approach that fosters resource synergy. This pooling goes beyond mere addition, as the integrated use of resources from multiple stakeholders can lead to outcomes greater than the sum of their individual contributions. By strategically pre-positioning materials near anticipated disaster zones, such a unified approach ensures that resources are deployed based on critical needs rather than availability, ensuring optimal use. In the past, the UCPM's pooled resources on forest fires in southern Europe, where firefighters, equipment, and aircraft from different EU Member States have collaborated under a unified strategy, have contributed greatly to improving the overall emergency response.[102]

- Through collaboration, training modules can be standardized and harmonized to ensure uniform preparation throughout the country. While specific regions or entities may possess expertise in certain areas, collaboration promotes the exchange and transfer of knowledge and skills, thereby enhancing the collective capabilities of civil protection. Collaboration and open science have been widely recognized as effective approaches to address global public health challenges such as pandemics, antimicrobial resistance, and climate change (see 3.1 Climate Change Adaptation). The fight against COVID-19 highlights this effectively, as one-third of all vaccine candidates were developed through partnerships. This accomplishment was driven by unprecedented global data sharing, unconventional collaborations, and initiatives to share knowledge, intellectual property, and technologies.[103]

- Well-established collaboration among various entities involved in disaster prevention and preparedness can significantly contribute to mitigating risks and ultimately save lives. An example of this is the European Flood Awareness System (EFAS), which supports flood monitoring in large trans-national European river basins. As the 2021 floods affected large parts of western Europe, EFAS informed neighboring countries (including Switzerland) about ongoing or possible further floods.[104]

- With world-renowned scientific institutions and universities, Switzerland is uniquely positioned to foster collaborations between academics, experts, and civil protection authorities to develop evidence-based strategies to detect, monitor and respond to incidents or crisis situations. One example of this is the collaboration between the Swiss EPFL and the civil protection authorities in the development of early warning systems for avalanches, which combine academic research with practical application. The Federal Council's decision to better incorporate academic experts into crisis advisory groups in December 2023 supports this trend.[105]

- Collaborative approaches can foster a sense of unity among communities and thus strengthen their resilience and collective capacity to cope with crises. If public resources are scarce, the private sector may be able to step in, as ARISE, the Private Sector Alliance for Disaster Resilient Societies, shows. ARISE[106] is a network of private sector entities led by the UN Office for Disaster Risk Reduction (UNDRR). By joining ARISE, private sector companies voluntarily commit to supporting and implementing *Sendai Framework for Disaster Risk Reduction 2015–2030* and contributing to reducing disaster risk in communities worldwide.

3.6.5 Policy Implications

Effective collaborative approaches require proactive planning, establishing of inter-agency cooperation frameworks and strengthening local response before emergencies. Emphasis should be given to clear communication strategies that promote mutual trust and strong leadership.

Collaborative approaches in crisis management require meticulous planning and proactivity. Given the importance of a joint response to crises, it is crucial to establish inter-agency collaboration frameworks and platforms before emergencies occur. Such groundwork helps build mutual trust, familiarity, and a pre-established working relationship among different entities. Each agency should designate dedicated liaison officers who can facilitate

communication and coordination across different entities. These officers should be proficient in official languages and play a vital role in interpreting and disseminating essential information across their respective agencies. The report *Bericht zur Verbesserung der Zusammenarbeit von Bund und Kantonen in einer Krise,* published by the Federal Council in December 2023, takes a step in this direction by recommending the implementation of the concept of a single point of contact.[107]

A robust and cohesive communication strategy is of great importance in collaborative disaster management, as communication challenges often occur. A clear, unified approach in disseminating information across multi-agency teams is crucial to prevent the spread of misinformation and ensure that the public receives accurate and consistent updates.

Collaborative approaches require strong and effective leadership that must bring together different, sometimes conflicting views towards a common goal. Effective leadership demands proactivity, access to reliable information, and structured methods for its dissemination. Leaders must also be willing to leverage available information, even if it is imperfect or incomplete, to take decisive action. It is pivotal that these leaders undergo training in consensus-building, negotiation, and conflict resolution to guide collaborative approaches smoothly. Given that even the most detailed and systematic emergency plans cannot anticipate every situation, a management style that emphasizes adaptability and flexibility is crucial. This approach not only encourages innovation but also ensures that a rapid and effective response can be implemented when circumstances differ from anticipated scenarios.

A firm reliance on community involvement and volunteer efforts makes collaboration at the grassroots level particularly crucial. Local communities often must rely on their own resilience and resources for a period of time if central assistance is delayed. To respond more effectively to emergencies, individuals and communities need to be invested in and supported as builders of response capacity.

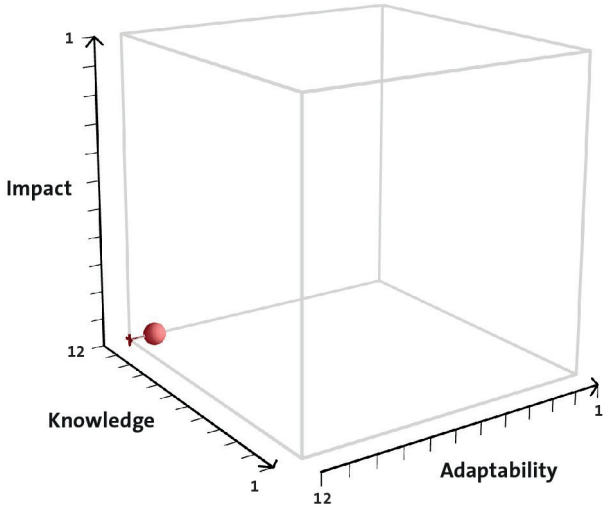
Involving a broader range of stakeholders can complicate and potentially slow down decision-making processes, but is crucial during critical phases of disaster response. Stakeholder representation and participation are particularly important in legitimizing recovery efforts, which are instrumental in improving future disaster preparedness. Equipping people with the necessary training and skills and setting clear, actionable goals is crucial. Such initiatives promote an open and participatory culture of civil service, which ultimately leads to a more agile and responsive system in the event of emergencies.

Civil protection pool of resources

The European Union Civil Protection Mechanism (UCPM) aims to improve cooperation between the EU Member States and ten participating countries in the field of civil protection. Its primary objective is to strengthen disaster preparedness by facilitating rapid forecasting and the exchange of critical assets and information. The UCPM plays a crucial role in providing support when national resources and response capabilities come under pressure, as specialized teams and equipment, such as firefighting planes, search and rescue and medical teams, can be mobilized at short notice for deployments inside and outside of Europe. In 2023, the Mechanism was activated 116 times to respond, among other emergencies, to war in Ukraine; wildfires in Europe; COVID-19 in Europe and worldwide, or assistance for consular support.[108]

3.7 Convergent Technologies

Impact: **12**, Adaptability: **11**, Knowledge: **12**



3.7.1 Introduction

Convergent technologies (CTs) refer to a process that integrates and synergizes at least two traditionally unrelated technologies or knowledge systems as they advance, leading to new devices, services, or areas of research.[109] A prime example is the smartphone which integrates various formerly unrelated technologies into one device. The phenomenon of technological convergence is an important source of innovation as it integrates the strengths of different technologies, and transfers technologies from one sector to another.[110] CTs often replace single-function technologies or render them obsolete, leading to a progression or evolution of technology.[111] There is no defini-

tive group of technologies that are converging, but the phenomenon affects scientific and technological fields as diverse as nanotechnology, biotechnology, information technology, cognitive science, genetics, robotics, and Artificial Intelligence (see 3.10 Big Data and Artificial Intelligence, and 3.11 Unmanned Systems and Autonomous Robotics). The synergies brought about by CTs create various challenges and opportunities for civil protection.

3.7.2 Uncertainties

The emergence and development of CTs are subject to many uncertainties. Technological convergence is not a new phenomenon, but the ever-faster pace of technological progress is expanding and dynamizing this process more and more. The phenomenon has only been viewed and analyzed through this lens for a few years, which is why many stakeholders are not yet aware when they are confronted with convergent technology or the resulting challenges and opportunities. The multidisciplinary nature and inherent technological dependencies of convergence make it extremely difficult to predict whether technologies or knowledge systems will converge and, if so, when. Convergence is not limited to a specific set of technologies but can result from the interaction of technologies from many different fields. Many of the most dynamic CTs are so-called emerging technologies that have inherently uncertain timelines and can develop faster or slower than expected.[112] Accordingly, technological convergence does not develop in a linear fashion and depends to a large extent on the right timing for mutual enrichment of technologies. External factors, such as the pressure to innovate in the wake of the COVID-19 pandemic, can also have a significant influence on the emergence and development of convergence. The challenges and opportunities arising from CTs are equally difficult to predict, as all possible outcomes of planned developments in emerging technologies and their interactions with each other would have to be considered. The multi-layered complexity surrounding CTs makes the long-term prediction of developments in this trend uniquely difficult. Therefore, most methods used to date for a better understanding of CTs have been limited to using information from patent databases for short-term predictions or ex-post analyses, more recently supported by machine learning.[113]

3.7.3 Challenges

The convergence of technologies is leading to a convergence of challenges in many areas, which can have an impact on civil protection.

- CTs make it difficult for policymakers to establish legal oversight and regulatory responsibility as they merge and integrate multiple technologies from distinct functional categories.[114] There is no longer a clear one-to-one relationship between a convergent technology and a responsible regulatory authority or policy. As a result, CTs can remain self-, under-, or non-regulated for a long time, which may increase resulting risks.

- Many devices and services based on CTs collect and use personal and machine data, for example, to improve the user experience through anticipatory results.[115] A lack of transparency about what data is collected and how and by whom it is used can cause privacy concerns, especially if they are used in sensitive areas. Aggregated data can be used, for example, to identify users or reveal activity patterns.

- Many such devices also generate and consume large amounts of data without employing strong encryption, e.g., to reduce the cost and size of devices or increase battery life.[116] This raises various data security issues, such as a larger attack surface for cyberattacks and data theft, for example, to compromise biosecurity in laboratories.

- The replacement of single-function technologies by CTs and the increasing networking of convergent devices and services with each other and the Internet aggregate risks, with potentially catastrophic consequences of outages and disruptions.[117] For example, a telephone outage in the past only affected voice services, whereas an Internet outage today would have cascading effects on numerous areas.

- CTs help "democratize" science by giving new actors access to cutting-edge scientific tools. However, broader, unregulated access combined with high affordability creates new risks relevant to civil protection. For example, the convergence of biological sciences or chemistry with Artificial Intelligence can be exploited for the design of new, more virulent pathogens or the discovery of new, toxic chemicals.[110,112]

3.7.4 Opportunities

Despite these challenges, CTs offer several important opportunities relevant to all phases of the Integrated Risk Management Cycle.

- Technological convergence offers numerous ways to save costs, e.g., through optimized use of resources and energy and device management, fewer procurements and real estate costs, shared use of infrastructure, and lower costs for the transmission of digital

content.[118] It also enables more cost-effective production of a wide range of components, from metals and alloys, chemically resistant polymers, and entire buildings through additive manufacturing, to the conversion of cells into "biofactories" for the low-cost production of chemicals.[119]

- CTs offer a better quality of service. For example, networked, remote-controlled, or even implanted smart sensors in combination with Artificial Intelligence and big data (see 3.10 Big Data and Artificial Intelligence) offer more efficient and comprehensive monitoring for risk assessment and analysis.[120] In the field of drug delivery, technological convergence enables tailored delivery methods of medical countermeasures to treat exposure to chemical weapons.[121]

- CTs are user-friendly and offer new possibilities for training. The use of convergent devices such as tablets is more intuitive and requires less training than operating a classic computer, while the smartphone allows communication in many ways according to user needs.[117] Augmented and virtual reality offer new teaching options, for example around safety training (see 3.8 Digitalization).[122]

- The convergence of technologies enables further technological advances and agile innovation. This phenomenon not only makes it easier for new players to access high-performance technologies at lower costs, but also opens up numerous possibilities for dealing with urgency. For example, during the COVID-19 pandemic, delivery services for nursing homes and first responders as well as novel testing, tracking and isolation processes, vaccinations, and other medical procedures emerged within a very short space of time.[123]

3.7.5 Policy Implications

Convergent technologies increase the need for scientific expertise, monitoring capacities and knowledge exchange across the administration to identify and exploit arising opportunities. Emerging risks must be addressed through appropriate regulation, knowledge management, and scientific advice.

The current and future convergence of technologies and knowledge systems offers almost endless possibilities for optimizing the performance of tasks and the further development of civil protection. At the same time, the sheer scope of the possibilities, their identification, and targeted integration is a major challenge in exploiting the opportunities for civil protection created by CTs. The phenomenon is so all-encompassing that it is challenging to agree on a suitable definition and to communicate its relevance even to a specialist audience. Added to this is the difficulty of predicting future CTs and their benefits for civil protection. Technological convergence is often more science-, market- or circumstance-driven than the result of targeted R&D with a pre-defined goal. The occurrence of convergence is therefore difficult to predict, the resulting opportunities relevant to civil protection are not always obvious and their realization often requires adaptation, for example, of commercial devices and services to the specific needs of civil protection. Swiss civil protection and the wider Federal Administration must have the relevant expertise, systematically monitor developments, and continuously identify opportunities in the form of technologies, devices, and services. To this end, specialist knowledge and disciplinary competencies must be broadly distributed across departments.

The creation of regulatory transparency in this trend is particularly urgent. The distribution of expertise across departments would also help to develop capacities at the federal level to clarify responsibilities, address regulatory issues surrounding this phenomenon, and tackle them at the governance level. In this context, the Spiez CONVERGENCE conference, hosted every two years by the Spiez Laboratory in Switzerland, can provide an interesting point of reference (see textbox).[124] Among other things, it offers a platform for international exchange on potential regulations regarding the challenges in arms control arising from chemical-biological convergence. A similar exchange forum for experts and policymakers at the national level could be an opportunity to promote interdepartmental exchange, create a common understanding of regulatory challenges, and discuss possible solutions.

In addition to expertise and capacities for realizing the opportunities of CTs, civil protection also needs specialist contact points with suitable knowledge management to be able to deal with the new risks and threat areas arising from this trend. The integration of corresponding specialist personnel into the structures of Swiss civil protection is not only important for appropriate preparedness and adaptation to the changing risk landscape, but also for the rapid procurement of information in the event of an incident. Future risk analyses and assessments in civil protection should take into account and incorporate an ever-broader spectrum of experts from as many disciplines and scientific fields as possible to do justice to the increasingly dynamic risk situation. Due to the ever-increasing complexity of technological development through CTs, the importance of scientific advice for politics and society will continue to grow in the future, for which appropriate structures must be created, for example in crisis management.[125] The proposal adopted by the

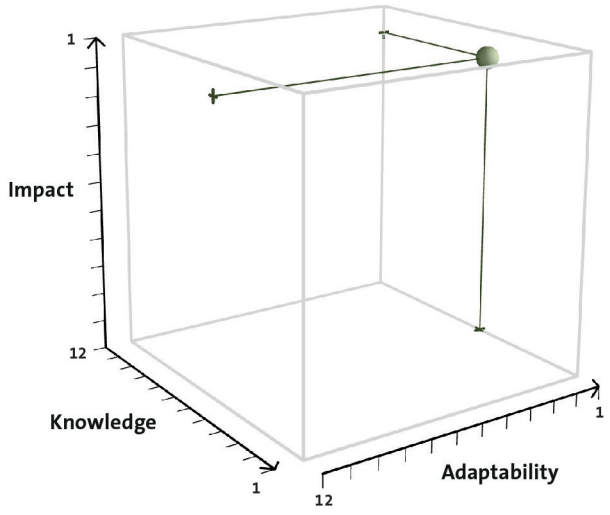
Federal Council at the end of 2023 for the involvement of ad hoc advisory bodies in crises, combined with a code of conduct for scientific advice in crises, is an important step in this regard.[126]

Spiez CONVERGENCE

Spiez CONVERGENCE is part of the Federal Council's Arms Control and Disarmament Strategy.[127] It brings together experts from academia, industry, and scientific policy advice to review the latest advances in science and technology and how they may affect the conventions banning chemical and biological weapons.[128] In recent years, machine learning, deep learning and Artificial Intelligence have had an increasing influence on technological and scientific advances, as demonstrated by an experiment presented at the 2021 conference in which a machine learning model generated 40,000 highly toxic molecules in less than six hours. This led to great media attention and high-impact publications on dual use.[129]

3.8 Digitalization

Impact: **2**, Adaptability: **1**, Knowledge: **6**



3.8.1 Introduction

In its early stages, the process of digitization primarily referred to the conversion of information from analogue to digital format. Today, digitalization encompasses the comprehensive integration and use of digital technologies in all facets of social life and digital business conduct.[130] The demand for digital services made digitalization indispensable across all sectors of society and the economy, ranging from the impact on employment, income distribution, trade, productivity, and the environment.[131] Furthermore, digitalization intersects domains such as the Internet of Things, 5G technology, blockchain technology, big data analytics or AI, or virtual reality, and has both direct and indirect effects on many of the other trends in this report (see 3.9 Hyperconnectivity, 3.10 Big Data and Artificial Intelligence).

The digital transformation of the economy is further evidenced by the rapid increase in global internet traffic, which has increased 25-fold since 2010.[132] Digital data has become both a commodity and a driver of economic growth.[133] Digitalization fundamentally transforms how we communicate, consume, live, and work. However, this comes with its own set of risks and uncertainties associated with the design, development, and deployment of such technologies, as well as the respective regulatory environment.[134] Civil protection organizations have progressively started to implement new digital methods, without the large investments to back these endeavors. The COVID-19 pandemic offered an impetus to accelerate the process of digitalization and align civil protection systems with digital solutions.[135]

3.8.2 Uncertainties

Rapid technological advancements have outpaced current regulations, many of which are based on multilateral rules established before the digital era. This discrepancy not only introduces legal ambiguities but has also raised concerns over accountability and responsibility in the digital space. The EU has been at the forefront of attempting to regulate the digital space whilst fostering innovation with the EU Digital Services Act and Digital Market Act, which comes into effect in 2024. However, the practical implications and effectiveness of this regulation in the rapidly evolving digital landscape, which transcends administrative boundaries both domestically and internationally, remain to be seen.

Digitalization has blurred the traditional distinction between markets and sectors, which are now all intrinsically interconnected.[136] Since digital technologies often intersect different regulatory frameworks, digitalization is challenging the conventional notion of liability and has brought the question of attribution to the fore. The complexity of the regulatory-legal landscape surrounding digitalization creates additional external risks with regard to the adoption, deployment, and integration of these technologies in disaster response.[134]

Many of the current digital solutions are designed, procured, and distributed by private actors who continue to expand their market power, while the governments that shape the regulatory environment are lacking the agility to respond to the fast pace of digitalization. This raises the question of how human-centric digital progress will evolve, and it remains unclear to what extent development will be driven by economic profits, political

power incentives, and dependence on the concentration of resources in a few Big Tech organizations.[137]

Another major uncertainty lies in how resource- and energy-intensive digitalization is and will be in the future. Data centers, for example, are essential to digitalization and are therefore subject to increasing energy consumption, with varying environmental impacts. Today, the tech industry already accounts for around two to four per cent of global CO^2 emissions. Operations related to information and communication technology (ICT) represent around 20 per cent of global electricity demand, a third of which is accounted for by data centers alone.[138] This is followed by the overarching question of the resources required for digitalization and a society that is enhanced by digital technology to foster sustainable economic growth and societal well-being through the fusion of cyberspace and physical space (see 3.2 Social and Demographic Changes).

Even if digitalization typically leads to greater efficiency, civil protection organizations must consistently plan for redundancies that can be activated in the event of digital solution failures during disasters and crises. Scenarios such as loss of mobile connectivity or power supply shortages are of crucial importance. The reliability of digital services under such conditions continuous to be the subject of debate. It is not yet clear whether these technologies will ever advance to the point where civil protection and emergency organizations can fully rely on them without any fallback options.

3.8.3 Challenges

The increasing dependence on digital solutions, cybersecurity issues, and the potential absence of transparent structures for data utilization and sharing pose many threats as well as regulatory and ethical challenges, including:

- A major disadvantage of the interconnectedness brought about by digital technologies is that the increasing use of and dependence on digital technologies can hinder social and individual resilience during disasters.[134] This has been referred to as the 'vulnerability paradox', where individuals have become so accustomed to and reliant on digital infrastructure services that they are more vulnerable in the event of a sudden disruption of these services.[139] In addition, the digital infrastructure and the technology itself can be adversely affected by disaster events. For example, the 2021 floods in western Germany severely disrupted the telecommunication infrastructure and it took two weeks for the connectivity to be restored.[140]

- Cyberattacks are becoming increasingly common during crises, as the numerous attacks on organizations such as the World Health Organization during the COVID-19 pandemic have shown.[138] An overview of current incidents in Switzerland compiled by the National Cyber Security Centre provides an insight into the widespread threats in the digital space, including cybercrimes and attacks on authorities, businesses, critical infrastructure operators, and the broader population.[141] In this context, Swiss legislation has expanded its law on information security and obliges critical infrastructure providers to report cyberattacks.[142]

- Data protection cannot keep pace with the speed of digitalization, and the right to privacy remains an imperative challenge to overcome. Data that could enhance civil protection capabilities is often sensitive in nature, such as location tracking during a pandemic, and can present significant obstacles to civil protection if not handled with ethical and protective care.

3.8.4 Opportunities

The use of digital technologies, as underlined by the *Sendai Framework for Disaster Risk Reduction 2015–2030*[143], has multiple benefits that can add value to civil protection systems, including:

- Collection and storage of high-quality data over longer periods of time can contribute to more reliable forecasting models. For example, geographic information systems, when integrated with open data such as the location of evacuation shelters, are particularly useful for creating and visualization efficient evacuation routes that can help with disaster preparedness.[144]

- Cloud computing is a formidable tool for on-demand network access and facilitates data collection. For example, the establishment of a Shared Information Platform for Disaster Management (SIP4D) in Japan, an information sharing platform for public and private sector data, has greatly facilitated disaster risk response.[145] Another example is the Swiss Data Cube, a cloud archive for earth observation data.[146]

- Data mining, in which large amounts of data are extracted from user-generated content through geo-tagging or spatio-temporal analyses, can be pivotal for disaster risk reduction. An example is Artificial Intelligence language models that identify tweets with rescue requests and thus helps to locate victims.[147],[148] Crowdsourcing is another, a more targeted approach, in which individuals contribute data on affected areas via online platforms. A notable example in this context is the OpenStreetMap

platform, where digital volunteers provide their expertise to track and collect spatial data in support of humanitarian operations. For example, after the earthquake in Haiti in 2020, the information provided by users on the extent of the damage was used to coordinate relief efforts. Similarly, the real-time mapping of the floods in Jakarta was achieved through data feeds on social media.[134]

- The digital representation of scenarios, objects, and the environment by means such as virtual reality or digital twins would allow simulations and tests, for example for decisions by first reponders through mimicking the effects of a natural hazard on a city. Such digital solutions for civil protection could include virtual or mixed-reality training grounds that offer a range of different emergency situations so that civil protection personnel can train a variety of scenarios.[149] A virtual twin is a virtual replica of a physical object, such as a critical infrastructure or a city, which is constantly adjusted by feeding in real-world data. This digital twin makes it possible to simulate various scenarios, for example an earthquake, on the object and assess the consequences.[150]

3.8.5 Policy Implications

Swiss civil protection organizations should embrace digital solutions while remaining vigilant of potential vulnerabilities and aligning with Switzerland's 2024 digitalization strategy. The focus should be on improving cybersecurity, ensuring the protection of privacy, fostering digital skills, curating data structures, and advocating for the interests of civil protection in policy debates for informed regulation.

Civil protection organizations must adapt to an increasingly connected and data-driven world. First, there are major concerns about the lack of regulatory agility to accommodate the increasing pace of technological developments. However, this should not deter investments and capacity building for digital civil protection solutions. This approach is in line with guiding principles of Switzerland's 2024 *Digital Transformation Strategy,* which encourages laws to be designed to enable innovation and support digital solutions whenever possible.[151]

Second, special attention should be paid to the cybersecurity of all digital civil protection operations. With regard to cyberattacks, strengthening cyber resilience through coordinated disclosure of vulnerability, transfer of know-how, or the application of ICT security standards are some of the key priorities to consider.[152] Developing mitigation strategies is also crucial and requires training in digital security, technical legal knowledge, and investments in cybersecurity.[134]

Third, for effective cybersecurity and the implementation and maintenance of digital solutions, it is essential to have skilled personnel dedicated to civil protection-specific tasks.

Fourth, to fully exploit the benefits of digitalization, appropriate data management structures must be established. This includes the digitalization of information that is currently analog or missing, the harmonization of heterogeneous data, and the creation or automation of links between data sources from different stakeholders and data owners. These steps enable the implementation of digital processes such as data mining or crowdsourcing and the maintenance of relationships with other stakeholders, including critical infrastructure operators and scientists. Sharing information with these partners increases the wealth of data and solutions. This could eventually lead to centralized data repositories that can be accessed by relevant civil protection actors when needed, making them interoperable between different actors who can use them for specific purposes.[135] A pioneering step toward such a concept was taken in December 2023, when the Swiss Federal Council adopted a set of measures to enable a data ecosystem to strengthen crisis response.[153]

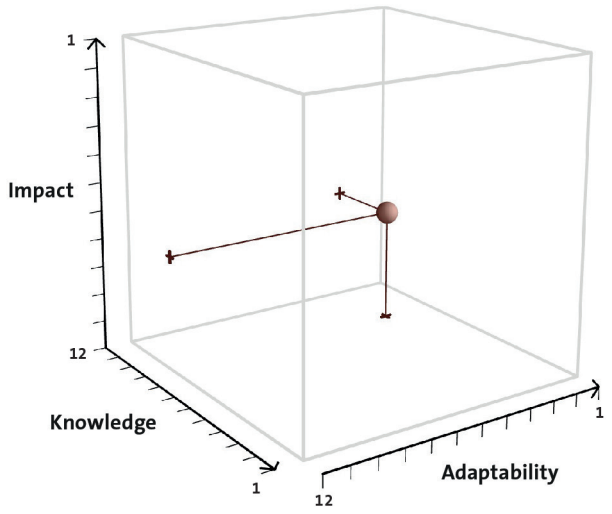
Lastly, due to the sensitive nature of data and digitalization in civil protection operations, it is crucial that civil protection organizations actively participate in policy debates. By participating in these discussions, they can inform legislators about the potential benefits, challenges, and risks associated with digitalization in their field and support the cause of civil protection in future regulation.

Exploring digital solutions for emergency training

The use of virtual reality for training purposes is cost-efficient and improves the training of first responders by simulating life-threatening situations. An EU-funded project entitled TRACENET is currently being carried out with the aim of establishing a network of training centers for civil protection with the help of virtual reality solutions and online collaboration.[154] A similar project is also underway in Switzerland with PolVR, a police training and scenario simulator in virtual reality.[155]

3.9 Hyperconnectivity

Impact: **8**, Adaptability: **3**, Knowledge: **9**



3.9.1 Introduction

Hyperconnectivity refers to the advanced, continuous networking state that encompasses both the technical and the social dimension. It is characterized by multiple levels of connectivity between individuals, devices, and systems. This trend, which is fueled by the overall digital transformation of society (see 3.8 Digitalization), encompasses the widespread use of technologies such as the Internet of Things (IoT) or Web of Things (WoT).[156] Specifically, IoT considers technologies for connecting devices to the internet, the WoT extends the IoT capabilities by defining standard definitions and models for the representation of devices on the internet. In October 2023, there were 5.3 billion internet users worldwide, which corresponds to around 66 per cent of the global population.[157] Hyperconnectivity has made user-generated content the foundation of the world's media. It is revolutionizing how we access knowledge, work, produce, interact, and even perceive fundamental concepts such as information, freedom, and governance.

Hyperconnectivity is not limited to person-to-person interactions, but also extends to people-to-machine and machine-to-machine connections. With attributes such as broadband, ubiquity, ready accessibility, rich information content, and interactivity, it constantly records and facilitates various communication constellations, from one-to-one to many-to-one interactions.[158] As our society becomes increasingly intertwined with this digital fabric, all areas of life, from health to energy production, are undergoing rapid changes (see 3.2 Social and Demographic Change).

3.9.2 Uncertainties

The world we live in today is highly connected, but also full of uncertainties that threaten the foundations of societies, governments, and businesses. The transparency that comes with being increasingly connected to the digital world exposes vulnerabilities in a way that was not possible before. As the number of connected devices increases, so do the vulnerabilities, such as data breaches.

The frequency of cyberattacks continues to increase, causing major disruptions to public services, putting people's lives at risk, and compromising the personal data of millions of citizens, as well as government and industrial processes. It is important to note that the dangers of cyberattacks are not limited to external actors. Even employees can unknowingly compromise institutional integrity by becoming conduits for misinformation or acting as unofficial spokespeople, which poses a significant risk.[159] In the age of hyperconnectivity and hypervulnerability, organizations face uncertainties about how to protect their internal structures and increase the resilience of their own collaborators in crisis situations.

However, the uncertainties in a hyper-connected world extend beyond cyber threats. The reliability of vast networks and the consequences of possible outages or breakdowns introduce their own set of ambiguities. Network reliability, which measures the length of time an infrastructure operates without disruption, is under constant scrutiny. The potential fallout from system outages or failures has not yet been fully explored, raising concerns about society's reliance on digital infrastructures.

The long-term effects of hyperconnectivity on the human mind, behavior, and social interactions are still unfolding. As hyperconnectivity continues to expand, it is essential to find a balance between embracing its benefits and recognizing its potential risks.

3.9.3 Challenges

The increase in constant connectivity also promotes a state of hypervulnerability, in which the vast number of interconnections can amplify potential risks and susceptibilities.

- The increasing online presence also raises the risk of cyberattacks. These attacks can pose a threat to critical infrastructure and interrupt communication at important times. The hyperconnectivity of today's information and (social) media landscape favors the generation and dissemination of misinformation and unverified news that can lead people to take inappropriate actions during a crisis. Increasing hyperconnectivity has resulted in an enormous influx of data generated through mobile communication networks and social media use. The sheer volume and varying quality of this data can complicate real-time analysis,

potentially causing delays or inaccuracies in responding to emergencies can make real-time analysis difficult, which can lead to delays or misjudgments in crisis response. Moreover, there are privacy concerns when certain user data, such as date and location information of citizens during the COVID-19 pandemic, is monitored and analyzed without explicit consent. This is especially concerning when personal data is accessed without consent and can have serious privacy implications.[160]

- The increasing reliance on hyper-connected platforms has raised concerns that traditional communication channels may be neglected in favor of social media platforms. This vulnerability to dependency was highlighted during the 2023 wildfire season in Canada, for example, when major social media outlets restricted the dissemination of news.[161] Furthermore, despite the wide reach of hyperconnectivity, around a third of the world's population still lacks internet access and is cut off from key digital resources.[162] This disparity underscores the need for governments to prioritize inclusivity in their communication strategies and ensure that all segments of society are connected and have access to information.

- Networks need to become more resilient and dynamic to support the speed of digitalization, otherwise they will become vulnerable to attacks. The interconnectedness of modern infrastructure means that even small changes in one area can have far-reaching effects on the entire global system. However, building, maintaining, and regularly upgrading infrastructure to support hyperconnectivity requires significant investment in resources.

- There is growing concern about the effects of constant connectivity on mental health, including stress, anxiety, and decreased face-to-face social interactions.[163] The work environment can exacerbate the need to be constantly digitally connected and put further strain on people's wellbeing.

3.9.4 Opportunities

Hyperconnectivity is revolutionizing the way we access knowledge, work, and interact and offers many opportunities that civil protection authorities can take advantage of.

- In a hyper-connected world, data from physical devices can be integrated into the development of new data-driven services and scenarios. The combination of big data analytics (see 3.10 Big Data and Artificial Intelligence) with ubiquitous wireless coverage is essential for incorporating physical devices in different sectors. This includes civil protection and defense, transportation, eHealth, and the energy sector. One example of this integration is the use of wearable devices for wellness and activity tracking used in health-oriented services. In the area of civil protection, these devices play a crucial role in the immediate transmission of alerts and messages, enhancing real-time communication and response capabilities.

- In crisis situations, the ability of authorities to reach affected population quickly and directly is crucial. Hyperconnectivity plays a key role in this, as it facilitates real-time communication and the efficient dissemination of information. Civil protection authorities can utilize applications, web portals or social media to disseminate emergency alerts, guidelines, and updates to a vast audience quickly. This ensures that critical information is accessed fast and extensively, leading to an improvement in the overall efficiency of evacuation procedures. One example of such an application is the Alertswiss app operated by the FOCP.[164] Through this emergency information platform, the public receives alarms, warnings, and information about their current location continuously via their smartphones. This enables the timely transmission of vital information to the population during times of crisis.

- Social media has become an indispensable tool in emergencies. Platforms where users can share their location have become active elements in rescue operations. This was demonstrated during the earthquakes in Türkiye and Syria, where such platforms were instrumental in locating survivors.[165] As the digital landscape evolves, such platforms are likely to play a central role in collecting data on disaster impacts, as they offer a more comprehensive approach compared to traditional methods. Their advantage lies in their ability to collect data at scale and capture society's reactions to digital and real-world events. In emergency situations, social media is incredibly useful, as it enables quick damage assessments through active user engagement, on-scene imagery, and citizen journalism.

- In emergencies, hyperconnectivity enables the rapid mobilization of volunteers and resources. This is often done through the use of hashtags or targeted campaigns. In addition, civil protection authorities can use online platforms to educate citizens and promote disaster preparedness and resilience-building activities. A notable example of this is the Swiss Federal Office of Topography's workshops[166] aimed at

informing the public about event documentation techniques following disasters caused by natural hazards in Switzerland.

3.9.5 Policy Implications

Hyperconnectivity carries risks such as data breaches and mental illness of individuals. The establishment of official civil protection channels and clear communication strategies are necessary to ensure security and mitigate misinformation and other threats.

The hyperconnectivity made possible by digitalization has become a critical driver of economic growth, fostering innovation and global collaboration. However, it also poses a significant risk as it enables malicious actors to compromise important personal, commercial, and national assets. Policymakers face the challenge of balancing two key priorities: improving the functionality, usability, and appeal of digital platforms for legitimate users, while simultaneously protecting them from attacks and outages.

A key element of this approach is the establishment of official channels for civil protection authorities. These channels should include various communication platforms, from social media to traditional analog networks, and ensure comprehensive accessibility to diverse population groups. This approach not only broadens the reach but also strengthens the integrity of information and thus reduces the risk of misinformation. Additionally, the use of data mining techniques can improve the ability of authorities to detect false and misleading information. Legal frameworks, such as the recent EU Cybersecurity of 5G networks, can further strengthen the network structures to prevent and counteract cyber threats.

Official channels are not only useful for communicating with the public, but also for enhancing communication among practitioners. The integration of scientific online platforms, such as the international Global Disaster Alert and Coordination System[167] (GDACS) or the Swiss Joint Information Platform for Natural Hazards[168] (*Gemeinsame Informationsplattform Naturgefahren* GIN), which provide all available data on natural hazards in a map application, can serve as a comprehensive basis for identifying scientific information and dealing with natural hazards at an early stage.

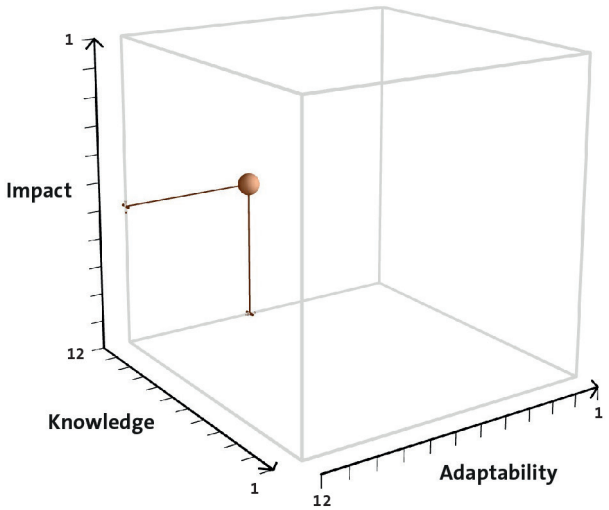
In today's world of hyperconnectivity, it is important to recognize that while constant connectivity has its benefits, it can also lead to new psychological risks, especially in the workplace. These risks are not only due to technology itself, but also to the greater flexibility it offers, which can blur the boundaries between work and personal life. It is the responsibility of employers to educate their employees about the potential adverse effects of technology integration. This education should not only include the dangers of excessive connectivity, but also the importance of establishing healthy digital boundaries. Employees must receive comprehensive training to ensure safe and competent use of technology and protect them from the negative effects of overuse or misuse, such as burnout and other stress-related illnesses.

Digital volunteerism in emergency response

The use of trusted digital volunteers, also referred to as Virtual Operation Support Teams[169] (VOST), has become pivotal in emergencies. Spain introduced the first European VOST team in 2012 during a severe forest fire season. These digital volunteers, organized into dedicated support teams, focus primarily on compiling, authenticating, and integrating information from a variety of sources during disasters. They not only support civil protection authorities, but also advise people on how to protect themselves in crisis situations.

3.10 Big Data and Artificial Intelligence

Impact: **7**, Adaptability: **7**, Knowledge: **12**



3.10.1 Introduction

Big data refers to large amounts of data that require new system architectures and digital technologies in data management to extract value from the data for enhanced insight and decision-making. It is difficult to analyze big data using traditional analysis methods due to its inherent characteristics that can be described using the five Vs: Volume, Veracity, Velocity, Variety and high Value.[170] For this reason, several Artificial Intelligence (AI) techniques

have been designed to process big data. AI can be defined as computing systems that emulate and aim to exceed human intelligence in the execution of problem-solving tasks. To process big data, AI makes use of machine learning (ML), which uses statistical, neural, and data-driven processes as well as training data to teach computers how to independently recognize consistencies, patterns, and irregularities in large data sets.[171,172] With increasing data generation and availability, AI is expected to benefit disaster risk management in predictive analytics for forecasting, event detection for early warning systems, and improving situational awareness in real-time.[173] Recent developments in ML algorithms, such as the development of AI-powered chatbots, have marked the beginning of the generative capabilities of such systems, while also highlighting their current weaknesses. AI will increasingly serve as a basis for and in conjunction with other systems and therefore offers potential in all phases of disaster and crisis management (see 3.7 Convergent Technologies, 3.9 Hyperconnectivity, 3.11 Unmanned systems and Autonomous Robotics).[174,175,176]

3.10.2 Uncertainties

AI has been on the rise since the 1950s, but its full impact on society, the economy, and government is still unclear. Advances in computational power and hardware have been considerable, but regulatory frameworks for AI in the public and private sectors have so far only resulted in soft laws due to the novel and complex nature of this field. The Swiss Federal Council, for example, has adopted a technology-neutral stance, favoring guidelines over binding legal instruments to regulate AI in order to promote innovation and investment while maintaining a degree of caution.[177] This cautious approach creates uncertainties for civil protection organizations when introducing AI due to the lack of legal clarity.

The effective utilization of big data via AI faces challenges due to inherent uncertainties within AI technology. These uncertainties revolve around the collection and use of personal data for big data mining, and the use and efficacy of algorithms in machine learning models for predictive analytics. In disaster management specifically, this issue is exemplified by the heavy reliance on historical data, which results in AI models primarily reflecting past patterns, limiting their ability to anticipate future scenario.[178] This limitation raises critical questions about the extent to which these systems can accurately predict future events, especially if they fall outside historical patterns. The capability of AI-driven systems to accurately predict and effectively respond to catastrophic events therefore remains uncertain.

Further uncertainty surrounds the evolution of AI, in particular regarding the duration of its reliance on human input data. This raises important questions about the extent to which AI can support civil protection processes and systems, and at what point it may turn from an asset to a potential liability or vulnerability.

Finally, the inherent uncertainties of AI as an enabling tool are linked to the broader question of its risk potential. The full extent and impact of AI as a risk factor is not yet fully understood, necessitating careful and continuous assessment.

3.10.3 Challenges

To maximize the potential of big data and AI for civil protection, research, design, and application must overcome several challenges and limitations to ensure responsible deployment in all phases of crisis management:[179,180]

- Good quantity and quality of data is key for AI systems. However, in disaster and crisis situations, data is often incomplete or unavailable, making it difficult to obtain reliable AI outcomes (including training data). The risk of biases in data or algorithms can negatively affect the civil protection system or the beneficiaries of the system.[181,182] Also, AI may misjudge cases or events that fall outside historical patterns that are not included in training or observed data (e.g., black swans).

- In the context of disaster risk reduction, data harmonization is a major concern addressed in the *Sendai Framework for Disaster Risk Reduction 2015–2030*.[143] It is essential to ensure that disaster databases are accurate, accessible, credible, and reliable. This requires proper data collection methodology and hosting by reputable institutions. Neglecting these aspects can have adverse effects on disaster response planning and risk reduction.

- As the data used in civil protection is sensitive data, adequate privacy protection procedures must be in place. Additionally, network vulnerabilities and cyber threats can significantly impact AI solutions in the digital realm. [183,184,185]

- The use of AI systems in civil protection depends on the availability of resources. Apart from the high computational requirements, the development and maintenance of these AI systems requires technically skilled professionals who need to be trained regularly. This highlights the importance of investing in both technology and human expertise.

- The black box bias, which refers to the idea that users cannot see or understand the inner workings of AI models and therefore cannot question or reasonably judge the outcomes derived from them, is a concern.

This makes it difficult for civil protection to use AI solutions that lack explainability and transparency, which fuels public skepticism.[172,173,186,187]

- Many of the challenges will lead to ethical considerations, including the question of how personal data is used and what responsibility and accountability should look like in the context of AI solutions. Additionally, humans still have certain abilities, such as common-sense reasoning, emotional intelligence, intuition, that AI algorithms have struggled to emulate and may never be able to fully imitate. These are qualities that are valuable for civil protection systems, operations, and personnel.

3.10.4 Opportunities

While AI is subject to changes given the rapid pace of innovation in this field, it has the potential to improve and support civil protection activities in all phases of disaster and emergency management:

- AI has the potential to be used in civil protection scenarios where data needs to be collected, analyzed, and presented. In pre-disaster settings, this is particularly helpful for forecasting and predicting emergency situations and thus triggering more precise early warnings (e.g., area-, person-, language-specific). During a crisis, AI can improve decision-making by increasing real-time situational awareness, for example, by merging relevant input data into integrated situation reports, assessing evacuation routes, or simulating the evolution of a disaster including cascading effects.[188] In the post-disaster phase, AI and ML can significantly boost the efficiency of response measures. For example, AI can help with damage assessment using remote sensing imagery. Since the algorithms can incorporate new post-disaster data, they are constantly evolving, enriching their data sets and improving predictive capabilities for future incidents.[172,174,189,190]

- The implementation of AI can greatly improve strategic and operational planning of civil protection organizations, as a multitude of variables and inputs can be processed almost instantly. This involves optimizing the allocation of emergency resources, such as the strategic positioning of assets based on location-specific requirements, available equipment, and personnel distribution. Moreover, for operators of critical infrastructure, such as tunnel traffic management systems, AI can play a crucial role in ensuring efficient and safe operations.

- Due to the increasing amount of data, AI has emerged as a promising tool for climate change adaptation (see 3.1 Climate Change Adaptation). It offers a range of functions that can help to identify vulnerable areas, simulate future climate scenarios, and assess risks and opportunities for businesses and infrastructure.[191] Furthermore, AI models are becoming increasingly powerful, extending the scope of analysis from a single risk assessment to multi-risk simulations involving different systems.[192]

- The true value of big data and AI is realized when they are combined with other technologies and services, as discussed in Section 3.7 on Convergent Technologies. This includes applications such as data mining in the healthcare sector during pandemics, analyzing observations from remote sensing platforms, and integrating AI into unmanned and robotic systems (see 3.11 Unmanned Systems and Autonomous Robotics). From the perspective of civil protection, AI is not just a stand-alone instrument, but rather a means to an end, namely the protection of people.

3.10.5 Policy Implications

To make analytics of big data through AI an added value for civil protection, know-how, data structures, and innovations need to be built up while mitigating the possible harms of AI. Explainable algorithms, data privacy, and cyber security are key and should be regulated appropriately.

Considering the challenges, opportunities, and uncertainties of big data analytics through AI in the domain of civil protection, it becomes increasingly urgent to identify and implement mechanisms that enable the benefits of this innovation and mitigate the associated harms.

The primary aim is to overcome legal and ethical challenges while promoting innovation and investment. This requires the implementation of regulations to protect data, privacy, and cyber operations. One crucial aspect is the ownership of big data, which often involves personal data that can be traced back to specific individuals. Switzerland has been proactive in amending and/or implementing such regulations in recent years in line with EU recommendations. In particular, Switzerland has been at the forefront of introducing data protection laws in relation to AI systems, although there is still a need for more legal certainty. To promote safety in the use of emerging technologies, it is important to establish clear standards for testing, evaluation, validation, and verification (TEVV) methods. These standards can help to identify the benefits and harms associated with AI technologies and take into account safety-critical contexts.[184]

Another issue is the development of a global standard for the transparency of algorithms, which will be difficult to achieve considering the complexity of methods used in big data analysis. Various stakeholders are concerned that the existing AI guidelines and frameworks do not protect the fundamental rights of citizens.[193] The goal of creating transparent and explainable AI, also known as XAI, to address potential vulnerabilities in the design process should become a prerequisite for the developers of these technologies.[173] The EU recently agreed on the first Artificial Intelligence Act, which aims to ensure that AI systems used in the EU are safe, transparent, traceable, non-discriminatory, and environmentally friendly.[194]

Data is the key to the successful deployment of AI. To ensure the required quality, data sources must be generated where they do not yet exist, heterogeneous data must be harmonized, and the accessibility and security of the data must be guaranteed. An initial step toward sharing data among stakeholders has been achieved through the Federal Council's aforementioned measures to enable a data ecosystem that securely links data spaces between different topics and sectors.[195]

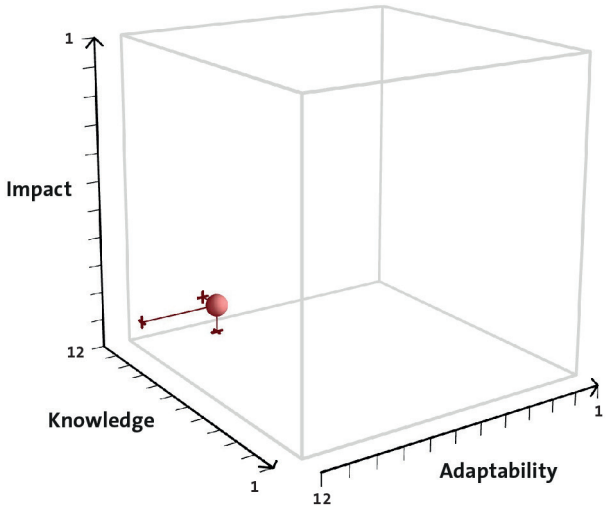
Finally, it is crucial that a sufficient number of AI specialists are educated, trained, and retained to ensure the development, maintenance, and deployment of AI activities in civil protection. Ensuring data quality, algorithmic transparency, and explainability should help to reduce the perpetuation of data bias and increase the quality of outputs. AI is a cutting-edge technology that offers many technological advancements and potential applications for civil protection. It falls into a cross-fertilized field of scientific knowledge, operational craft, and regulatory frameworks. For this reason, collaboration between stakeholders, i.e., academia, industry, legislators, and users, is essential to maximize the benefits of this technology.

AI-driven crisis detection

Launched in 2021, the Artificial Intelligence for Emergency Response project aims to link Earth Observation analysis with social media activity to identify spatial and temporal hotspots of a crisis (see 3.9 Hyperconnectivity, 3.12 Space-based Capabilities).[196] During the Hokkaido earthquake in Japan in 2018, it took experienced engineers five days to detect landslides, while AI satellite image interpretation took five minutes and achieved a hit rate of 93 per cent.[197]

3.11 Unmanned Systems and Autonomous Robotics

Impact: **11**, Adaptability: **9**, Knowledge: **11**



3.11.1 Introduction

The integration of unmanned systems and service robots in civil protection continues to gain traction, as predicted by the last two reports and demonstrated by the investments in research and development.[198] While unmanned systems include aerial, ground, and underwater vehicles, robotics in this context can be understood as the development and operation of mechanical and digital systems with sensors, actuators, and software (i.e., control) that perform a task autonomously or semi-autonomously.[199] Thanks to catalytic technologies such as Artificial Intelligence or the Internet of Things (see 3.9 Hyperconnectivity, 3.10 Big Data and Artificial Intelligence), unmanned systems and robotics are gradually merging into single devices or complex solutions that enable intelligent systems.[200,201] These unmanned and progressively autonomous robotic systems can be deployed at every phase of the Integrated Risk Management Cycle.[202] Unmanned systems and robots are already increasingly deployed in civil protection operations, from firefighting robots and unmanned aerial vehicles for remote sensing to supply deliveries during the COVID-19 pandemic.[203] Lessons can be learned from this that will be useful for future efforts.[204,205]

3.11.2 Uncertainties

While technological advances continue to push the boundaries of the capabilities of unmanned systems and autonomous robots, several questions remain that will be critical to the broader deployment of such systems for civil protection and crisis management. The uncertainties run through various areas, starting with the devices themselves and the question whether the technical as-

pects, such as sensory perception, cognition, motion, manipulation, adaptability, and interaction, will meet the required standards. Even today, many robots are not yet as capable as humans in traditional human tasks, e.g., as medical first responders.[206,207] This raises the question of how broad the range of applications can be and what exact capabilities and specifications are required for civil protection, including aspects of human-machine interaction and collaboration.

While certain prototypes achieve promising results in laboratory and field testing, they still need to be adapted to the harsh environments of crisis situations. The development of sensory perception, mechanical capabilities, and input information processing will determine the extent to which unmanned systems and autonomous robots will be able to perform civil protection tasks as autonomous systems. Since there is only a limited number of buyers and users for such systems, the economic feasibility of developing and operating such systems will also be decisive in determining how widely and quickly such applications will find their way into civil protection organizations.[208]

Overall, the success of autonomous systems will depend on the alignment of the above aspects, which will be reflected in the reliability and trustworthiness of the systems in crisis and disaster environments.

3.11.3 Challenges

With the increasing capabilities of unmanned systems and autonomous robots, new challenges and dependencies arise:

- As with other technological advances and increasing autonomy, ethical concerns will be ever-present.[194] Ethical dilemmas of unmanned and autonomous systems include fairness and discrimination, false expectations, workforce replacement (see 3.2 Social and Demographic Changes), privacy, responsibility and authority in deployments, technical safety and robustness (including logistical autonomy), and the question of the right level of human-in-the-loop.[209]

- While unmanned systems have only begun to be implemented in civil protection structures, the increasing deployment of autonomous robotic systems will require new forms of coordination and regulation involving human-robot teams and robot-robot systems, such as the management of airspace between manned and unmanned air vehicles.[204] Furthermore, some relatively new autonomous systems still rely on sophisticated control and command procedures, highlighting the need for specialists or specially trained civil protection staff for future systems. Meeting this demand will require new capabilities in civil protection organizations, which may not be feasible for a number of Swiss authorities if they rely largely on reserve personnel.

- Unmanned and robotic systems can encounter technical, design and operational issues that require redundancies, such as human intervention at any time. These interconnected devices rely on a network infrastructure for communication and control, which may be disrupted or unavailable in the event of a crisis. Their dependence on the network infrastructure also makes autonomous systems vulnerable to cyber security threats.[210]

3.11.4 Opportunities

The more capable and reliable unmanned systems and autonomous robots become, the more opportunities they offer for civil protection operations:

- Technological advancements in sensory perception, cognition, motion, manipulation, adaptability, and interaction, found in both military and commercial applications, have the potential to improve civil protection in the field.[211] For example, ensuring maintenance and safety in critical infrastructure, by using intelligent systems for health monitoring of infrastructure, such as inspection of bridges.[212]

- The convergence of material development, soft robotics, and bio-inspired robots creates new possibilities for unmanned and autonomous systems. Incorporating biological principles into engineering, for example, will allow future autonomous robots to not only be physically rigid, but also better adapt to their operational environment or task. By changing their morphology, for example, robots are better suited to enter confined spaces. Such developments underline the fact that autonomous systems can add value at every phase of disaster risk management. For example, soft robotics can support pre-disaster inspections of critical infrastructure, or snake robots can navigate through rubble in the search for survivors.[213,214] In the recovery phase, remote sensing devices can assist with damage assessments, while advances in construction automation can support faster recovery through debris and earthmoving systems and prefabrication of components.

- Through increasing connectivity and interconnectivity (machine-to-machine), a multitude of individual robotic and unmanned devices communicate and coordinate and act as a system of systems to perform tasks, especially in the preparation and response

phase of disaster events.[215] For example, swarms of drones that carry out search operations over large areas, monitor hotspots during forest fires or independently map unknown areas offer a promising perspective.[216]

- The merging of different technologies (e.g., robotics and AI) and autonomous decision-making will further enhance the capabilities of intelligent systems in remote, difficult, or dangerous terrain, reducing the risk to emergency personnel. For example, while drones are already being used to monitor hotspots in wildfire scenarios, unmanned autonomous systems may be able in the future to initiate "prescribed burn" when combating wildfires (see 3.7 Convergent Technologies).

3.11.5 Policy Implications

Swiss civil protection should explore the opportunities of unmanned and autonomous systems and foster relationships with universities and industry. This will allow civil protection to benefit from external know-how and contribute to discussions on design, ethics, and regulation.

Switzerland has a well-established innovation and research community spanning both the academic and industrial spheres, particularly in the field of drones and robotics. Swiss civil protection should therefore participate in and encourage cross-fertilization between these institutions to actively shape the development of unmanned autonomous systems and harness the emergence of disruptive technologies from other domains, as the EU does through its network (e.g., Collaris).[217] Setting standards in the development phase will also make it easier to intervene in the regulatory processes.

As the challenges posed by the autonomous systems have shown, it is crucial to proactively address ethical dilemmas through regulation to ensure their safe and responsible use. This requires anticipating ethical issues, establishing empirical guidelines, and answering questions about authority and responsibility, in accordance with existing legislation. This strengthens society's trust in such solutions, reduces public skepticism, and offers proofs of concepts.[209] The creation of regulatory frameworks also leads to creation of favorable conditions, e.g., for the training of civil protection personnel, the testing of new systems in practice, and the exchange of know-how, best practices, and experience.

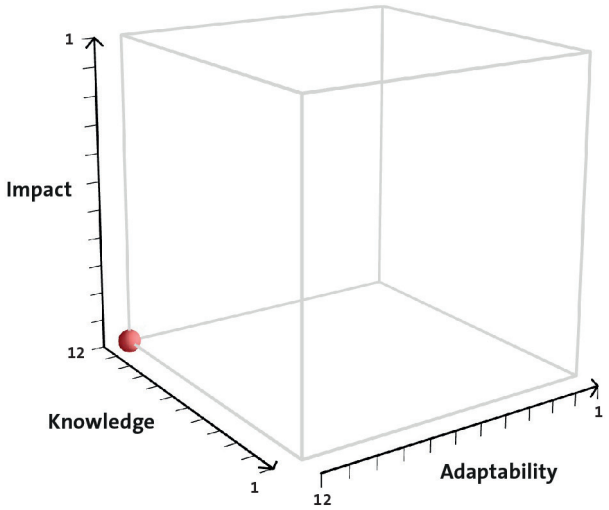
While research, innovation, and the development of disaster robotics is an emerging market, there are only a limited number of buyers from civil protection authorities, emergency response organizations, and the military. Therefore, cost efficiency must be achieved to make these technologies accessible. Alternatively, substitutes could be sought in the non-disaster related commercial market. One possible solution for this issue could be the pooling of resources and expertise among different civil protection stakeholders (see 3.6 Collaborative Approaches). While the replacement of civil protection personnel by autonomous robots is not predicted, civil protection organizations need to start planning which solutions can be implemented and how the civil protection system needs to adapt to them (e.g., training, logistics, dependencies, coordination).[218]

Bridging robotics knowledge with emergency services

The Swiss platform Advanced Robotic Capabilities for Hazardous Environments (ARCHE) highlights the collaboration between academic and government actors in disaster response. The aim is to share robotics knowledge with emergency services. During the 2023 public event, prototypes were presented for the detection of pollutants, access to difficult or dangerous terrain, construction work, and underwater mapping.[219]

3.12 Space-based Capabilities

Impact: **12**, Adaptability: **12**, Knowledge: **12**



3.12.1 Introduction

Space-based capabilities refer to the use of assets and applications beyond the Earth's atmosphere, such as satellites and the associated ground stations. The satellites transmit information via radio frequencies. The ground stations send data, including operating instructions, to the satellites, and in return the satellites transmit information to these stations, end-users, or other satellites.

Space-based capabilities are crucial as they offer important services such as positioning, navigation and timing (accurate measurement of local time and location), communication (television, broadband internet, telephone and data transmission services), and Earth observation (monitoring of the Earth's land, marine and atmospheric environments).

Switzerland does not have its own national space agency, but obtains its access to satellite data and services primarily through its participation in the European Space Agency (ESA), and secondarily through agreements and partnerships with national space agencies. As a founding member of ESA, Switzerland supports ESA's programs and activities with 190 million CHF annually.[220] Through ESA and the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT)[221], Switzerland participates in parts of Copernicus, the EU Earth Observation Programme, which produces satellite data for many applications dedicated to the monitoring and forecasting of the Earth's system. Through a cooperation agreement with the EU, Switzerland has secured access to the EU's Galileo satellite navigation program, which provides improved positioning and timing information.

3.12.2 Uncertainties

Switzerland has developed considerable expertise in various space technology domains, which has led to its significant contributions to numerous space missions. The country's space industry comprises around 250 different entities, including start-ups, small medium enterprises, large corporations, and universities, distributed throughout the country and engaged in various activities.[222] However, Switzerland lacks a dedicated national space agency, and primarily relies on access to space-based data through commercial partnerships, collaborations with national space programmes, or international initiatives. Due to uncertainties surrounding the ongoing negotiations on the *Institutional Framework Agreement*[223] (InstA), the Federal Council has prioritized access to space-based capabilities and their resilience through targeted programme participation. Timely access to satellite data is particularly relevant in civil protection, as satellite imagery combined with Artificial Intelligence (see 3.10 Big Data and Artificial Intelligence) can significantly improve crisis and disaster response.

Financial commitments are a factor that will influence Switzerland's future participation in ESA and other international initiatives, such as *Composante Spatiale Optique*.[221] Although Switzerland consistently provides significant funding to the ESA, this commitment may be affected by possible economic shifts or changes in domestic policies. The growing influence of the EU on intergovernmental organizations such as ESA and EUMETSAT adds to this uncertainty, as the delegation of program implementation by the EU to these entities may alter the dynamics of involvement and decision-making.

The increasing involvement of commercial entities in the outer space sector introduces an additional degree of uncertainty regarding the use of space-based capabilities for civil protection. This trend has underscored the need for international regulations, as individual states enact their own local laws to promote commercial space activities by their domestic private companies. A fragmented approach to space exploration can result in overcrowding and potential monopolization, an issue similar to conflicts over scarce natural resources on Earth (see 3.5 Growing Supply Dependency).[224] These challenges have far-reaching implications and require an internationally coordinated effort to ensure that space exploration remains accessible and beneficial to all stakeholders.

The space sector is increasingly influenced by geopolitical tensions and the trend towards polarization or unilateralism (see 3.4 Geopolitical Polarization). Security and defense concerns have intensified due to the dual-use nature of space assets, which can be used for both civilian and military purposes. These geopolitical dynamics can influence partnerships, with global events strengthening or weakening alliances. Disputes between countries cannot only hinder cooperative space projects, but also lead to the termination of existing agreements. Meanwhile, international space laws are in a state of flux and Switzerland faces the challenge of navigating these new regulations, establishing its diplomatic position on the global stage, and effectively advocating for its interests and perspectives.

3.12.3 Challenges

The increased reliance on satellites for communication, navigation, and observation has increased the risk of disruptions to these critical infrastructures, compromising not only economic activities but also national security. The disruption of satellite services can occur through unintentional damage or targeted attacks by state or non-state actors. Another major challenge for Switzerland is the limited access to satellite imagery, particularly to swift data during the initial stages of disaster management.

- Unintentional damage and disruption can be caused by collision with space debris or by the explosion of spacecrafts and their upper stages due to residual fuel in tanks or fuel lines. Over 560 in-orbit fragmentation events have been recorded since 1961.[225] As the number of satellites and related debris increases, so does the probability of collisions. Although guidelines are in place to prevent the creation of new debris, it is challenging to determine responsibility for removing the huge amount of debris already in orbit. In addition, extreme space weather events such as

geomagnetic storms can cause outages lasting hours to days, resulting in the loss or disruption of satellite-based services.

- In addition to accidental disruptions, there have also been deliberate attempts to interfere with space operations by launching missiles from the ground to intercept satellites. There are four types of counter-space capabilities that can be used against satellites, ground stations, and other assets: kinetic-physical (which directly damage physical structures), non-kinetic-physical (which cause damage without direct contact), electronic weapons, and cyberattacks. In 2022, for example, Russian hackers launched a malware attack on Viasat's KA-SAT satellite network, which caused temporary communication disruptions for many broadband users in Ukraine, Poland, Italy, and Germany. This cyberattack also affected 5,800 wind turbines in Central Europe.[226]

- Switzerland currently lacks a national Earth Observation program, which limits the ability to use satellite imagery for disaster risk reduction. The use of satellite imagery for Swiss civil protection is currently underexplored and underutilized, especially at the cantonal level.[221] Its application is mostly limited to the documentation of events, despite its potential for the broader spectrum of event management and response.

3.12.4 Opportunities

Space-based capabilities have proven crucial in all phases of managing disasters and complex crises, assisting with preparedness, response, and recovery and enhancing the protection of the population from hazards.

- The integration of satellites with advanced 5G and upcoming 6G networks offers a reliable and speedy worldwide data transmission, which can massively benefit many industries and individuals alike. This vital infrastructure improves connectivity, especially in rural and remote regions, and provides consistent coverage for mobile devices. Space-based satellite communications are vital for real-time data exchange and connectivity, enabling coordination centers and first responders to receive information on the ground, especially in areas where terrestrial communications are unavailable or compromised. The importance of satellite communication was highlighted during the 2017 forest fires in Portugal, where the destruction of telecommunications stations, poles, copper and fiber optic cables led to a lack of coordination between firefighters and rescue services, resulting in multiple fatalities.[227]

- Navigation satellites provide signals from space that transmit positioning and timing data to ground-based receivers to pinpoint their exact location. This technology has become an indispensable part of our society, as it increases public safety by preventing traffic accidents and shortening the response times of ambulances, fire brigades, and other emergency services. In addition, the precise timing signal from GPS, anchored in atomic clocks, is fundamental to critical operations such as power grid synchronization and electronic transaction validation.

- Satellite-based Earth observation is essential for monitoring the Earth's land, marine and atmospheric environments. Weather satellites track air quality and various environmental and climate factors to assess global and regional trends in a changing climate. Satellite imagery provides detailed and high-resolution data that is useful in measuring the extent and intensity of human activities, such as deforestation and urban expansion. Additionally, satellite imagery is a crucial tool for rapid mapping and damage assessment, making it invaluable for determining immediate need for assistance. It also allows for the efficient planning of evacuation routes by identifying areas of high population density. Beyond immediate response, satellite imagery supports reconstruction efforts and the restoration of services to mitigate the impact of future events.[221]

3.12.5 Policy Implications

Switzerland faces intricate policy challenges to ensure access to vital satellite services such as communications and Earth observation. On the global stage, Switzerland could advocate for sustainability in space, including debris management and the prevention of space militarization.

The development of space-based technologies presents Switzerland with complex policy challenges and opportunities that require a thorough and multidimensional analysis. One of the most critical aspects for a nation as interconnected as Switzerland is ensuring uninterrupted access to vital services, such as communication, navigation, and Earth Observation. To minimize disruptions to satellite services, it is essential to improve the resilience of satellite-based capabilities. In the event of satellite failures, improving cyber security structures or accessing terrestrial backup system can help maintain access to vital services.

The progress of Swiss interests in the space sector depends to a large extent on the joint efforts of politics, administration, industry, and authorities. Due to the high financial costs of space-based capabilities, it is im-

portant to ensure a coordinated approach between the various federal offices involved in space activities. This approach promotes efficiency and allows the exploitation of the diverse potential of satellite capabilities. To achieve this, it is necessary to initiate interdisciplinary fora that bring together representatives from civil protection, defense, academic institutions, and the commercial sector. Such fora will promote the exchange of expertise and create synergies at both cantonal and federal level. This will lead to better informed decision-making in the area of space policy.

Switzerland's policy priorities on the global stage with regard to space can be divided into two main categories: accessibility and sustainability. One of the key challenges for Switzerland is the limited access to essential satellite services, such as the rapid acquisition of satellite imagery. It is therefore important that Switzerland strengthens its position in terms of data accessibility through solid international partnerships, whether through bilateral or multilateral cooperation.

The potential militarization of outer space is a pressing concern that requires international deliberation. Due to its neutral stance and reputation in global diplomacy, Switzerland could lead initiatives to negotiate international treaties or guidelines that prevent the weaponization of space and promote peaceful space activities. The increasing number of spaceborne assets and the associated space debris also require a proactive approach to space sustainability. Switzerland's policy framework should endorse sustainable practices such as active debris removal, collaborative space traffic management, recovery of semi-functional assets in orbit, and environmentally conscious satellite design.

Earth Observation for emergency management

The Copernicus Emergency Management Service (CEMS)[228] is an EU program that uses satellite imagery and other geospatial data to provide free and on-demand mapping services in emergencies such as natural disasters and man-made accidents. The two components (i.e., on-demand mapping and early warning and monitoring) support the activities of decision-makers in all phases of disaster risk management, including prevention, preparedness, risk reduction, and recovery.

4 Stakeholder Participation

Building on the previous editions, this report aimed at actively engaging stakeholders at all levels of government as well as the private sector. The approach to stakeholder engagement was twofold and included a workshop and a survey to comprehensively assess the relevance and implications of the selected trends for Swiss civil protection.

First, stakeholders were engaged through a survey distributed to individuals within the Swiss civil protection network in August and September 2023. Participants in the survey rated the selected trends and ranked them according to their perceived importance on a scale of one to twelve, with one being the most important and twelve the least important. Their ratings were related to three key dimensions: *Impact, Adaptability, and Knowledge*. To gain insightful feedback, an additional open question was asked, inviting participants to share their thoughts on the trends identified and the dimensions rated. A total of 88 people participated in the survey, resulting in a solid data basis. The composition of the participants was well balanced, with 46 per cent representing cantonal authorities, 39 per cent representing the Federal Administration and 15 per cent representing the private sector.

Nineteen of the twenty-six cantons were represented, and the participants were geographically well distributed across Switzerland. This diverse participation allowed for a holistic view of the trends and their implications for the different sectors and regions.

The survey was designed to be as simple as possible and was primary intended to familiarize civil protection stakeholders with the upcoming trends in this report. No specific prior knowledge was required to rank the trends, as participants were given a brief description of each trend and asked to rank them according to their individual perspective. Survey participants were encouraged to assess the trends through the lens of the Integrated Risk Management Cycle, considering the impact on various aspects such as mitigation and prevention, emergency preparedness, recovery, and reconstruction. The survey stimulated reflections on how these trends will impact civil protection systems, taking into account challenges and opportunities. It provoked reflections on how these trends will affect civil protection stakeholders, both in their professional and personal capacity, including their impact on day-to-day institutional operations. Ultimately, the aim was also to gather insightful feedback on the selection of the trends, and to understand the interconnections between these trends and the three dimensions.

Second, a workshop was held in September 2023 with 30 participants, including representatives from the FOCP and other federal agencies, the cantonal and municipal civil protection authorities, the private sector

actors, NGOs and the authors of this study. The workshop facilitated dynamic group discussions between participants with diverse backgrounds. These discussions focused on the trends described in this report and explored their scope, associated uncertainties, challenges, opportunities, and potential policy implications. This workshop was particularly useful for identifying ongoing projects and applied examples in Switzerland and beyond that are relevant to the twelve trends. The qualitative insights gained from these discussions have been integrated into the discussion of each trend in this report.

4.1 Impact, Adaptability, Knowledge

The three dimensions of *Impact, Adaptability,* and *Knowledge* were crucial for assessing the significance and consequences of the individual trends for Swiss civil protection. *Impact* concerns the degree to which Swiss civil protection could be influenced by each trend, particularly regarding its operational effectiveness. *Adaptability* examines the perceived capacity of Swiss civil protection to adapt and respond to the challenges and opportunities these trends may bring. *Knowledge* refers to the existing expertise in Swiss civil protection regarding the impacts of the trends and the necessary adaptability. The chosen dimensions provide an indication of how the emerging trends could reshape the civil protection landscape in Switzerland. They also provide insights into the overall resilience of the civil protection system to future trends. In this context, resilience is defined as the combined ability of the civil protection system to cope with impacts, adapt to change, and leverage existing knowledge within the system.

To analyze how the participants rated the trends in the three dimensions of *Impact, Adaptability,* and *Knowledge,* the data was aggregated and average scores were calculated as a statistical measure, as represented in Figure 4. The results of the survey indicate that Swiss civil protection is expected to be most significantly affected by the trends Climate Change Adaptation, Growing Supply Dependency, and Digitalization in the coming years. Trends considered to have a lower impact include Convergent Technologies, Space-based Capabilities, and Unmanned Systems and Autonomous Robotics. This confirms the results in previous editions of this series.

In terms of *Adaptability,* the experts identified Digitalization, Collaborative Approaches, and Climate Change Adaptation as areas in which Swiss civil protection possesses greater adaptive capacity. Trends requiring more adaptability include Geopolitical Polarization, Space-based Capabilities, Convergent Technologies, and Unmanned Systems and Autonomous Robotics. Since the last edition of this series, Climate Change Adaptation has evolved from a trend with limited coping potential to one with significant adaptive capabilities in Swiss civil protection.

For the dimension of *Knowledge,* the survey revealed more pronounced differences in existing expertise in relation to individual trends than in terms of *Impact* or *Adaptability*. Within Swiss civil protection, there is extensive knowledge about the trends Climate Change Adaptation, Urbanization and Metropolization, and Growing Supply Dependency, likely due to the fact that these areas have long been discussed in Switzerland and are the focus of numerous projects. In contrast, there appears to be less knowledge among the relevant authorities concerning Space-based Capabilities, Big Data and Artificial Intelligence, and Unmanned Systems and Autonomous Robotics.

The trends with the smallest gap between the three dimensions include Digitalization and Space-based Capabilities. According to the experts, *Impact, Adaptability* and *Knowledge* have a higher significance in the first trend and a lower value in the latter.

Figure 4 Average scores assigned to trends in the dimensions *Impact, Adaptability,* and *Knowledge*
(1 is most relevant, 12 is least relevant)

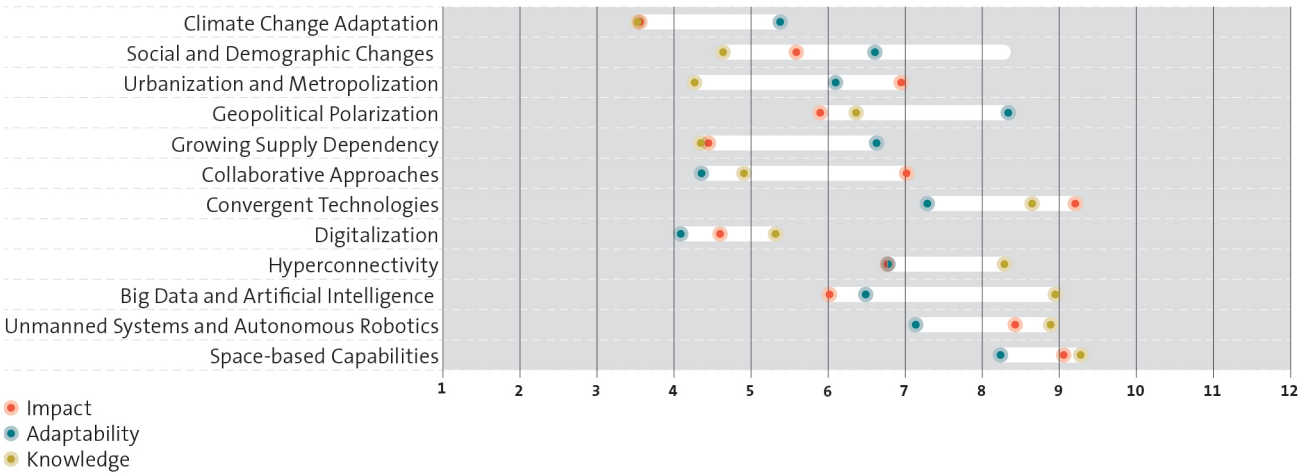
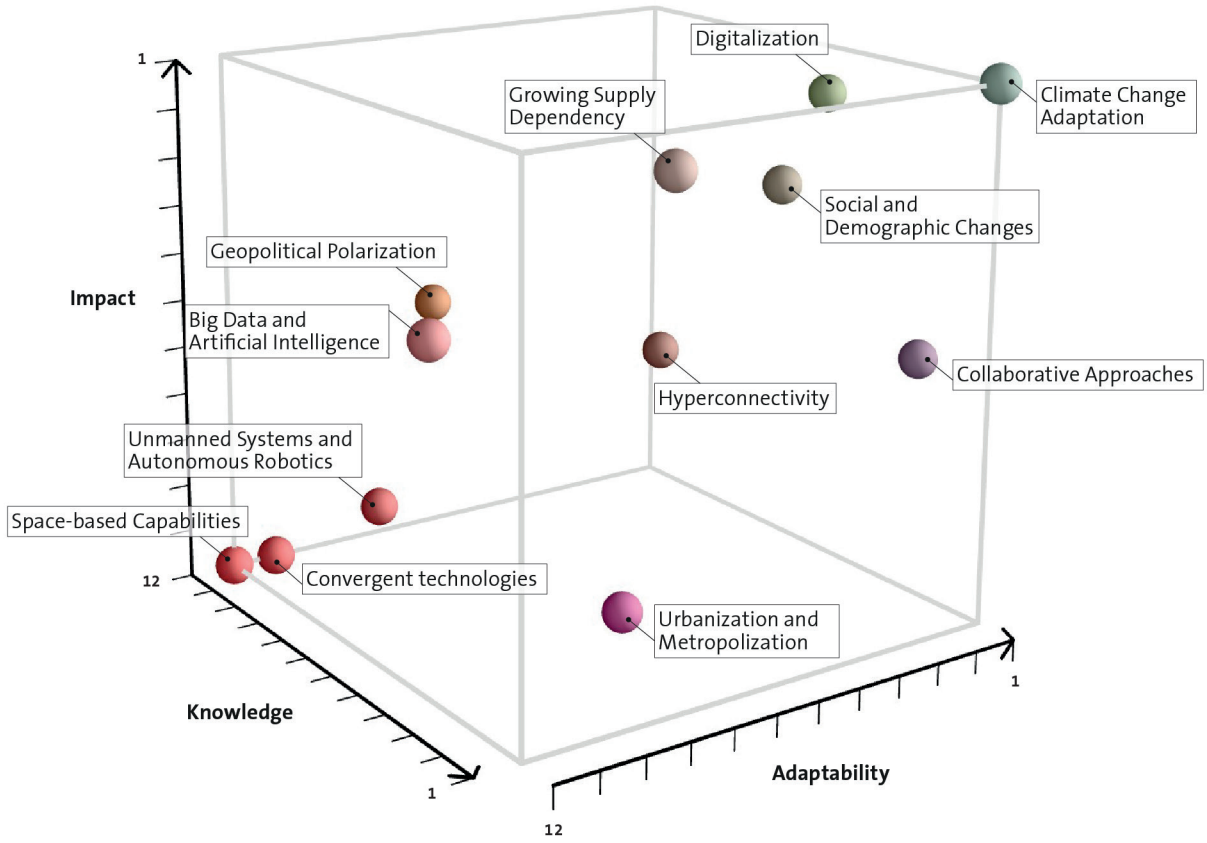


Figure 5 Spatial distribution of most frequent (Mode) scores assigned to trends in the dimensions *Impact*, *Adaptability*, and *Knowledge* (1 is most relevant, 12 is least relevant)



To gain a better understanding of how the three dimensions of *Impact, Adaptability,* and *Knowledge* intersect, the survey data was visualized in a three-dimensional plot, using the mode as statistical metric, as represented in Figure 5. In this context, the mode represents the most frequently occurring value in the survey responses. The results show that trends such as Climate Change Adaptation, Digitalization, and Growing Supply Dependency are perceived as having the greatest impact on Swiss civil protection. These are also the areas where the adaptive capacity of civil protection is perceived to be the highest and where the most knowledge is available to effectively manage impacts and adapt to change.

In contrast, trends such as Space-based Capabilities, Convergent Technologies, Unmanned Systems and Autonomous Robotics are viewed as the areas with the least impact on civil protection. They are also perceived as areas with the least adaptability and knowledge. Especially in this latter group of trends, *Knowledge* seems to be a particularly influential factor, affecting not only the perception of the trends, but also the other two dimensions of *Impact* and *Adaptability*. This suggests that enhancing knowledge about these trends could potentially improve both the perceived impact of these trends and the capacity to adapt to them.

Apart from the aforementioned extreme groups, the other trends displayed different combinations of *Impact, Adaptability,* and *Knowledge,* as illustrated in the heatmap in Figure 6. The experts held similar views on the impact of Big Data and Artificial Intelligence and Collaborative Approaches on civil protection. However, there were differences in other dimensions. In relation to Big Data and Artificial Intelligence, *Adaptability* is perceived as relatively low, along with very limited available *Knowledge* in this area. In contrast, participants recognized robust *Adaptability* and extensive existing *Knowledge* for Collaborative Approaches.

The trend Urbanization and Metropolization was most frequently assessed by the experts as less impactful, noting that there is already a relatively high level of knowledge in the civil protection system. However, they also noted that the capacity to adapt to this trend is limited. Regarding the trend Geopolitical Polarization, most experts agreed that this trend is likely to have a moderate impact on civil protection. Yet, the capacity to adapt to the changes associated with this trend is perceived to be quite low, despite a recognized good level of existing knowledge.

These different assessments reflect the complex and nuanced nature of the impact of different trends

on Swiss civil protection, with each trend bringing a different combination of impact, adaptability, and knowledge considerations.

Figure 6 Most frequent (Mode) scores assigned to trends in the dimensions *Impact, Adaptability,* and *Knowledge*
(1 is the most relevant, 12 is the least relevant)

Trend	Impact	Adaptability	Knowledge
Social and Demographic Changes	3.5	3	5
Urbanization and Metropolization	11	8	3.5
Geopolitical Polarization	5	12	4
Collaborative Approaches	7	1	3
Hyperconnectivity	8	3	9
Big Data and Artificial Intelligence	7	7	12

1 12

In the context of preparing for future trends, particularly in areas such as civil protection, the interplay between the dimensions of *Impact, Adaptability,* and *Knowledge* proves to be intricate and crucial. *Impact* refers to how trends will affect the civil protection system and influence its operational efficacy. This in turn influences the ability of civil protection to adapt or evolve in response to these trends. The *Adaptability* of a system is deeply rooted in its *Knowledge* base; the more comprehensive the understanding of potential impacts and necessary adaptations, the more effectively the civil protection system can limit potential challenges or capitalize on the opportunities associated with the trends.

As a system adapts to new trends, it also accumulates knowledge that improves its future response capabilities. This creates a continuous feedback loop: understanding the impact of a trend can lead to the development of knowledge, which then informs adaptation strategies. These dimensions are therefore not isolated, but interdependent, and each plays a pivotal role in shaping a system's resilience and preparedness for future challenges and opportunities.

4.2 Stakeholder Feedback

This chapter summarizes the feedback received from stakeholders via an open question included in the survey and the participation in the workshop. The comments collected offer a more detailed understanding of the various challenges and considerations involved in ranking these trends, particularly in terms of their impact, adaptability, and knowledge for civil protection in Switzerland. The feedback also provides insight into how stakeholders believe the civil protection system is affected by these trends.

A key finding is the difficulty for stakeholders to rank the trends as they overlap. Some trends were perceived as complementary, while others appear to be redundant, making their assessment even more complex. This complexity is exemplified by the interplay of trends such as Climate Change Adaptation and Collaborative Approaches, or Digitalization and Hyperconnectivity. As a result, participants reported that it can be difficult to assess and prioritize these trends individually. To better illustrate these relationships, Figure 3 offers a visual representation of how the trends influence and intersect with each other.

Participants highlighted gaps in their understanding of certain trends, which affected their ability to make informed assessments. The need for clearer definitions and explanations of the dimensions *Impact, Adaptability,* and *Knowledge* were also stressed.

Some stakeholders questioned the continued relevance of certain trends, in particular Digitalization, Urbanization and Metropolization, and Societal and Demographic change. They believe that these processes have been underway for a long time, which reduces their current importance. However, it is relevant to point out that although these trends have been observed for some time, their impact on Switzerland remains significant and is likely to increase in the future. While Swiss civil protection cannot directly steer or influence these trends, it must be flexible and able to adapt to the ongoing and expected changes that these trends entail. One example of such an adaptation is the revision of the compulsory service model for civil protection *(Dienstpflichtmodell),* as proposed by some stakeholders. Furthermore, one participant emphasized that while trends such as Climate Change Adaptation are recognized as important forces shaping our world and collective future, there is a noticeable gap in documentation, in-depth research, and interconnected analysis of these phenomena, especially in relation to other trends.

Several survey participants pointed out the technological focus of the selected trends, with particular attention to those associated with digital advances. Furthermore, they emphasized the importance of considering societal changes when anticipating the future evolution of civil protection, particularly in areas related to risk perception and management. It was also noted that the effectiveness of civil protection is directly linked to the resilience of society – the more resilient society is, the lower the burden on civil protection. This leads to the suggestion of strengthening the self-help capabilities and personal responsibility of the individual or community as a key objective for civil protection authorities.

When analyzing the feedback, it became clear that the limited understanding of the cascading effects of various trends poses a significant issue. This issue is further compounded by the varying levels of knowledge and expertise at different levels of government. These knowledge gaps not only hinder the capacity of civil protection stakeholders to respond effectively, but also lead to difficulties in accurately defining roles and responsibilities within the integrated civil protection system. As a result, there is a pronounced need for more consistent and cohesive knowledge sharing between civil protection actors throughout the Integrated Risk Management Cycle.

Most of the participants expressed a desire for increased collaboration between the various authorities involved in civil protection. This may be largely due to the growing uncertainties and complex challenges associated with the identified trends. To achieve this goal, participants suggested integrating different expertise into crisis units, ranging from technological to social disciplines. They also emphasized the need for better coordination between local and federal authorities, as well as between the partner organizations of the integrated civil protection system. Such strategic integration and cooperation could significantly improve the efficiency and effectiveness of Swiss civil protection.

5 Conclusion

5.1 The Legacy of Recent Years

This concluding chapter synthesizes the key findings of the report and highlights recurring themes and cross-sectional insights that emerged from the trend analysis.

Since the last edition of this series, the structural and infrastructural changes in Swiss civil protection have been limited. The findings from the previous two reports therefore remain valid, although many of the trends previously identified are not only still relevant but have even intensified. New trends have also emerged in recent years, such as Space-based Capabilities. However, the full exploration of their applicability to civil protection is an area that needs to be investigated further.

The impact of global events on Switzerland has intensified. The direct effects of climate change are becoming even more apparent, as evidenced by the increasing occurrence of extreme weather and climate events such as temperature fluctuations, heat and cold waves, heavy precipitation, and other related hazards. Geopolitical events such as the Russian invasion of Ukraine have profoundly affected global markets, heightening security concerns and contributing to a pervasive sense of uncertainty. The rapid acceleration of technological advancement brings its own set of challenges, including escalating security breaches and growing privacy concerns.

The findings detailed below provide an opportunity for reflection and strategic planning. The proposed measures are intended to strengthen the further development of Swiss Civil Protection. They aim to ensure that the system remains responsive and adaptable, while effectively navigating the complexities of an ever-evolving hazard landscape.

5.2 Governance in Complex Systems

Civil protection in Switzerland is a multi-layered system, characterized by a large number of actors and responsibilities. Added to this is the complexity of trends and a landscape full of uncertainties. Often, initiatives to improve disaster preparedness focus primarily on the challenges that the described trends bring, which can lead to missed opportunities. As these trends are interlinked, when addressing issues in one area, it is important to consider that they may have an unintended impact on other areas. Rapid technological development adds additional complexity. Coping with this dynamic environment requires a comprehensive and adaptable approach to civil protection that not only addresses immediate challenges, but also recognizes and capitalizes on the interlinked opportunities.

- **Balancing challenges with opportunities:** In this report, each analyzed trend presents not only challenges that require action, but also opportunities for improvement and development. The focus on opportunities is often overlooked in institutional planning. As a result, crisis practitioners are primed to recognize and manage challenges, but are typically less trained or equipped to identify and capitalize on opportunities. These opportunities can manifest themselves in various forms, such as restructuring crisis management units, establishing new partnerships, incorporating new professional roles, integrating technological innovations, or expanding training programs. By actively recognizing these opportunities and embracing the necessary changes, practitioners and emergency responders can be better equipped with the necessary tools and strategies to effectively manage stressful and complex situations, make informed decisions, and take effective action.

- **Interconnectedness:** A recurring theme throughout the analysis of trends is the fact that they are interconnected. For example, a trend that is primarily technological in nature may be significantly influ-

enced by another trend associated with societal changes, such as Hyperconnectivity. Such interaction between trends can reinforce existing challenges and opportunities or create new ones, often with cascading effects. The impact of a trend can ripple through several societal sectors, amplify its consequences and lead to secondary and tertiary effects. For example, the use of Artificial Intelligence in emergency response raises broader societal issues, such as ethical considerations in handling private data or changing requirements for civil protection personnel. These implications inevitably influence policy and governance, as they quickly become interdisciplinary and shape the landscape in which these trends operate.

The dimensions *Impact, Adaptability,* and *Knowledge* are also closely connected. The impact of a trend on the civil protection sym is closely linked to the adaptability of the system, i.e., its capacity to respond effectively to change. This adaptability in turn depends heavily on the level of knowledge and understanding of the trend.

Recognizing and preparing for such interactions and cascading effects can help to effectively mitigate challenges and seize the opportunities associated with the trends. Such understanding should be disseminated among all stakeholders and emergency response personnel using tools such as scenario and early warning exercises.

- **Navigating the technological landscape:** As technology continues to advance, various segments of government and society are struggling to understand, regulate, and integrate these innovations. The analysis of trends in this report shows that a balancing act must be performed between ensuring safe use and effective regulation that promotes innovation while minimizing potential harm. Effective technology management in civil protection involves not only ensuring access to data and technological services, such as the use of space-based capabilities, but also understanding how human and technological systems can collaboratively enhance each other's functions. For example, deep-learning models can help identify trends in civil protection by retrieving information from existing publications and selecting relevant case studies. However, their limitations become apparent in areas that require strategic foresight or complex decision-making, where human intelligence is indispensable. This example illustrates the importance of a balanced approach, where technology is seen as complementary to human expertise and integrated into innovative civil protection strategies, rather than being an overpowering force.

5.3 Harmonizing Resources and Expertise

One of the key findings from the trend analysis and stakeholder engagement is that collaboration is essential to effectively address the trends. These collaborative efforts can take the form of international cooperation, sub-national partnerships, or cross-sectoral alliances. A collaborative mindset is critical to managing the complexities of current trends and the uncertainties inherent in civil protection. This mindset requires the integration of perspectives and expertise from different sectors and stakeholders through continuous exchange and exercises. Civil protection is an area that relies heavily on learning from past experiences, with each disaster providing critical lessons that can contribute to greater safety for the population. A key element of collaborative efforts is the establishment of mutual trust, supported by robust regulations, effective communication strategies, and a shared understanding of key concepts such as challenges, opportunities, resilience, and response capabilities. When collaborative efforts are harmonized through effective communication and mutual trust, and enhanced by continuous learning, civil protection systems are not only reactive to current challenges but are also proactively able to anticipate and adapt to future developments.

- **International cooperation and domestic collaboration:** International cooperation and assistance are essential in disaster management, particularly when national response capacities are overwhelmed. Leveraging transnational expertise, participating in international training programs and adopting innovative solutions and technologies from abroad are critical aspects that can enhance national preparedness and resilience in the face of evolving trends. International partnerships also play a vital role in harmonizing technical requirements and standards, allowing for better regulatory convergence. These features of collaborative efforts are reflected in the rapid development of safe and effective COVID-19 vaccines (see 3.6 Collaborative Approaches). In Switzerland, international cooperation in disaster management takes various forms, a key of which is the engagement within the UNDRR, the central coordinating body for disaster reduction within the UN system. Participation in the UCPM would enhance Switzerland's response capacity and provide access to pooled and certified emergency response resources. Strengthening and updating bilateral agreements with neighboring countries would ensure effective coordination of Switzerland's response to cross-border emergencies and contribute to a comprehensive and efficient response system.

Given the challenges posed by growing geopolitical polarization (see 3.5 Geopolitical Polarization), which can impede international cooperation, it is also becoming more important to focus on individual preparedness and cantonal readiness in civil protection. Such a strategy involves a thorough assessment of the individual capabilities and responsibilities of each partner organization. By identifying these specific requirements, efforts can be more effectively directed towards ensuring that each entity is adequately prepared and equipped to deal with diverse and potentially large-scale emergencies. Fostering intercantonal collaboration can lead to the sharing of best practices, resources, and expertise, creating a more harmonized and efficient response system across cantons. These collaborative efforts are especially important during times of resource scarcity and shortages. They promote the active participation of individuals and communities in civil protection measures, an engagement that should be continuous rather than limited to times of crisis. This coherent approach, combining individual, cantonal, and national efforts, forms a solid foundation for comprehensive disaster management and resilience building.

- **Leveraging best practices and experiential learning:** In this report, each trend analysis is enriched with relevant examples and best practices to illustrate the importance of learning from successful initiatives to strengthen civil protection response capabilities. The application of these best practices and lessons learned from past experiences, whether directly or through simulated exercises and planned drills, is crucial for the continuous improvement and development of civil protection systems. Such an approach enables organizations to create a collective memory among their members, an invaluable asset for future preparedness. However, it is important to recognize that simply recording details of best practice or a training exercise, followed by a superficial review, falls short. Effective learning requires in-depth analysis, critical thinking, and systematic implementation of these best practices and lessons learned. Only with such an approach the acquired knowledge can contribute to the adaptation and evolution of hazard response strategies and civil protection systems.

- **Trust-building communication:** Effective communication is crucial for fostering trust within civil society, where networks are built and reshaped through communicative practices. As the trends analysis shows, trust in regulations and institutions is a key mechanism for managing uncertainty and complexity in interactions. The way experts and policymakers communicate uncertainties significantly influences public trust and acceptance. This influence directly shapes emergency response efforts and adaptation strategies to new trends. Ineffective communication can lead to fragmented management and operational inefficiencies, as different entities may operate with misaligned objectives and procedures.

  Communication is essential not only for fostering trust between individuals, groups, and organizations, but also for demonstrating the trustworthiness of these entities and their representatives. For crisis managers and civil protection professionals, effective communication is central to their perceived competence and their ability to lead and manage crises effectively. This is particularly evident in trends such as Social and Demographic Changes and Collaborative Approaches. Therefore, great importance should be given to the development and maintenance of strong, transparent, and effective communication channels within civil protection frameworks to ensure coherent, trusted, and efficient responses to emergencies.

5.4 Shaping the Future of Civil Protection

Civil protection, once viewed as a local initiative focused on protecting people within specific communities, has evolved to be understood as a more dynamic and comprehensive concept that encompasses not only local safety measures, but also a global vision of preparedness, response, and resilience to various emergencies and disasters.[229]

In Switzerland, civil protection has the potential to become an even more diverse and well-organized system that integrates a variety of experts and contributors from different regions. It can serve as a platform where, for instance, representatives from one Canton with expertise in managing drought events can share their knowledge and experience with authorities from all other Cantons in need of such expertise. To expand the scope of civil protection, the initial steps should involve breaking down existing bureaucratic and operational silos. This can be accomplished by establishing a network and setting clear objectives for action to achieve cross-sectional benefits.

- **Civil protection knowledge network:** This report suggests that the creation of a national civil protection knowledge network, incorporating the finding of this analysis, would be a beneficial step towards strengthening and unifying the efforts of various stakeholders involved in the protection of the population. Such a network could be more than just a formal meeting platform, but rather serve as a dynamic and purpose-driven hub, where participants

engage in resource and knowledge exchange, share experiences, and collaboratively develop strategies. Such an initiative would not only enhance the traditional role of civil protection in disaster management, but also increase its efficiency and impact.

The exchange of knowledge in Swiss civil protection currently focuses mainly on day-to-day political issues and the latest developments, and follows a top-down approach, while anticipatory thinking and integrative dialogue are neglected. These tendencies also feed into the formation of silos that are limited to certain areas of expertise or regions.

The workshop held for this report was highly appreciated by the participants and gave an indication of the potential benefits of such a knowledge network. Participants particularly appreciated the opportunity to engage with a wide range of civil protection stakeholders from the local to the federal levels. Besides learning about other stakeholders' activities, these interactions provided a shared understanding and an exchange on the challenges and opportunities faced by the different institutions. A civil protection knowledge network would help cultivate a collective intelligence that spans all stakeholders and levels of administration. It would ensure that knowledge is made available to practitioners across the civil protection spectrum and not just a selected few. Such an approach would not only aim to disseminate existing knowledge, but also to leverage strategic foresight to anticipate and prepare for future challenges and opportunities.

- **Civil protection resilience goals:** Setting practical goals and objectives for civil protection can make a decisive contribution to increasing the resilience of the system and its actors. These objectives should be in line with Switzerland's 2021 Security Policy report, which emphasizes the early detection of threats, the strengthening of interagency coordination, and the intensification of international cooperation for security and stability. Adopting a "governance through goals" approach involves not only setting ambitious objectives, but also identifying the means to achieve them. Clearly defined objectives help authorities to allocate resources more efficiently, streamline response strategies and measure progress against specific benchmarks. Such an approach encourages stakeholder participation from different sectors in a collaborative environment where different expertise and perspectives are utilized to achieve a common goal.

  However, as the trend Climate Change Adaptation shows, the gap between goal setting and practical implementation must be narrowed. This means that objectives need to be translated into tangible outcomes. For example, if an objective is to enhance preparedness and infrastructure resilience to forest fires, implementation should include a clear assessment of firefighting assets, detailed plans for infrastructure assessments, analysis of evacuation routes, and risk communication initiatives.

  Finally, a dynamic approach to goal setting should be considered, where objectives are continuously reviewed and adjusted based on changing scenarios, security concerns, and new data and technology.

5.5 Robust Political Will

The efficiency of a civil protection system is most evident during a crisis, highlighting its critical role in emergency response. However, the focus on immediate crisis management can make it challenging to advocate for and implement anticipatory actions. This is because the urgency and visibility required for strategic and costly investments or difficult and unpopular decisions are politically less appealing in times of stability. As a result, there may be a lack of preparedness and resilience-building measures as effective changes in civil protection are typically made after an event. One example are the 2005 floods in Switzerland, which led, among other things, to the institutional establishment of the Rapid Mapping Service (RMS) by the Federal Office of Topography swisstopo. More recently, Germany has updated its warning system in response to its failure during the 2021 floods in the west of the country.

Civil protection systems must be constantly refined to be prepared for future crises. This requires strong political will and unity among cantonal and federal decision-makers to maintain a proactive approach to civil protection that focuses on continuous improvement and preparedness, even in the absence of immediate threats. Proactive leadership has proven its worth in managing emergencies and saving lives, as demonstrated by the pre-emptive evacuation of the village of Brienz (GR) in 2023 due to the potential risk of rockslides. Here, the natural hazard was proactively managed by a regional crisis management unit through the integration of geological survey technologies, clear communication strategies to inform citizens of the risks, and decisive political leadership.

Institutional actors need to champion civil protection, understood as a comprehensive system, by elevating its importance on the public agenda and increasing its visibility among citizens. Greater visibility not only educates the public about the role of civil protection in strengthening societal resilience, but also fosters a sense of shared responsibility and community involvement.

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