



RISK AND RESILIENCE REPORT

Measuring Individual Disaster Preparedness

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Risk and Resilience Team
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Authors: Kevin Kohler, Andrin Hauri, Florian Roth and Benjamin Scharte.

Editor: Christine Eriksen

Client: Federal Office for Civil Protection (FOCP)

FOCP project supervision: Stefan Brem, Head of Risk Analysis and Research Coordination

ETH-CSS project management: Benjamin Scharte, Head of the Risk and Resilience Team;
Oliver Thränert, Head of Think Tank.

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Executive Summary

Disaster preparedness consists of the knowledge and capacities to effectively anticipate, respond to and recover from the impact of natural, societal, and technological hazards. Whereas it remains the primary responsibility of public authorities to manage collective risks, the preparedness of individuals plays a crucial role in enabling societal resilience.

This Risk and Resilience Report provides an overview of recent individual preparedness research. It serves as a preliminary study that could inform the design of future disaster preparedness studies. Conceptualizing preparedness requires distinctions between generic actions that provide a baseline across a range of hazards, as well as more specific actions guided by risk monitoring and early warning. Preparedness needs to be adapted to specific contexts, including the local frequency and severity of hazards, the individual vulnerability and exposure to hazards, as well as geographical features that affect the accessibility of critical infrastructure, services and goods. Furthermore, the study of preparedness behavior should acknowledge that actions have multiple underlying motivations, levels of preparedness differ across socio-demographic factors and there are cognitive and material barriers to preparedness.

The report discusses a broad variety of indicators that can help to measure individual disaster preparedness. The most common indicator is the availability of an emergency supply kit that mitigates short-term supply gaps. Recommended items usually include food, water, medicine, energy and communication devices, as well as hygiene articles. Other preparedness indicators include the prevalence of cash, insurance, vaccines, safety installations in buildings and access to vehicles. Preparedness also includes cognitive factors like risk knowledge, pre-defined strategies to coordinate communication and meetings, hazard-specific behaviors and skills, such as first aid and fire fighting training.

The report explores the data availability of these preparedness indicators for Switzerland. The Federal Statistical Office (FSO) offers typologies and socio-demographic statistics of Swiss municipalities. However, as many relevant indicators are not available at this granular level, surveys are crucial to fill in the blanks, such as those conducted by Maduz et al. (2018) and Zimmermann and Pescia (2018).

The report highlights existing gaps in the preparedness literature with regards to empirical

evidence for the composition and effectiveness of emergency supply kits, as well as the specific challenges of suburban contexts. Recommendations for future analyses include: individual preparedness actions and public communication in the early phase of the ongoing COVID-19 crisis to highlight the dynamics of disaster-related demand shocks; an evaluation of smartphones' potential for digitizing disaster preparedness tools, such as hazard maps, flashlights, radios and language translation apps; research into the positive and negative impacts of the sharing economy on access to cars, housing and tools during disasters; and an ethnography of people that make individual disaster preparedness part of their identity and lifestyle, as well as their potential engagement for social innovation in areas such as emergency supply kits.

1 Introduction

The global coronavirus pandemic has highlighted the importance of public preparedness to respond to and recover from disasters and emergencies. Even before the outbreak of this global health emergency, many countries had identified the preparedness of individual citizens as a key element in civil protection and disaster management. While individual disaster preparedness is an important part of societal resilience, well-prepared communities and public authorities are a significant precondition for effective citizen awareness and behaviour in a crisis event (Levac, Toal-Sullivan & O’Sullivan, 2012).

Individual disaster preparedness used to be measured narrowly in terms of practical measures on a to-do list or contained in an emergency supply kit. Yet, as recent research shows, there are many relevant and impactful individual preparedness indicators that do not directly relate to stocks of food, water and medicine or battery-powered devices, such as torches and radios. We advocate for a broad understanding of disaster preparedness and discuss a wide range of indicators that could be used to assess the readiness of individuals to respond to and recover from natural, societal and technological hazards.

In order to foster greater public preparedness, it is essential to build a detailed understanding of the capabilities, resources and knowledge of different layers of society – from school kids to elderly people, lay people and engaged volunteers to professional responder. It is also imperative to understand disaster preparedness in the various local contexts in which it manifests. What is required of individuals in order to be adequately prepared will likely differ for people living in a large metropolitan area compared with people in a rural town or a remote mountain village.

1.1 Aims and scope of report

This report provides an overview of recent individual preparedness research, focusing particularly on the practical and theoretical challenges and opportunities associated with individual preparedness, and on established differences between rural, sub-urban and urban populations. It also serves as a potential starting point for further research.

The report applies the findings from the overview of individual preparedness concepts and indicators to a case study focusing on the current state of public preparedness in Switzerland. The report provides an

overview of publicly available information on individual preparedness in the Swiss context, as well as gaps in current knowledge and research.

The report builds on research conducted by the Risk and Resilience Team of the Center for Security Studies (CSS) at ETH Zurich – including both theoretical and practical perspectives (Prior and Eriksen 2013; Prior and Roth 2014; Roth 2018; Eriksen et al., 2020). Specifically, it draws on two CSS studies on disaster preparedness in Switzerland (Maduz et al., 2018, Maduz et al., 2019), further academic literature on disaster preparedness and public recommendations by disaster management organizations.

1.2 Structure of the report

The report first defines individual disaster preparedness, discusses why it matters and distinguishes between different types of it. Second, it reiterates some of the theoretical findings on individual disaster preparedness. Third, it lists and explains indicators that can be used to measure preparedness both in terms of tangible resources and intangible knowledge and skills. It then aggregates data sources for these indicators for the specific case study of Switzerland. Lastly, the report discusses further research questions and how future studies could strengthen understandings of individual disaster preparedness in Switzerland and beyond.

2 Conceptualizing disaster preparedness

The UN Office for Disaster Risk Reduction defines disaster preparedness as “the knowledge and capacities developed by governments, response and recovery organizations, communities and individuals to effectively anticipate, respond to and recover from the impacts of likely, imminent or current disasters” (United Nations General Assembly, 2016, p. 21). Accordingly, preparedness “aims to build the capacities needed to efficiently manage all types of emergencies and achieve orderly transitions from response to sustained recovery” (ibid).

The most common units of analysis for disaster preparedness are individuals or households, communities, businesses, and governments. The focus of this report is individual disaster preparedness, which refers to actions that individuals can take to be more self-sufficient and resilient while responding to and recovering from a disaster. Based on the type and severity of disaster, this includes, among other things, the ability to shelter-in-place and/or to evacuate in a timely manner. The subsequent sections discuss disaster preparedness in the context of resilience, the need for generic preparedness and its complementation with adaptations that target specific hazards, vulnerabilities, exposure, and local contexts.

2.1 Individual preparedness as a key element of resilience

Resilience is defined as “the ability of a system, community or society exposed to hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard” (United Nations General Assembly, 2016, p. 22). The guiding principles of resilience in disaster research highlight distributed capacities for disaster prevention, preparedness and recovery, and explicitly recognize the need for social vulnerability analysis (Eriksen et al., 2020; Oliver-Smith et al., 2017; Wisner et al., 2004). Societal resilience depends on multiple factors, including social characteristics (e.g., class, age, gender) and social capital (e.g., affluence, networks, trust), as well as disaster preparedness across all levels. The crucial contribution of individual preparedness to societal resilience stems from well-prepared individuals’ ability to help themselves and others to deal with the physical and psychological impacts of disasters. This frees up resources and allows the community and the

public authorities to concentrate a larger part of their capacities on the most vulnerable during an emergency.

Individual disaster preparedness consists of both tangible resources (referred to as material preparedness for the purpose of this study), such as an emergency supply kit, and intangible knowledge, skills and behaviors (referred to as cognitive preparedness). The distribution of resources and knowledge can help to bridge supply gaps, for example, when critical infrastructure and services degrade or fail. Preparedness can also reduce the negative social and psychological impacts in the recovery phase (Lindell, 2013 p. 799; Eriksen et al., 2020).

Individual disaster preparedness does not imply that authorities can or should abdicate their responsibility of protecting the population from collective risks. In Switzerland, the Federal Government places a legal stockholding obligation on vital goods importers to protect necessary national supply chains during crises (Hauri, 2019). Swiss residents are encouraged to keep an individual emergency supply kit with enough resources for at least three days of water and seven days of food. During the coronavirus pandemic, public authorities have asked citizens to frequently wash their hands with soap or, at times, to shelter-in-place. However, the provision of expensive equipment, such as ventilators, or specialized services, such as research on vaccines, clearly cannot be expected to be performed on an individual level.

2.2 Generic preparedness

Generic preparedness, also referred to as basic preparedness (FEMA, 2012) or minimum preparedness actions (Inter-Agency Standing Committee, 2015), aims to establish a preparedness baseline independent of specific warning signals and across a multitude of hazards. This type of preparedness is particularly important for sudden-onset disasters, such as a blackout, an earthquake, or an industrial accident. The contents of emergency supply kits recommended by disaster management organizations are mostly meant to strengthen this generic preparedness. The focus on advice and resources that are robustly useful across a wide range of disasters and emergencies makes sense insofar as context-based preparedness advice can become overwhelmingly complex, which may inhibit uptake.

Nevertheless, hazard-specific resources and knowledge can be part of baseline individual

preparedness depending on the local and individual levels of vulnerability, exposure and access to them. Indeed, depending on the actual and perceived risks, people have developed and use myriads of tailored disaster adaptation and mitigation strategies to optimize their response and recovery activities with respect to specific hazards. For example, the Tokyo Metropolitan Government (2015, pp. 94-105) published an individual preparedness guide that dedicates 12 pages to how to stabilize furniture and devices to avoid injuries and damages from earthquakes.

Hazard-specific preparedness is relevant based on identifiable early warning signals. For example, hurricanes, heatwaves and pandemics tend to come with a window of opportunity of several days to carry out additional preparations tailored to the likely or imminent hazard.

Generic preparedness and shorter-term hazard-specific preparedness based on warning signals, also referred to as advanced preparedness actions (Inter-Agency Standing Committee, 2015), are complementary rather than supplementary actions. For example, the coronavirus pandemic has led to sudden demand shocks in many countries for products, such as face masks, disinfectants, soap, pasta, rice, canned foods, toilet paper and painkillers. While it is appropriate that individuals increase their preparation in response to risk signals, dealing with such a sudden surge is a logistical challenge. In extreme cases, individual preparedness actions in response to imminent hazards can become detrimental to societal preparedness, for example, when individuals exhaust the market for specific goods, such as high-filtration face masks, that are more urgently needed by specific groups, such as in occupations with high exposure. It is the task of governmental crisis communication to balance individual preparedness needs while discouraging mass purchases (panic buying) of scarce vital goods. This can be accompanied with fines against price-gouging to discourage mass purchases with the intention of reselling the good at a vastly higher price. If the supply of specific critical goods, such as medications, is at risk, legal limits on the quantity of individual purchases can be introduced.

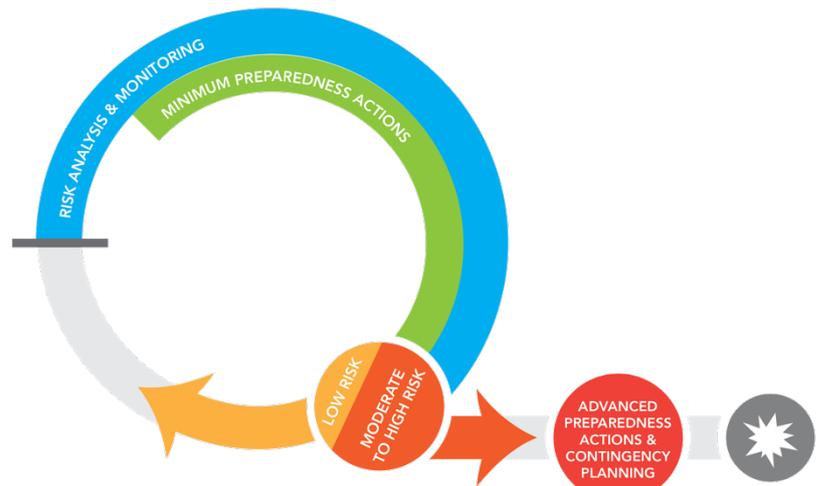


Figure 1. Emergency Preparedness Cycle. Adapted from Inter-Agency Standing Committee (2015, p.9).

2.3 Hazard-specific preparedness

The preparedness guide by the US Federal Emergency Management Agency (FEMA) from 2012 lists advice for 21 different types of hazards. The following are three examples of hazard-specific preparedness measures.

Against **transmissible diseases**, vaccination is the most effective preventive measure. However, vaccines are not available for all diseases. In such cases, the interventions that help individuals to reduce the likelihood of infection most effectively are usually washing hands with soap or using hand-sanitizer. Disposable plastic gloves and disposable face masks that block incoming or outgoing viral or bacterial pathogens are useful as well, but only publicly recommended for specific groups (Federal Office of Public Health (FOPH), 2018, pp. 58-62). The stock of medicine and food can be adapted and expanded to reduce the need to go out, especially if sick. Other measures to reduce personal exposure include physical distancing, such as using the car instead of public transport, working from a home office, and avoiding non-essential travel.

Floods can cause great damages to property. Hence, aside from personal safety measures, an important part of flood preparedness is to ensure that flood damages are covered by insurance. If a flood is imminent, disaster preparedness includes removing valued possessions from basements and groundfloor rooms; installing flood proof barriers, flood vents or plugs to prevent floodwater from backing up into sewer drains; ensuring no dangerous chemicals might be flooded, locating the position of gas and electrical shut-offs, and raising elevators to the second floor and turning them off (FEMA, 2012, pp. 49-55).

Physical items that are useful for **heatwave** preparedness are air-conditioning for living and working spaces, an emergency supply of water, loose-fitting clothes in light colour as well as a hat with a wide brim. Behavioral knowledge includes keeping the shades closed on windows that get morning or afternoon sun, reducing physical and outdoor activity, drinking water to stay hydrated, taking cold showers, and regularly checking-in on vulnerable neighbors, friends and family members to help them with their preparedness (FEMA, 2012, pp. 85-91).

2.4 Vulnerability-specific preparedness

The physical and social vulnerability of communities and individuals is a key factor for determining their disaster resilience. Groups with particular vulnerabilities include, amongst others, children, the elderly, minority or marginalized people and low income households (Fatemi et al., 2017, pp. 223&224). It is usually not the actual attributes that cause the heightened risk but the associated particular needs or limited access to social, economic and material resources prior to, during, and after a disaster (Levac et al., 2012, p. 727; Eriksen et al., 2020).

As an example, older people are more likely to have impaired physical mobility, diminished sensory awareness, pre-existing health conditions, and could be more reluctant to evacuate their home for financial and psychological reasons (Fernandez et al, pp. 69&70, 2002). Therefore, elderly persons often need more preparedness actions and a stronger social support network than others. For example, people aged 65 or older are advised to avoid prolonged exposure to the sun and to get vaccinated against the seasonal influenza (FOPH, 2020, p. 9).

Persons with chronic illnesses are a vulnerable group for whom it is particularly important to have a supply and written record of their prescription medicine. Although acute injuries and conditions have a high priority in the immediate aftermath of a disaster, it is important not to forget about chronic illnesses. About 24 per cent of emergency visits in the New Orleans area during Hurricane Katrina were due to chronic issues (Sharma et al., 2008) and medication procurement was one of the biggest medical challenges (Arrieta et al., 2009).

2.5 Exposure-specific preparedness

Individual exposure to specific hazards is often related to occupation and travel. For example, healthcare workers are more likely to be exposed to

respiratory pathogens compared to the general population, with a potential threat to their own and their patients' health. Hence, healthcare workers are advised to vaccinate against seasonal influenza (FOPH, 2020, p. 27). For COVID-19 there is, as yet, no vaccine available. Consequently, it is especially important to provide healthcare workers with needed personal protective equipment. In a similar fashion, occupational groups, such as firefighters, construction workers, miners, landscapers, agricultural workers, and bakers require personal protective equipment to cope with heightened exposure to different sources of heat and particles.

2.6 Local contexts of preparedness

Urban areas tend to have higher redundancies in infrastructure, greater institutional capacity and more diversified economies (Cutter et al., 2016). Urban areas also have faster average access to food and medical services, as well as a higher share of households with relatively small living spaces. For example, the share of households with $\leq 60\text{m}^2$ is 29 per cent in Zurich and 41 per cent in Geneva (Federal Statistical Office, 2019). People living in urban areas might therefore be less inclined to purchase and make space to store resources for an emergency preparedness kit.

In contrast, rural areas tend to have higher community capital and environmental resilience (Cutter et al., 2016). For example, they have more pervious surfaces, that allow rainwater to drain. However, rural economies are often more dependent on single industries, such as tourism, and have a higher share of elderly inhabitants. They also tend to have less access to food and medical services. In the more rural cantons on the Central Plateau of Switzerland, such as Aargau, Thurgau or St. Gallen, less than 10 per cent of households have $\leq 60\text{m}^2$ living space (Federal Statistical Office, 2019).

Such context-specific comparisons demonstrate how the need for individual disaster preparedness measures differ considerably between urban and rural regions. These differences need to be considered systemically in order to adequately measure, compare and respond to different levels of preparedness. The same holds true for differences in the local frequency of hazards, personal vulnerabilities and exposure. They all call for specific ways to individually prepare for disaster situations. Consequently, there is not one single perfect way to engage in individual disaster preparedness due to the context-specific conditions.

3 Brief insights from empirical preparedness research

There are general preparedness research findings that are relevant for thinking about how to measure and improve individual disaster preparedness. We particularly highlight the aspect of barriers to, motivations for, and predictors of individual disaster preparedness. However, it is also important to reiterate two important limitations of preparedness research. First, there is often a fairly narrow understanding of individual disaster preparedness in terms of having an emergency supply kit. While this is an important aspect of individual disaster preparedness, it is by no means the only aspect. In this report, we purposefully offer a wide range of indicators that could arguably be useful to measure individual disaster preparedness. Second, the empirical basis for many recommendations, such as the composition of emergency kits, needs to be improved upon.

3.1 Motivations for preparedness

In Switzerland, Zimmermann and Pescia (2018, p. 26) have surveyed the motivations for having additional stocks of food and water. The most common motivation was the convenience of having to shop less often (64%), followed by additional purchases during discount campaigns (37%), being prepared for visitors (35%), not being able to shop everyday (24%) and in case of sickness (22%). Preparedness for a supply crisis (15%) was the least mentioned reason for personal preparedness.

3.2 Predictors of preparedness

Commonly used predictors for individual disaster preparedness are age, income, gender, race, education, hazard experience, and risk perception. In Switzerland, Maduz et al. (2019, p. 15) found that preparedness positively correlates with being female, being older, living in municipalities with less than 10'000 inhabitants, higher perceived risk and actively seeking disaster preparedness information. Zimmermann and Pescia (2018, p. 4) found that the proportion of the population with insufficient supplies is significantly higher amongst inhabitants of urban areas, persons in the French speaking part of the country, persons below 40 years of age, and persons with very low or very high income levels. Some studies also indicate that individuals living in areas that are frequently threatened by natural

disasters are more prone to take preventive measures and to comply with warnings than persons with infrequent exposure (Sattler et al., 2000, p. 1399). However, this appears to be linked to disaster experience and it has to be noted that learning from personal disaster experience can be overly specific and that there have been documented cases of individuals that “refused to evacuate because two previous floods came only as high as their driveways” (ibid).

3.3 Barriers to preparedness

Researchers have identified a variety of potential barriers to household disaster preparedness. For example, Diekman et al. (2007, p. 498) conducted qualitative interviews with Atlanta residents and found that the effort to keep track of supplies and their expiration dates as well as insufficient communication from the government as to what resources are needed, were perceived as barriers. Olympia et al. (2010) conducted a survey on disaster preparedness in the United States with a bit more than 1'000 participants, which asked them to check which of seven selected barriers to preparedness apply to them: “My family has not thought about emergency preparedness” (48%), “no one has told me and my family how to prepare for an emergency or disaster” (17%), “no matter how much my family prepares, nothing will be effective to deal with the disaster” (11%), “my family and I do not want to think about emergencies or disasters affecting us” (9%), “being prepared is too time-consuming” (6%), “being prepared is too expensive” (4%), and “an emergency or disaster will never happen to my family” (1%). In Switzerland, Maduz et al. (2018) found that a majority of survey respondents would like to get more information about hazard-specific individual disaster preparedness.

4 Indicators of material preparedness

The following outline of material resources are individual disaster preparedness measures that are bought, stored or built to prevent and mitigate harm to the health and property of individuals in a disaster situation.

4.1 Emergency supply kit

A basic element of individual preparedness for disasters and emergencies is an emergency stock of resources that can bridge supply gaps due to degraded transport, water, electricity, and communication infrastructures. Population surveys on the availability and contents of an emergency supply kit are a common way to measure individual and household disaster preparedness (Pickering et al., 2018, Table 1). The following are the most common items recommended in kits by local authorities. The bracketed per centage numbers after specific items indicate how often the component was included according to the 71 disaster kit checklists aggregated by Perman et al. (2011, pp. 12-15).

Food and water: Disaster management organizations generally recommend a minimum emergency stock of drinkable water (100%) and non-perishable food (94.4%) that lasts for about three days. Switzerland recommends a minimum of nine litres of water per person, which should last for three to four days. After this period, the local authorities are again responsible by law for an emergency supply of drinking water. Germany recommends 20 litres of water per person and food that lasts for ten days. Emergency food should not require refrigeration and should ideally be consumable with improvised or even without any cooking facilities. Suitable products include canned meat, fish, vegetables and fruits, ready-made soups, rice, pasta, potatoes, oil, condensed milk, hard cheese, tomato sauce, fruit juice, chocolate, rusk and dried foods. Where applicable, the emergency stock should include infant formula and animal food.

Medicine: Disaster management organizations recommend storing prescription medicine (92%) as well as a first aid kit (45.1%), which includes, amongst other things, disinfectants (65%), bandages (61%), painkillers (56%), sterile gloves (55%), medicine against diarrhea (48%), tweezers (48%), and a thermometer (47%). Depending on the local climate, it should also contain remedies against the cold,

mosquitoes or sun burns. Depending on proximity to potential sources of radioactive hazards, such as nuclear power plants, it should also contain iodine tablets.

Energy, light and warmth: Disaster management organizations recommend stored energy and alternatives for the case of a blackout. Extra batteries (62%) are needed to operate the emergency radio, flashlight and some medicinal products. Cooking requires a manual can-opener (82%) and potentially a camping cooker with gas (23%). Matches or lighters (73%) can be used to light candles, fires or to ignite cooking burners. Light itself can be provided by a battery-, sun-, or dynamo-powered flashlight (92%). Extra clothes (65%) and one sleeping bag or warm blanket (89%) per person protects from cold. In lightly sunny weather conditions, mobile foldable solar panels can generate enough energy to power a few essential devices, such as mobile phones.

Communication: Disaster management organizations recommend a battery or hand-powered radio (95.8%) to be able to receive official communications even if the regular communication networks for the internet, landline and cell towers fail. If available, a car radio or FM-enabled phone can also fulfil this function.

Hygiene: Disaster management organizations recommend storing some hygiene items, such as toilet paper (73%), garbage bags (68%), moist towelettes (63%), plastic plates and cutlery (62%), chlorine bleach (62%), soap (56%) and hygiene products for women (56%).

4.2 Financial preparedness

Insurance policies are an important part of disaster recovery preparedness, as they transform large individual damages to a predictable, regular risk premium (Lindell, 2020, p. 22). Financial reserves are another type of preparedness that helps to absorb unplanned, short-term expenses. Preparedness also includes the accessibility of financial means. Cash may be the only viable means of payment if the information and communication infrastructure is temporarily degraded. Hence, disaster management organizations recommend both a credit card and a cash reserve as part of a grab bag (80%).

4.3 Physical preparedness

Being fit and able bodied is important when evacuating dangerous areas. Similarly, personal health levels have a big influence on an individual's ability to withstand hazards, such as pathogens or

heatwaves. Most of the positive effects of a healthy diet and regular exercise only manifest over longer time periods. The range of actions for short-term body preparedness is more limited. However, there are steps that can be taken. For example, there are vaccinations against various types of diseases based on age, chronic diseases, as well as the chance of exposure to pathogens based on occupation or travel. Furthermore, supplements, such as vitamin C, vitamin D, or zinc (Gombart et al., 2020), as well as a sufficient amount of sleep, could help to strengthen the immune system ahead of an exposure event.

4.4 Building

Earthquake-resistant construction and civil protection shelters are part of longer-term disaster mitigation. Individual disaster preparedness to protect buildings and its inhabitants can include securing furniture against the wall as well as the installation of smoke detectors, fire extinguishers and air conditioning. Furthermore, fuel-based generators or large, often solar-powered, home batteries attached to buildings, can provide large amounts of stored electricity to a household in the case of a blackout. In the early warning period for a flood, building preparedness can include actions such as constructing flood barriers and emptying the basement for valued goods.

4.5 Vehicle

In most disaster situations privately owned vehicles offer the greatest amount of security and flexibility to provide mobility, which can be useful to access medical facilities, food resources or evacuate an area. To achieve this, vehicles should have at least a half-tank of gasoline or a half-charged battery (Murphy et al., 2009, p. 54). In the case of adverse weather conditions, off-road capability may be useful, as well as the vehicle providing some shelter from the elements. In the case of wildfires or pandemics, a strong air filter in vehicles provides particular protection. Where vehicle-to-home technology is available and electric vehicles are not required for evacuation, they may also provide emergency electricity to the household.

4.6 Autarky

The emergency supply recommended by national disaster management organizations is meant to bridge the temporary degradation or complication of access to critical infrastructure goods and services. Hence, regular individual disaster preparedness does

not require individuals to autonomously produce critical goods and services, such as food, water, and electricity. This ability would only be relevant in the case of a prolonged severe degradation of critical infrastructure goods and services. Still, household autarky may be viewed as a form of preparedness for extreme disaster scenarios, such as civil and interstate wars.

For example, rainwater collection systems and water filtration systems are potential autarkic sources of water, whereas planting vegetables or raising chickens are potential autarkic food sources. Immobile energy autarky can be achieved through good isolation of buildings and local electricity generation through solar panels or windmills.

5 Indicators of cognitive preparedness

This report defines cognitive individual disaster preparedness as the intangible set of knowledge, strategies, behaviours and skills that help to prevent and mitigate harm to individuals' physical and mental health, as well as the property of a household in a disaster situation.

5.1 Risk knowledge

Local hazard knowledge: Knowledge about the frequency, severity and types of hazards that have occurred in a region is crucial to be able to adapt individual disaster preparedness to the local context.

Local vulnerability knowledge: Individuals should communicate special needs, such as mobility restrictions, impairment of hearing and vision, prescription medication and allergies to others within close proximity. Local knowledge about people in need of assistance in an emergency can be vital for the resilience of a community. This allows individuals to check on vulnerable people, such as the elderly, during emergencies.

Local exposure knowledge: Being aware of local exposure levels to an impending hazard is an important precondition to mitigating the potential economic, physical and psychosocial impacts of the hazard. Local exposure is measured by the number and types of people, infrastructure, housing, production capacities and other tangible human assets located in a hazard-prone area combined with their specific individual and collective levels of vulnerability and coping capacity (UN General Assembly 2016; Eriksen et al. 2020).

Access to early warning: Websites, social media and apps can provide citizens with up-to-date information on issues and hazards before they amount to a full blown disaster. In Switzerland, the MeteoSwiss app covers weather-related hazards. Via the Federal Office for Civil Protection's app 'Alertswiss', Cantonal authorities can inform the population about all hazards affecting a certain region. In Germany, the app NINA fulfils the same purpose.

5.2 Pre-defined response strategies

In a disaster situation communication can break down and decisions have to be made under stressful conditions and time pressure. Designing default

strategies ahead of time for various disaster scenarios reduces the risk of hasty decision-making and helps the coordination with other family members. Having a dedicated family emergency plan that covers communication and meeting points, amongst other things, is recommended by many disaster management authorities.

Communication: In order to enable communication under degraded conditions, disaster management organizations recommend keeping a written list of important phone numbers and addresses in the house and in the wallet. Such a list should include the numbers of emergency services, family members, neighbours and an out-of-town contact, as it may not be possible to reach local connections exposed to the same situation. A family emergency plan should define a default strategy for establishing contact when disasters strike. Schools should be given emergency contact numbers for the legal guardians of their pupils.

Local meeting points: Disaster management organizations recommend designating safe and familiar places where families can seek shelter or reunite during or after a disaster. One place could be within the house for events such as storms, another in the neighbourhood for hazards such as a structural fire, and one in a more elevated neighbourhood in events, such as a flood or tsunami.

Evacuation: It is recommended that one or several places belonging to relatives or friends are identified as places where one could stay for a while, and potentially reunite with other family members, in case an evacuation is necessary.

5.3 Hazard-specific behaviors

Appropriate behavioural responses to impending hazards can reduce a lot of potential harm. Such behaviors do not require extensive training. However, they differ widely based on hazards and can range from sheltering-in-place to evacuating an area before it is exposed to an identified hazard. In the case of the coronavirus pandemic, governments around the world have instructed citizens to avoid non-essential travel, to frequently wash their hands with soap, to keep a minimum distance in public spaces, to cough into disposable tissues or their elbow, to stay at home and call their doctor if they have flu-like symptoms, as well as to wear surgical masks in certain circumstances.

5.4 Skills

The knowledge required to operate rescue tools can be lowered by ensuring that first aid kits and other tools come with instruction manuals. However, responding swiftly and correctly under stress often requires a certain level of prior training. This aspect is particularly pronounced in the preparedness test of the Finnish National Rescue Association (2015, p. 7), in which 7 out of 15 questions focus on skills rather than resources.

First aid: First aid skills refer to practical knowledge and experience of helping a person with acute medical problems. This includes applying bandages, putting an unconscious person in a recovery position, transporting an injured person, or performing cardio pulmonary resuscitation (CPR).

Fire fighting: The ability to use a fire extinguisher to quickly put out a fire within a building is a relevant disaster preparedness skill.

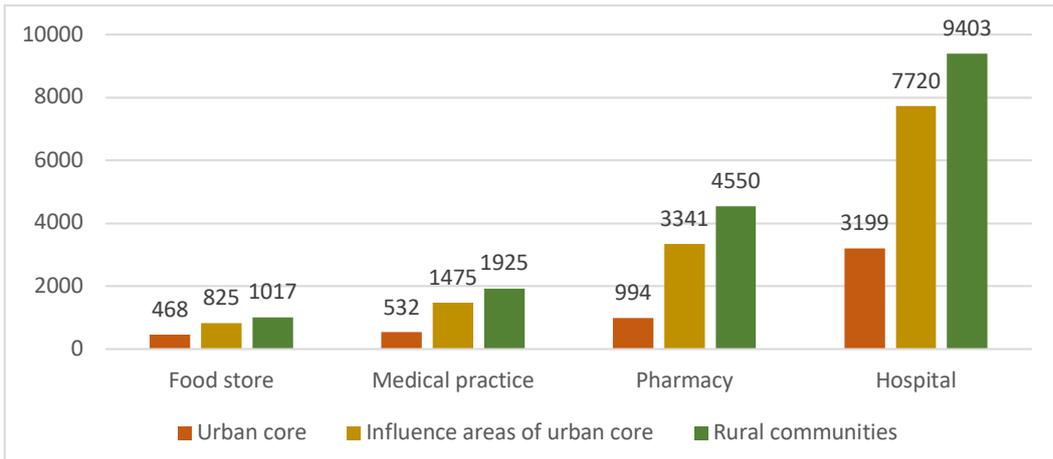
Swimming: The ability to swim as well as to potentially rescue drowning persons is a critical skill in the case of flooding.

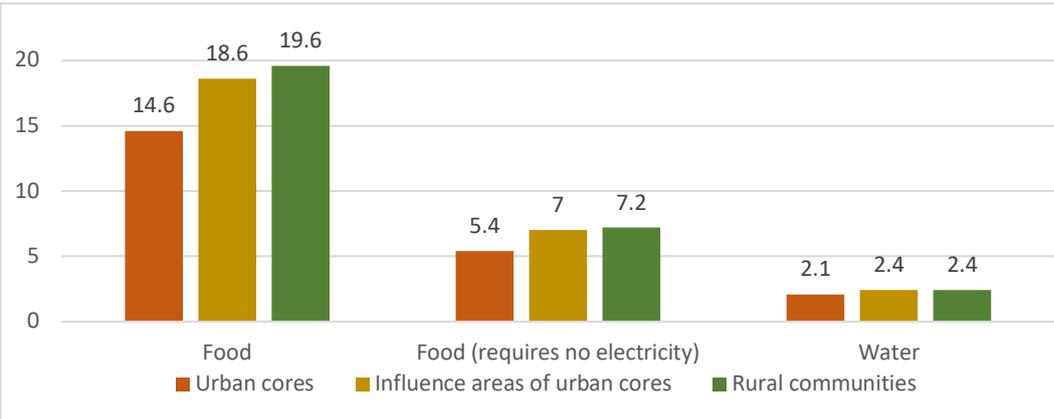
Driving: The ability to drive a car to evacuate from an area, or to bring injured persons to medical services, is a crucial skill in response to many hazards.

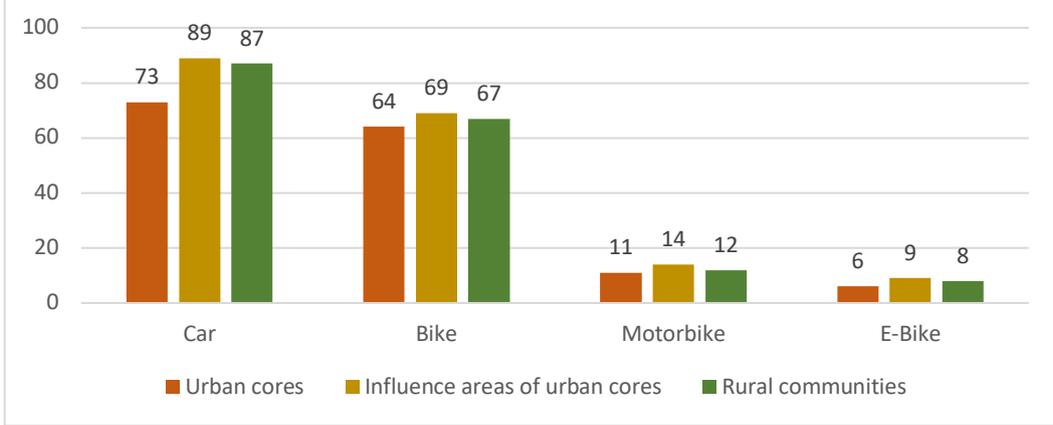
6 Case study: Data availability for Switzerland

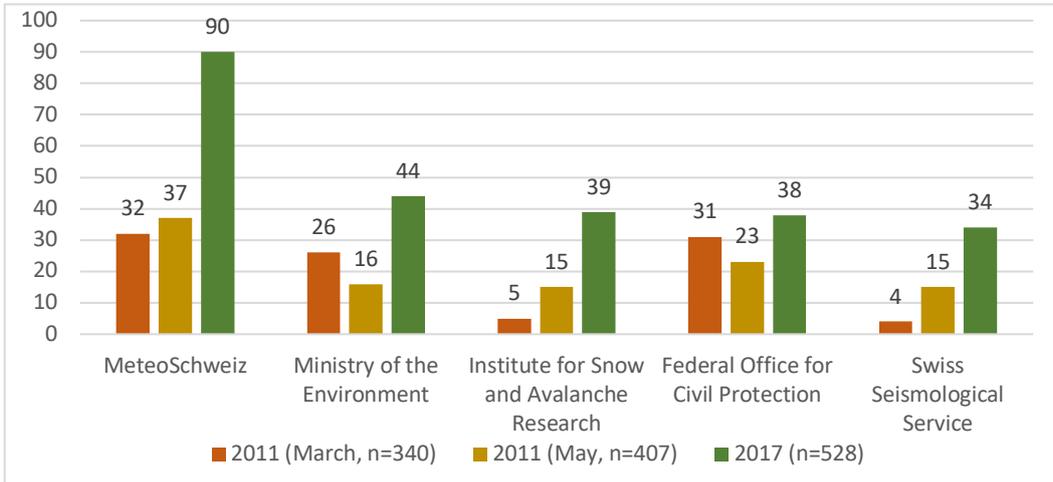
In this section, we list data sources to measure individual disaster preparedness in the specific case of Switzerland. Switzerland puts a high value on personal responsibility and is known for its preparedness efforts during the Cold War and the continuation and adaptation of them thereafter. As discussed in Section 2.6, such an analysis should optimally also reflect the local context. In order to analyse urban, suburban and rural differences in

Switzerland, data on individual disaster preparedness would have to be disaggregated to the level of municipalities. Unfortunately, the majority of official statistics in Switzerland are only disaggregated to the cantonal level. If the aim is to measure individual disaster preparedness disaggregated by an urban-rural typology, it requires targeted surveys that include place of residence or data from retailers.

<p>Urban-rural typology</p> <p>Possible indicators:</p> <p>individual disaster preparedness level per urban-rural category</p>	<p>The Federal Statistical Office (FSO) offers a variety of urban-rural typologies for the municipalities of Switzerland. The simplest typologies differentiate between statistical towns with at least 10'000 inhabitants and villages with fewer inhabitants (FSO, 2012d). Three distinctions are offered based on population density (FSO, 2011) – urban, rural and intermediary municipalities (FSO, 2012c), as well as urban core areas and their influence areas (FSO, 2014b). Swiss municipalities are divided into seven categories: core cities, main cores, secondary cores, agglomeration belt communities, multi-orientated communities, core municipalities outside agglomerations and rural municipalities without urban character (FSO, 2014a). An eight category exists based on the number of inhabitants per municipality (FSO, 2015). The most complex typology divides municipalities into 25 different types (FSO, 2012a).</p> <p>A summary of how Switzerland’s urban-rural typology correlates with various socio-demographic factors can be found in the FSO (2012b) reader on regional disparities within Switzerland. In particular, the FSO (2018) provides data on the accessibility of basic services, such as food shops, medical doctors, pharmacies, and hospitals, which is disaggregated into urban, intermediate and rural areas.</p>  <table border="1"> <caption>Data for Figure 2: Average distance in meters to critical services</caption> <thead> <tr> <th>Service</th> <th>Urban core</th> <th>Influence areas of urban core</th> <th>Rural communities</th> </tr> </thead> <tbody> <tr> <td>Food store</td> <td>468</td> <td>825</td> <td>1017</td> </tr> <tr> <td>Medical practice</td> <td>532</td> <td>1475</td> <td>1925</td> </tr> <tr> <td>Pharmacy</td> <td>994</td> <td>3341</td> <td>4550</td> </tr> <tr> <td>Hospital</td> <td>3199</td> <td>7720</td> <td>9403</td> </tr> </tbody> </table> <p>Figure 2. Average distance in meters to critical services in urban, suburban, and rural municipalities in Switzerland. Data from FSO (2018), urban-rural typology from FSO (2014b).</p>	Service	Urban core	Influence areas of urban core	Rural communities	Food store	468	825	1017	Medical practice	532	1475	1925	Pharmacy	994	3341	4550	Hospital	3199	7720	9403
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<p>Emergency supply kit (4.1)</p> <p>emergency supply kits per population</p>	<p>Maduz et al. (2018) surveyed the individual disaster preparedness of 758 people through an online panel representative of German and French-speaking Switzerland. With regards to the emergency supply kit, 50.5% of respondents adhered to the recommended stockpile of food for 7 days and drinking water for 3 days. Buob (2017) conducted a written survey of randomly selected persons in the German-speaking part of Switzerland on emergency supplies and purchasing behavior. In the survey, 79% of the 400 respondents complied with the</p>																				

<p>individual items from kits per household</p> <p>stockpile of food (kilogram, kcal, or days) per household</p> <p>stockpile of drinking water (liters or days) per household</p>	<p>recommended food supply for 7 days, and 59% of the respondents had a 3-day supply of drinking water. The negative predictors of preparedness were young, foreign residents, male, urban demographics and low household incomes. Zimmermann and Pescia (2018) compiled data from 900 written survey responses and 400 oral interviews with Swiss household on their emergency supplies and attitudes towards supply shortages. They found that the average household had stocked food for 16.2 days (written) or 12.5 days (oral), with about a third of respondents not having the recommended stock of food for 7 days. The average drinking water supply per person was 7.7 liters with 69% of households being below the recommended 9 liters per person.</p>  <table border="1"> <caption>Data for Figure 3: Average days of emergency supply per person per household</caption> <thead> <tr> <th>Category</th> <th>Urban cores</th> <th>Influence areas of urban cores</th> <th>Rural communities</th> </tr> </thead> <tbody> <tr> <td>Food</td> <td>14.6</td> <td>18.6</td> <td>19.6</td> </tr> <tr> <td>Food (requires no electricity)</td> <td>5.4</td> <td>7</td> <td>7.2</td> </tr> <tr> <td>Water</td> <td>2.1</td> <td>2.4</td> <td>2.4</td> </tr> </tbody> </table> <p>Figure 3. Average days of emergency supply per person per household in urban, suburban, and rural municipalities in Switzerland. Adapted from Zimmermann & Pescia (2018 p. 36), typology from FSO (2014b).</p> <p>We did not find publicly available data sets that use demand shocks for specific products to quantify preparedness actions for slow-onset disasters in Switzerland. However, the ongoing coronavirus pandemic provides an unique opportunity to study this behavior. For example, the app Bring! has published a list of products whose demand has increased the most in Switzerland. Aside from expected increases for products such as disinfectants (+2485%) and rice (+150%), it also shows increases in potting soil (+558%) and beer (+95%) (Haltinner, 2020). More of this type of longitudinal product sales data should be available from large retailers (e.g. Migros, Coop, Aldi, Lidl), pharmacies (e.g. Galenica-Group, Winconcept Partner, TopPharm), as well as online shops (e.g. Amazon, McDrogerie).</p>	Category	Urban cores	Influence areas of urban cores	Rural communities	Food	14.6	18.6	19.6	Food (requires no electricity)	5.4	7	7.2	Water	2.1	2.4	2.4
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<p>Financial preparedness (4.2)</p> <p>cash or credit card per household</p> <p>insured/ uninsured earthquake risk per canton</p> <p>life insurance per population</p>	<p>The mandatory building insurance in Switzerland already covers damage from natural hazards, except for earthquakes. The Swiss Earthquake Relief Pool makes a maximum of CHF 2 billion available to its 17 member cantons twice a year to compensate affected building owners. The Canton of Zurich and the Canton of Berne have their own earthquake relief pools. In the Cantons of Appenzell Innerrhoden, Geneva, Obwalden, Schwyz, Ticino, Uri and Valais private building insurers provide natural hazard cover and no funds are available for compensation after an earthquake. Furthermore, in the event of a major earthquake the voluntary protection against earthquakes by cantons might not cover all costs. The cost of the damage from the earthquake in Basel in 1356 is estimated at 50 to 100 billion CHF today (Swiss Seismological Service, n.d.). Data on the number and distribution of households with private earthquake insurance is available to insurers. Zurich Insurance, in particular, distributes cantonal statistics to media outlets (Quinto, 2017, p. 31; Huber, 2018).</p>																
<p>Physical preparedness (4.3)</p> <p>vaccinations (of vulnerable</p>	<p>In Switzerland key recommended vaccines include hepatitis B, cervical cancer, polio, measles, mumps, rubella, tetanus, whooping cough, pneumonia, chickenpox, meningitis, diphtheria, encephalitis and the seasonal influenza. The Swiss National Vaccination Coverage Survey collects the cantonal and national vaccination quotas of 2-year-old infants, 8-year-old children and 16-year-old adolescents (FOPH, 2018, pp. 10-15). The seasonal influenza report</p>																

<p>people) per (vulnerable) population</p>	<p>lists the number of vaccine doses produced by four suppliers for the Swiss market (1.13 million in the 2018/2019 season), which translates into a coverage of about 14 per cent of the total population. Additionally, the FOPH has conducted a phone survey with DemoSCOPE, which indicates a vaccination rate of 31 per cent for persons above 64, 25 per cent for persons with chronic diseases, and 23 per cent for healthcare workers for the influenza season 2018/2019 (FOPH, 2019, p. 18).</p>
<p>Building (4.4) safety devices per household or building or m²</p>	<p>The number and regional distribution of secured furniture, smoke detectors, fire extinguishers, air conditioning and generators in private homes is not publicly available. Sales data from producers might provide some indications. Otherwise, surveys are likely the best option for further information.</p>
<p>Mobility (4.5) cars per household or population other types of transport per household or population</p>	<p>The Mobility and Transport Microcensus is conducted every five years by the FSO (2017) in collaboration with the Federal Office for Spatial Development. With its comprehensive catalogue of questions and a sample of more than 57'000 respondents, it is the most important survey on the transport behaviour of the population in the country.</p>  <p>Figure 4. Percentage of households owning vehicles in urban, suburban, and rural municipalities in Switzerland. Adapted from FSO (2017, p. 12), typology from FSO (2014b).</p>
<p>Autarky (4.6) electricity or food generation capacity per household</p>	<p>The number, demographics and preparedness level of Swiss citizens who prepare for a prolonged degradation of critical infrastructure and services is not directly available. Article 45 of the federal law on civil protection and civil defence mandates that every resident has an available place in a civil defense basement, which protects them from kinetic weapons, nuclear fallout and poison gas. The number and occupancy capacity of civil defense basements is available to the competent civil defense and civil protection authorities.</p>
<p>Risk knowledge (5.1) access to early warning per communication channel / population subjective risk knowledge per population</p>	<p>In 2011, the Federal Office for Civil Protection commissioned two surveys on the knowledge and needs for information on individual disaster preparedness in Switzerland (econcept, 2011). Maduz et al. (2018, p. 24) conducted a similar survey on risk perception, knowledge, and disaster-related information seeking behavior in Switzerland. In a follow-up study, Maduz et al. (2019) more deeply explored this data to explain disaster-related information seeking and preparedness behavior in Switzerland. The aggregate use of online information channels can also be monitored through traffic analysis sites, such as Alexa. The information seeking behavior of Swiss citizens can also be monitored through search engine query analysis, such as offered by Google Trends. Depending on search volume, this data is also provided disaggregated by Canton. Both econcept (2011) and Maduz et al. (2018) asked about hazard-specific subjective levels of awareness, as well as hazard-specific demands for more information. In the most recent survey, the highest demand for further information related to chemical accidents, cyberattacks, nuclear accidents, terror attacks and failure of ICT infrastructure (Maduz et al., 2018, p. 21).</p>

	<p>The access to early warning systems in Switzerland is given through sirens, radio, TV and digital means. The FSO provides annual radio and TV consumption indicators. However, these are only available disaggregated for linguistic areas. The data aggregated by municipality should be available to Serafe, the collection agency for Switzerland’s radio and television fee. The number of downloads of the warning app Alertswiss, as well as MeteoSwiss, can also be an indicator. However, mapping the location data of users to an urban-rural typology would be problematic in terms of privacy.</p>  <table border="1" data-bbox="375 470 1428 952"> <thead> <tr> <th>Channel</th> <th>2011 (March, n=340)</th> <th>2011 (May, n=407)</th> <th>2017 (n=528)</th> </tr> </thead> <tbody> <tr> <td>MeteoSchweiz</td> <td>32</td> <td>37</td> <td>90</td> </tr> <tr> <td>Ministry of the Environment</td> <td>26</td> <td>16</td> <td>44</td> </tr> <tr> <td>Institute for Snow and Avalanche Research</td> <td>5</td> <td>15</td> <td>39</td> </tr> <tr> <td>Federal Office for Civil Protection</td> <td>31</td> <td>23</td> <td>38</td> </tr> <tr> <td>Swiss Seismological Service</td> <td>4</td> <td>15</td> <td>34</td> </tr> </tbody> </table> <p>Figure 5. Share of survey respondents that use specific online information channels on hazards in Switzerland. Data from econcept (2011) and Maduz et al. (2018).</p>	Channel	2011 (March, n=340)	2011 (May, n=407)	2017 (n=528)	MeteoSchweiz	32	37	90	Ministry of the Environment	26	16	44	Institute for Snow and Avalanche Research	5	15	39	Federal Office for Civil Protection	31	23	38	Swiss Seismological Service	4	15	34
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<p>Response strategies (5.2) emergency plan per population</p>	<p>Maduz et al. (2018) found that 12 per cent of the people in Switzerland have a personal emergency plan. The Alertswiss app also includes the possibility to store response strategies. Checking how many people are using this feature, could provide an alternative trend indicator, even though it is difficult to estimate what proportion of people store their plan in an app.</p>																								
<p>Hazard-specific behaviors (5.3) free recall or familiarity with a hazard-specific behavior per population</p>	<p>Econcept (2011, p. 25) tested people’s ability to recall recommended response behaviors for terror attacks, floods and a nuclear accident. Furthermore, the familiarity with two behavioral instructions was asked for nine selected hazards. Respondents were most familiar with advice for pandemics and the breach of a dam. They were least familiar with advice for an avalanche or a chemical accident. Similarly, Maduz et al. (2018, p. 17) asked survey respondents whether they are familiar with two recommended behaviours in a pandemic (96.3% familiar with both), earthquake (81%) and a blackout (35.8%). In the current coronavirus crisis where individuals have been asked to avoid gatherings and non-essential travel, Swisscom (2020) provides aggregate location data to the FOPH to monitor adherence to the mandated behaviors. Additional data sources include the MOBIS-COVID-19 studies based on voluntary data from an app (Molloy, 2020), as well as community mobility reports by Google (2020), which contain data disaggregated for Cantons. The global interest in data that provides some insight into the adherence of handwashing with soap, such as soap sales data in retail stores, has been markedly lower.</p>																								
<p>Useful skills (5.4) licensed or self-reported skill per population</p>	<p>First aid training is a currently a mandatory part of acquiring a Swiss drivers license and for the recruitment school of the Swiss Armed Forces. Hence, data on newly registered drivers and military recruits provides indirect data on how many people have recently taken a first aid course and how they are distributed geographically. The Federal Office for Sports (BASPO) conducts large-scale surveys on the sport habits of the Swiss population, including swimming (Lamprecht et al., 2020).</p>																								

7 Conclusion and future research

In this report, we have provided a brief overview of empirical research on individual disaster preparedness and indicators that can be used to measure it. We have also provided a collection of concrete data sources for measuring individual disaster preparedness for Switzerland. In closing, we highlight specific knowledge gaps and suggest potential directions for further research on this topic.

7.1 Knowledge gaps

7.1.1 Effectiveness and composition of emergency kits

The use of emergency preparedness kits is advocated by many disaster risk management organizations. However, there are few empirical studies that examine how people with emergency kits actually fare in the response and recovery phase of a disaster compared to those without one. There is also a lack of literature on how to determine the appropriate contents of these kits. For example, Perman et al. (2011) examined 71 different disaster kit lists and observed large disparities in terms of the number, specificity and type of items on the list. As Heagele (2016) and Pickering et al. (2018) argue, emergency supply kits should continue to be promoted as a preparedness measure. However, further systematic empirical evidence regarding their usefulness needs to be generated.

7.1.2 Suburban disaster context

The literature on disaster preparedness discusses the impact of urbanization and urban-rural differences. However, little has been written on the specific opportunities and challenges in suburban contexts. Generally, suburban settings appear to have intermediate levels of infrastructure redundancies, institutional capacity, diversification of the economy, community capital and environmental resilience (Cutter et al., 2016, p. 1243). Given the predominance of suburban areas in Switzerland, it seems worth investigating what distinctive characteristics of suburban areas, such as a high share of commuters to city centers, create distinct challenges in terms of individual disaster preparedness.

7.2 Directions for future research

7.2.1 Individual preparedness in the COVID-19 crisis

It is often stated that the coronavirus pandemic is one of the biggest challenges society has faced since World War II. From a researcher's point of view, the coronavirus pandemic also provides opportunities to study the individual preparedness behaviour in anticipation of a slow-onset disaster in Switzerland and internationally. One of the challenges for evaluating generic preparedness is that purchases for storage purposes are largely indistinguishable from regular consumption patterns within aggregate sales data, except for purchases of specialized emergency kits. Hence, there is a reliance on surveys to deduce individual disaster preparedness. Most surveys are inherently limited insofar as they represent a relatively small sample, contain selection biases, as well as omissions and errors in reporting. It would therefore be interesting to collaborate with retailers to study when and how Swiss citizens took hazard-specific preparedness measures.

Furthermore, the global nature of the crisis provides a case study to empirically examine public policy approaches comparatively. For example, it would be interesting to compare the implementation of individual preparedness actions in response to the public messaging strategies in different countries to get a sense of their effectiveness. It could be interesting to look at compliance rates with recommended hazard-specific behaviors, such as upholding physical distancing and washing hands. It appears that many governments discouraged preparedness purchases in the early stages of the pandemic to avoid supply shortages. It would be interesting to study which messaging has helped to pre-empt and flatten demand curves for preparedness goods. It would also be interesting to analyse the use and reach of different information channels.

7.2.2 Digitalization of disaster preparedness

The emergence and spread of smartphones is still not fully accounted for in disaster preparedness guidelines for communities and individuals. Disaster risk apps, such as Alertswiss, are already deployed in the area of early warning and information distribution. However, many other smartphone functions are not as widely used yet. In the coronavirus crisis many governments have discovered the use of smartphones for pandemic-specific functions, such as contact tracing. Furthermore, most smartphones have a flashlight

function or can be turned into a flashlight with the right app. Most smartphones also have an in-built capacity to receive FM radio, even though that capacity is not advertised and usually requires an additional app, such as NextRadio (Glaser, 2016). Receiving the new European radio standard DAB+ without internet access usually requires an additional dongle. Moreover, GoogleMaps and similar apps can easily store up-to-date local maps offline. Similarly, it is much easier to digitize important documents, such as insurance and bank contracts or medical prescriptions, and store them in a cloud and on a device than to make and carry physical copies of them. While this entails privacy risks, there are readily available solutions with high security features, such as UBS Safe, which offers a simple way to save important documents on servers in Switzerland. For a younger and more urban population, “smartphone preparedness”, including back-up accumulators, pre-installing relevant apps, and choosing a phone that is water-proof and has an FM capacity, could be more attractive than traditional preparedness measures involving battery-operated flashlights and radios. Moreover, smartphones offer new preparedness possibilities, such as storing first aid advice or local languages and context information offline on the device.

7.2.3 Impacts of the sharing economy

Sharing platforms, such as Airbnb, enable a higher utilization rate of goods, services and buildings. On the one hand, sharing platforms might be an opportunity to match needs and capacities during and after a disaster. On the other hand, the more efficient use of goods also means that there is less overcapacity to deal with sudden demand spikes. For example, if access rather than ownership models become more popular for personal mobility, there would be less overall cars available in an evacuation scenario (Koon, 2018).

7.2.4 Ethnography of hobbyists and the “prepper” subculture

The “prepper” subculture takes individual disaster preparedness to the extreme, making it a part of personal identity and lifestyle. The goal of “preppers” is often to achieve full autarky and hence to be able to survive an anticipated societal collapse. Due to associations with political extremism, both the academic and the governmental disaster management communities have largely avoided engagement with this community (Barker, 2019). However, the “prepper” community also includes individuals that do not necessarily fit this stereotype,

such as Silicon Valley billionaires (Osnos, 2017). Overall, there is a lack of evidence on whether this subculture should be considered synergetic, orthogonal, or detrimental to public efforts for individual disaster preparedness. Consequently, it could be interesting to examine its composition and how motivations for preparedness, risk perception, information seeking behavior, as well as material and cognitive preparedness actions compare to the general public, as well as to recommendations by governments. Ultimately, citizens are an important resource in preparing and responding to disasters, and might also be engaged in social innovation in areas with a low risk of injuries, such as testing, iterating and improving the composition of emergency supply kits.

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