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DAREnet

D4.2 – Report of Topic Working Groups: Knowledge Base for Assessment and Roadmapping Cycle 1

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Abstract: D4.2 presents the current status of the DAREnet Knowledge Base as well as reports of the findings from each DAREnet Topic Working Group during the first roadmapping cycle.

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Glossary

Abbreviation / acronym	Description
2D	Two-Dimensional
3D	Three-Dimensional
3GPP	3rd Generation Partnership Project
4D	Four-Dimensional
APP	Application
ARC	Austrian Red Cross
BMBF	Bundesministerium für Bildung und Forschung [German Federal Ministry of Education]
BMVIT	Bundesministerium für Verkehr, Innovation und Technologie [Austrian Federal Ministry for Transport, Innovation and Technology]
CMT	Community Management Tool
CP	Civil Protection
CSP	Communication Service Platform
D2D	Device-to-Device
DEFRA	Department for Environment, Food and Rural Affairs [United Kingdom]
DMC	Dyke Monitoring and Conditioning system
DMR	Digital Mobile Radio
DNC	DAREnet National Contact
Dx.y	Deliverable x.y
EMS	Emergency Management Service
EUCPM	European Civil Protection Mechanism
FEMA	Federal Emergency Management Agency [United States]
GIS	Geographic Information System
IOP	Interoperability Standard
IP	Internet Protocol
ISO	International Standardisation Organisation
KB	Knowledge Base
LMR	Land Mobile Radio
MCPTT	Mission Critical Push-to-talk
MHP	Mapy Hydrogeologiczna Polski
MMI	Multi Media Interface
MVNO	Mobile Virtual Network Operator

OGC	Open GeoSpatial Consortium
PDF	Portable Document Format
PFA	Psychological First Aid
PFA-CE	Psychological First Aid in Complex Emergencies
PMR	Private Mobile Radio
PPDR	Public Protection and Disaster Relief
PSS	Psychological Support Services
QCI	QoS Class Identifiers
QoS	Quality of Service
RDI	Research, Development, Innovation
SoP	Standard Operating Procedures
SV	Spontaneous Volunteers
TWG	Topic Working Group
UAV	Unmanned Aerial Vehicle
UHF	Ultra High Frequency
UPS	Uninterruptible Power Supply
VHF	Very High Frequency

1 Executive Summary

The overall objective of the H2020 project DAREnet is to identify and analyse gaps and potentials for improvement with regard to flood and disaster management in the area of the Danube river basin. A key instrument to achieve this goal is a knowledge base (KB) that contains user expertise and know-how of actors of disaster management along the Danube. The deliverable D4.2 describes the current status of entries within the KB at the end of the first DAREnet roadmapping cycle. The underlying basic structure of the DAREnet KB is derived from an ontology developed in WP1 and was already described in the previous deliverable D1.2.

The contents of the KB are based on the work of WP4 to derive relevant topics within the fields “Solutions from Research and RDI Projects”, “Solutions on the Market”, “Best Practices and Lessons Learnt” as well as “Flood History and Background Information”. In the first DAREnet roadmapping cycle, six RDI subgroups were defined out of the whole amount of selected RDI Topics (cf. deliverable D1.1) and dealt within DAREnet Topic Working Groups (TWG). These topics are “Civil Protection Training”, “Resilience of Citizens”, “Spontaneous Volunteers”, “Civil Protection Methods, Procedures and Technology”, “Communication” as well as “General Data Management”. The expertise within the TWG was collected through intensive research and with the help of the DAREnet National Contacts (DNC) through expert interviews with national actors of disaster management using a survey. These data were subsequently reviewed and analysed under the aspects of “Relevance of the RDI Topic”, “Practitioner Needs”, “Available Solutions”, “Innovation Opportunities” and “Lessons Learnt”. Reports describing the related findings of each TWG are part of D4.2 as well.

2 Introduction

The mission of the DAREnet project is to support flood management practitioners across the EU Danube River basin and from different disciplines to deepen and broaden their research, development and innovation (RDI) related collaboration. Therefore, a multidisciplinary community of practitioners, organisations operating in the field of civil protection, and stakeholders from policy, industry and research is being built up in order to establish a trans-national and interdisciplinary ecosystem to foster synergies, innovations and to ensure the continuity of the DAREnet innovation process after project end.

A main outcome of the project is the RDI Roadmap, which will be a direct result from the dialogue in the DAREnet Community and Network. The RDI Roadmap aims at shaping future research and innovation policies for the Danube region and the research programmes implementing them. Specifically, the Roadmap will foster innovation opportunities that:

- Match practitioner needs and gaps experienced in the daily practice of flood management,
- Significantly improve nowadays flood management and/or enable practitioners to cope with upcoming flood events (e.g. due to climate change),
- Comply with regional strategies for flood prevention and risk management,
- Create synergies with modules and facilities of the European Civil Protection Mechanism (EUCPM),
- Strengthen exchange and collaboration between practitioners beyond borders and different disciplines,
- Have a promising perspective for industrialisation and market-entry.

The RDI Roadmap is the result of an iterative process of identifying, assessing and prioritising potential innovations as well as mapping important RDI requirements and gaps.

The roadmapping process starts with formulating the most critical challenges for flood management in the Danube region. From the challenges specific RDI Topics are derived, each covering a relevant field or source of innovation (cf. D1.1 DAREnet Challenges & RDI Topics). RDI Topics are then grouped and for the most pressing ones, RDI Topic Working Groups (TWG) are set up to correlate and contextualise the potential innovations with practitioner needs and gaps.

DAREnet is divided into four roadmapping cycles and during each cycle, practitioners bring forward and discuss potential solutions for innovating flood management with respect to the specific RDI Topic of the Working Groups. The discussions are fed with information about innovative solutions from the industry, research and best practices. In the next step, the identified innovation opportunities are taken up by the Innovation Assessment (cf. WP5) to benchmark the relevance of each innovation for practitioners from a holistic perspective.

A key instrument to achieve the described goal is a knowledge base (KB) that contains user expertise and know-how of actors of disaster management along the Danube. The contents of the KB are based on the work of WP4 subtasks T4.2 to T4.5 to derive relevant solutions within the fields “Solutions from Research and RDI Projects”, “Solutions on the Market”, “Best Practices and Lessons Learnt” as well as “Flood History and Background Information”. The set-up of the KB as well as its basic structure, which was derived from an ontology developed in WP1, was already described in the previous deliverable D1.2.

In the present deliverable, we present the current status of entries within the KB at the end of the first DAREnet roadmapping cycle. Moreover, this deliverable contains reports of the final findings of each TWG from selected RDI subtopics within the first roadmapping cycle.

During the first DAREnet roadmapping cycle, six RDI subgroups were defined from the selected RDI Topics (cf. deliverable D1.1) and dealt within DAREnet TWG. These topics were:

- Civil Protection Training,
- Resilience of Citizens,
- Spontaneous Volunteers,
- Civil Protection Methods, Procedures and Technology,
- Communication,
- General Data Management.

The expertise within the TWG was collected through intensive research and with the help of the DAREnet National Contacts (DNC) through expert interviews with national actors of disaster management using a survey (cf. questionnaire in ANNEX). These data were subsequently reviewed and analysed under the aspects of:

- Relevance of the RDI Topic,
- Practitioner Needs,
- Available Solutions,
- Innovation Opportunities and
- Lessons Learnt.

The results from these analyses are presented in detail within the present deliverable. A key role plays the subsection “Innovation Opportunities” from each TWG since these findings are direct input for the next process step of the roadmapping cycle “Innovation Assessment” (cf. WP5) where the relevance of each innovation opportunity is benchmarked for practitioners from a holistic perspective.

Deliverable D4.2 is structured as follows:

- **Section 1** “Executive Summary” provides a brief overview of the content of the document.
- **Section 2** “Introduction” describes the purpose and scope of the document, placing the results described in the document in the specific context of the project and explaining how they contribute to the objectives of DAREnet.
- **Section 3** “Current Status of the Knowledge Base” presents the current state of entries within the DAREnet KB at the end of the first roadmapping cycle.
- **Section 4** “Reports from the Topic Working Groups” present the findings from each TWG related to the selected RDI Topics of the first roadmapping cycle.
- **Section 5** “Conclusion” completes the deliverable by summarizing the major outcomes and describes the further use of the results within the project, including contribution to other work packages.

3 Current Status of the Knowledge Base

By the end of M12, a total of 589 solutions were integrated to the DAREnet Knowledge Base covering entries from the following Knowledge Types.

Table 1: Entries in Knowledge Base

Knowledge Type	Amount of entries
Research and RDI Projects	314
Technologies and Solutions on the Market	213
Lessons Learnt and Best Practices	37
Flood History and other Background Information	25

The most entries represent solutions from 'Research and RDI Projects', directly followed by 'Technologies and Solutions on the Market'. However, having only 37 and 25 entries for 'Lessons Learnt and Best Practices' respectively 'Flood History and other Background Information' is not a poor outcome since there are only few experiences due to the relatively little amount of actual events in comparison to the severity of those events.

The following sections give an insight in the current status of the entries within the DAREnet Knowledge Base. The knowledge types 'Lessons Learnt and Best Practices' and 'Flood History and other Background Information' are summarized in one subchapter due to the fact that most lessons learnt and best practices are direct outcomes of actual flooding events in the past.

3.1 Solutions from Research and RDI Projects

Related to the topic "Solutions from Research and RDI Projects", the Knowledge Base currently includes a total of 314 entries (query status: by the end of M12). These entries cover a wide range of solution types including RDI projects, journal publications and conference papers, technical reports, reviews etc. (cf. Figure 1). However, journal publications and projects are by far the most strongly represented solution types and cover almost 80% of all entries associated with Research and RDI Projects.

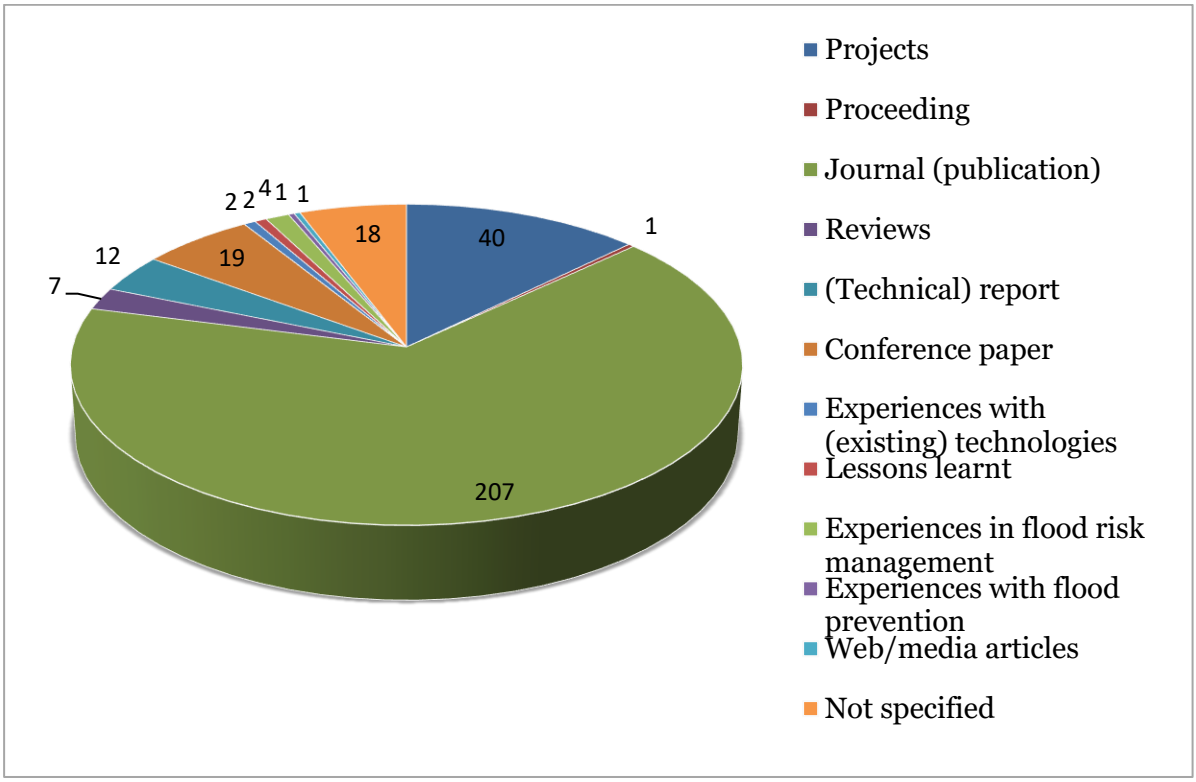

Figure 1: Solution types for "Solutions from Research and RDI Projects".

Table 2 gives an overview on specific entries of selected solution types that were integrated to the Knowledge Base in the first 12 month of DARENet project.

Table 2: Examples for KB entries from Research and RDI Projects.

Solution Type	Solution Name	Content
Research Project	Multi-hazard cooperative management tool [Project: HEIM-DALL]	Multi-hazard cooperative management tool for data exchange response planning and scenario building
	Flood Hazard Mapping [Project: FLOODsite]	Review on Flood Hazard Mapping deals with technical and modelling aspects related to mapping in rivers and coasts
	DANUBE FLOODPLAIN	Reducing the flood risk through floodplain restoration along the Danube River and tributaries and thus, improving transnational water management and flood risk prevention while maximizing benefits for biodiversity conservation
	Global Flood Awareness System (GloFAS)	It couples state-of-the art weather forecasts with a hydrological model and with its continental scale set-up it provides downstream countries with information on upstream river conditions as well as continental and global overviews.
	EartH2Observe	Global Earth Observation for Integrated Water Resource Assessment: objective is to contribute to the assessment of global water resources through the use of new Earth Observation datasets and techniques

Journal	LISFLOOD model	a GIS-based distributed model for river basin scale water balance and flood simulation
	E -learning and face to face training approach	Flood Hazard Prevention Appraisal in Europe: Training Key Stakeholders on the Benefits and Costs of Efficient Protection and Response
	Perceptions of flood hazard adjustments	Citizens' Perceptions of Flood Hazard Adjustments An Application of the Protective Action Decision Model
	Fostering Mechanisms for River Basins	Social Learning in European River-Basin Management: Barriers and Fostering Mechanisms from 10 River Basins
	Global flood risk models	Usefulness and limitations of global flood risk
	Vulnerability analysis in Flood Management	Integrating vulnerability analysis and risk assessment in flood loss mitigation: An evaluation of barriers and challenges based on evidence from Ireland
	Readiness of citizens	Qualitative research on the readiness of citizens to respond to natural disasters
	Torrent floodplain mapping	Torrent floodplain mapping and torrent flood control in Serbia in the conditions of economic crisis
	Flood risk assessment and management	Floods and climate: emerging perspectives for flood risk assessment and management
	Flood hazards maps	Evaluation of flood hazard maps in print and web mapping services as information tools in flood risk communication
(technical) Report	GIS-based Multicriteria Analysis	GIS-based multi-criteria Analysis as Decision Support in Flood Risk Management
	Global Flood Detection System (GFDS)	GFDS provides up-to-date information on the impact and extent of floods occurring across borders using real-time satellite observations; information is integrated into Global Disaster Alert and Coordination System (GDACS)
	Hochwasser und Klimawandel	Report and foresight showing the effects of climate change on floods in Austria
	The Global Flood Detection System (GFDS)	The global flood detection system. JRC scientific and technical reports (2007)
Proceeding	Empowering young professionals	Disaster Resilient Balkans: empowering young professionals
Review	Effects of climate changes	The effects of potential climate changes on flood and water regime components in selected catchment areas in Austria
	Flood regime changes	Understanding Flood Regime Changes in Europe: A state of the art assessment
	Vulnerability to	Vulnerability to flooding: health and social dimensions

	flooding	
	Flood Risk Management	Review of the flood risk management system in Germany after the major flood in 2013
Conference paper	Strategies for flood risk management	Strategies for flood risk management – a process perspective
	Temporary flood barriers	Development of a Standard Testing Framework for Evaluating Temporary Flood Barriers
	Flood preparedness	Assessment of Flood and Strategies for Flood Preparedness: A Study of Warna River and its Middle Basin Villages
	Flood reduction	Flood loss reduction of private households due to building precautionary measures -- lessons learned from the Elbe flood in August 2002

3.2 Solutions on the Market

Currently, the Knowledge Data base includes 98 entries related to the field “Solutions on the Market” that were collected during conferences and project events. The first was the FloodExpo in Birmingham. Flood Defence & Prevention Expo presents solutions to widespread flooding problems from the world's leading flood prevention companies. Acqua Alta is an international trade fair and conference for flood protection, climate change consequences and disaster management which takes place every two years in Essen. In order to identify future climate risks and affected areas German Red Cross works closely with the Red Cross Red Crescent Climate Centre in The Hague. Another source of solutions was the Global Flood Partnership, which is a multi-disciplinary group of scientists, operational agencies and flood risk managers focused on developing efficient and effective global flood tools that can address these challenges. The partnership aims at establishing a common platform for global flood forecasting, monitoring and impact assessment to strengthen preparedness and response and to reduce global disaster losses. There was another source of solutions - the SAYSO project. Its objective is to define the reference architecture and specifications for future innovative European cost-effective and user-friendly situational awareness tools that fulfil end-user requirements and can be used across different organisations, hierarchical levels and national borders.

There are 70 solutions that were collected during the Flood Expo out of which 41 provides products, 11 services, 15 technology and 3 data. There are also 7 companies met during the Aqua Alta Conference in Essen and German Red Cross Event that provides mostly products. In the Global Flood Partnership there are 9 companies providing technology, 1 providing service and 1 that is involved in a project. 7 companies have been identified thanks to SAYSO Project consortium and they provide technology. There are also 3 solutions from companies included in the KB that have been found in other ways (cf. Figure 2).

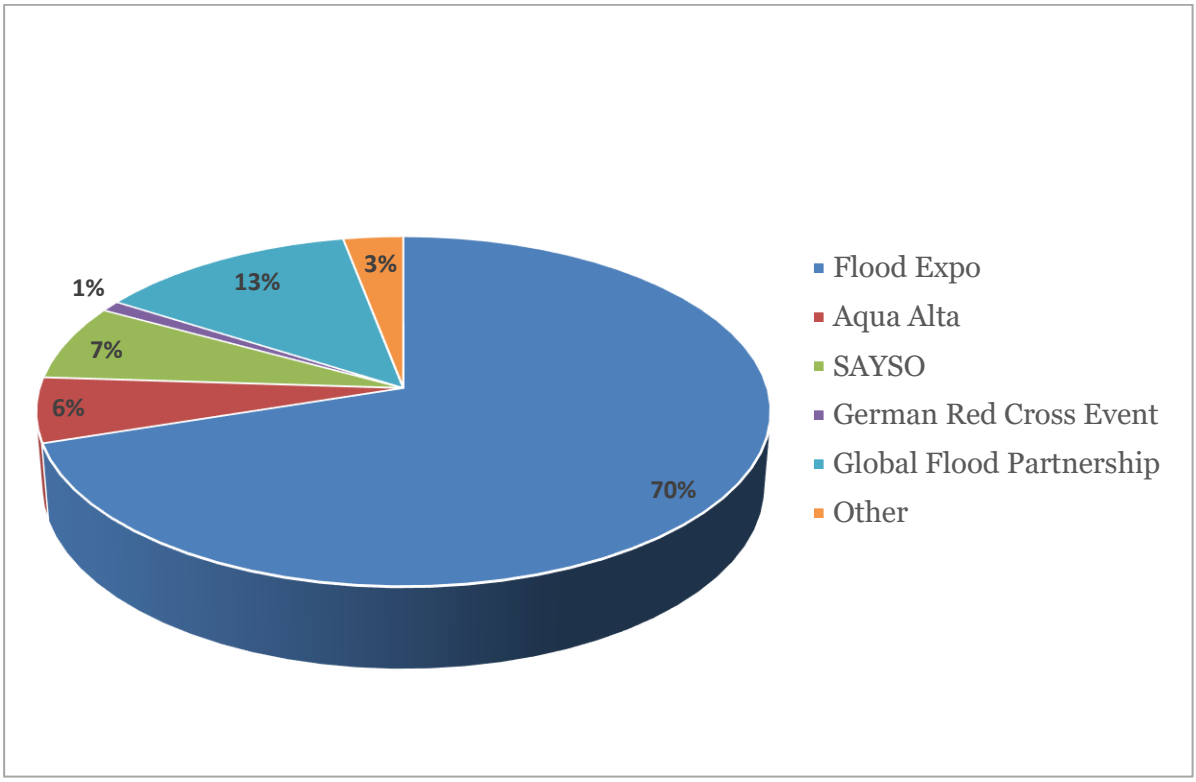

Figure 2: Sources for the research on "Solutions on the Market".

Figure 1 presents the overall solution types provided by identified entities and illustrates the trends in products and technology.

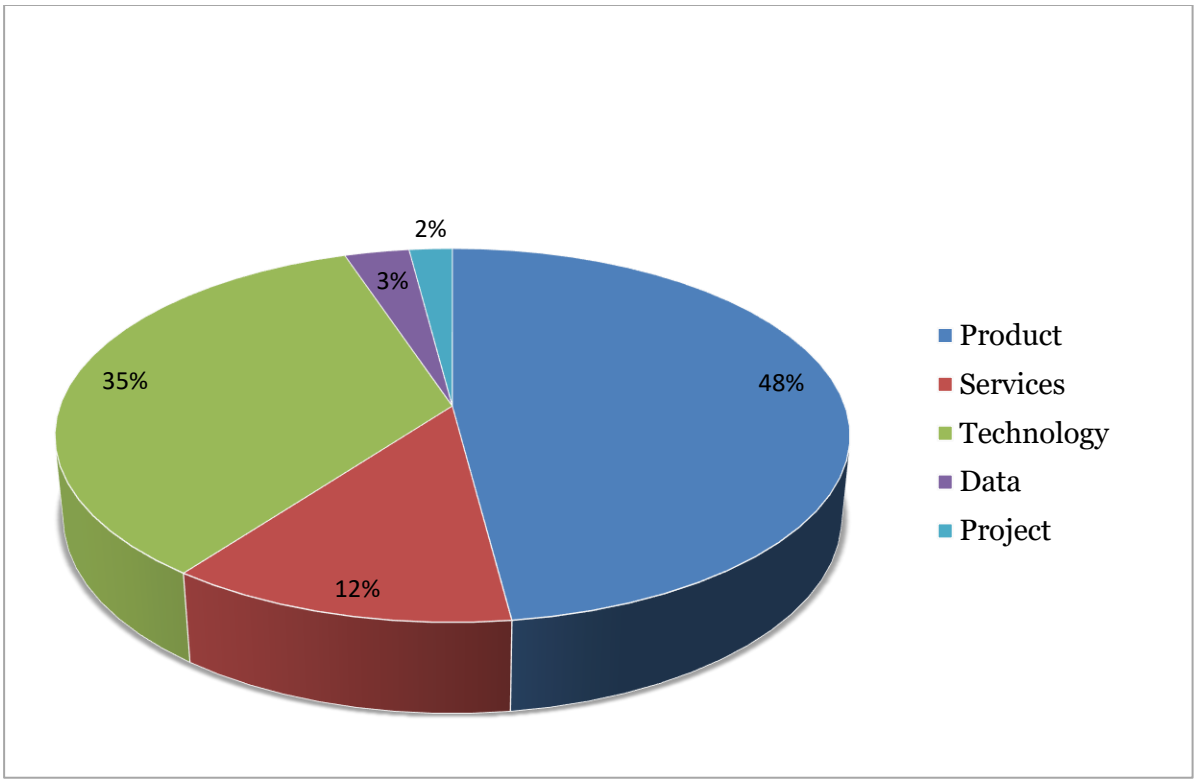

Figure 3: Solution types for "Solutions on the Market".

All the entities provide products, services and technologies that are in advanced stage of their development. The most common solutions are flood barriers and monitoring systems. There are also devices and methods for flood protection, forecasting and warning. Figure 4 presents the most common products and services provided by the entities included in KB.

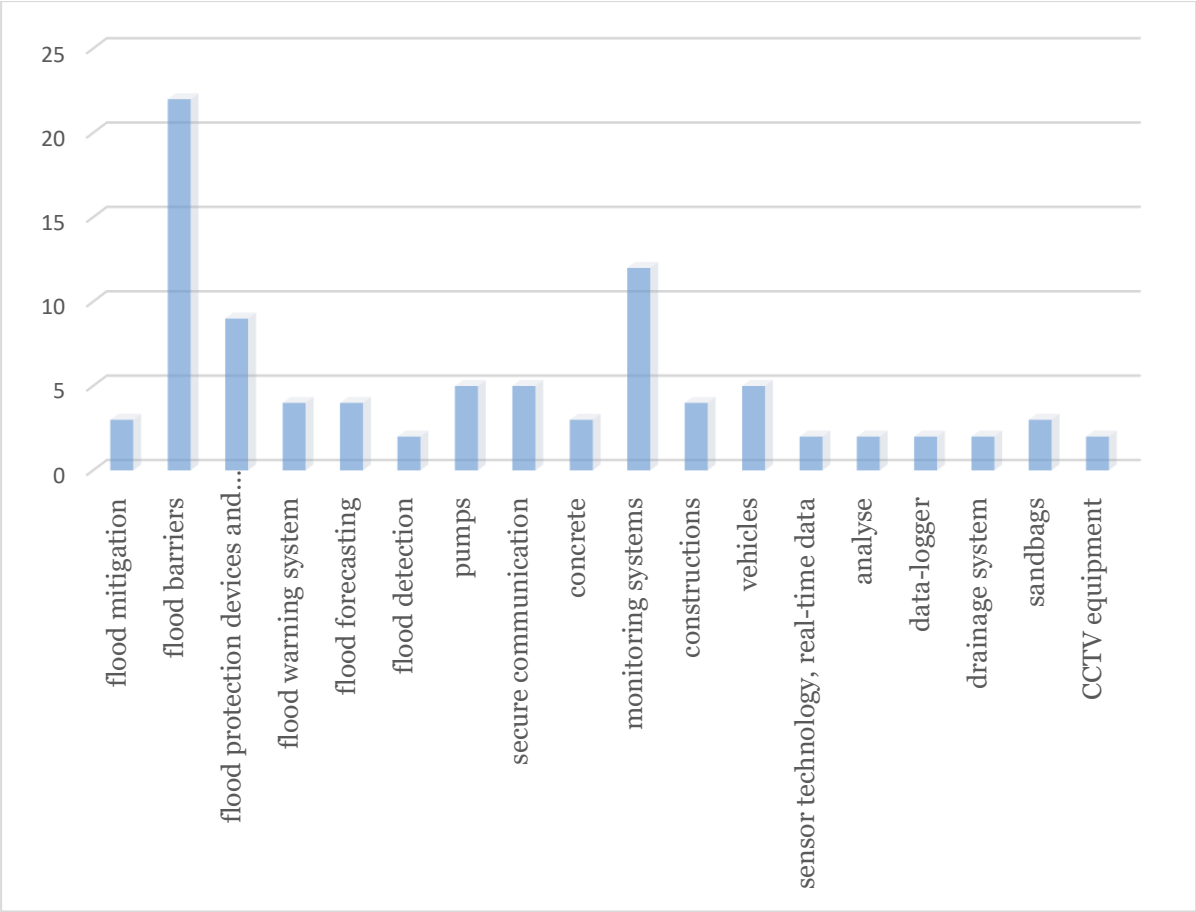

Figure 4: Most common products and services on the market.

Moreover, there are also entities that offer earth anchoring systems, driers, dehumidifiers, sandless sandbags, digital technology GPS, HADDMS, satellite soil moisture data, land surface temperature, fuel tanks, cables, lightning towers, generators and many more.

Identified providers are from various countries, mostly European, which is illustrated in the following map (cf. Figure 5). However, apart from European countries there are also entities form USA and Taiwan included in the KB.

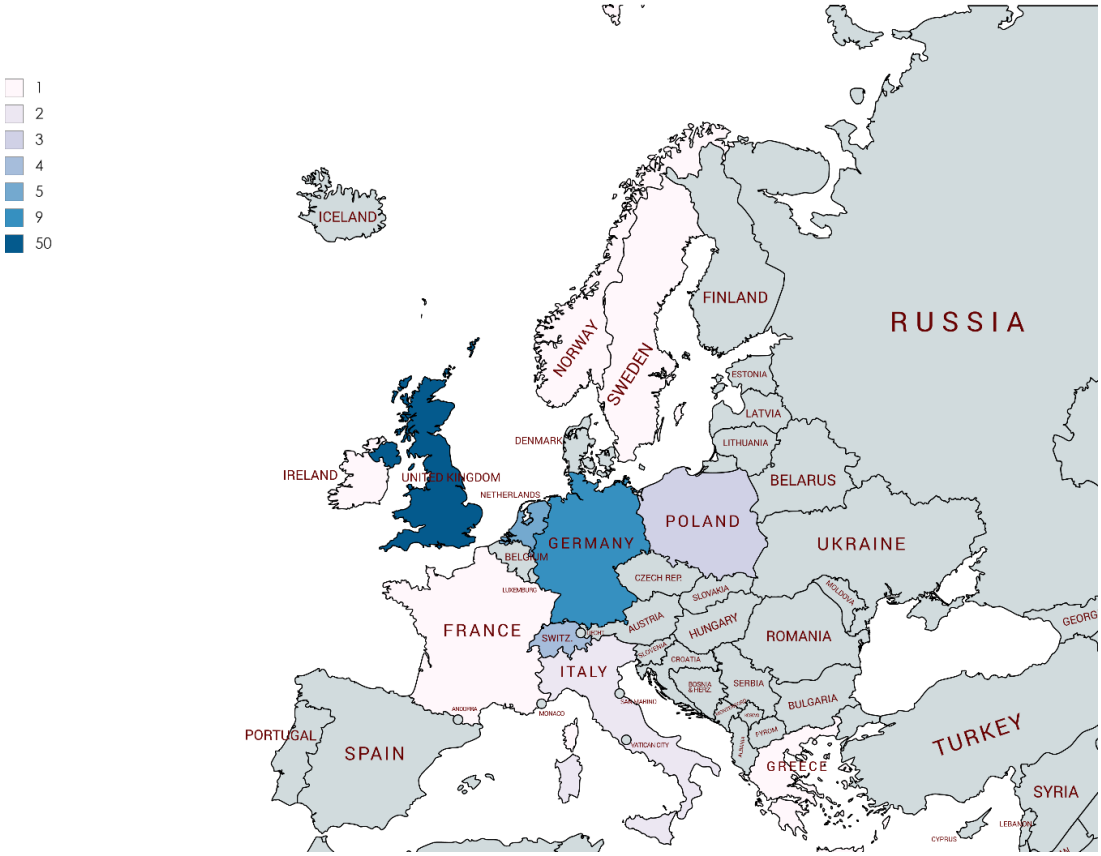

Figure 5: Nationalities of solution providers.

Table 3 presents the gathered data with the companies' names, solutions' names and their descriptions.

Table 3: Identified companies and their solutions on the market.

Flood EXPO		
HCP Pump Manufacturer Co	HCP Pump	HCP develop 20 different series and more than 300 models applications for: Waste Water, Municipal & Industrial water treatment, Oil & Gas water supply, Construction & Mining dewatering, Agriculture Irrigation, Aquaculture, landscape, Pumping Station for Flood Control. The output of HCP pump is about 50,000 units annually, and the volume is increasing continuously, the applications of pump are : waste water, recycling water treatment, drainage of construction site, general temporary drainage, agriculture irrigation, aquaculture, landscape and fountain, pump station for low-lying area, HCP pumps have been spread to many places.
Börger GmbH	Rotary Lobe Pumps, Mobile Pumps	Börger rotary lobe pumps convey dirty, sludgy, highly-viscous or chemically aggressive media without problems. The compact, low-on-space design, unproblematic pumping in slurp operation and the possibility to drive the pump by means of different motors or a PTO shaft are reasons why rotary lobe pump is the ideal mobile pump. Rotary lobe geometries, coatings and tips, pump casings and shaft seals are all select-

		ed depending on the medium to be pumped.
Ebsford Environmental	Flood Defences	We understand that a complex balance of factors contribute to flood defence solutions and that this results in a wide spectrum of schemes that all require implementing correctly. From coastal rock armour to establishing meanders in rivers, Ebsford are well placed to undertake the works with precision and sensitivity to the environment.
Ebsford Environmental	Sustainable Regeneration Developments	-
The Rivers Trust	The Rivers Trust Mapping Portal	This online resource is a collection of data, maps and apps, and GIS training resources, to help member trusts and catchment partnerships use data and evidence in their local catchments. There are example story maps which the RT team have helped local trusts and catchment partnerships to develop, and some national apps which help explore the range of catchment data and evidence available. There is an online data package, which contains a range of key layers to support catchment planning. Rivers trusts and catchment partnerships can use these layers in their own GIS systems, filtering the data to their catchment. There are also links to training resources, including an online training portal which rivers trusts and catchment partnerships can use to train staff in key GIS and spatial analysis skills.
ADC the specialist drainage company	CCTV Surveys	Our large range of CCTV equipment enables a complete survey and reporting service spanning large pipe work and culverts up to 2 meters in diameter to drainage pipes as small as 40mm. Larger culverts are surveyed using man entry methods, enabling our engineers to CCTV survey any size and structure. Drainage surveys are undertaken on behalf of the construction industry prior to adoption of pipelines by the water authorities. Our hi-tech equipment is used for clarification of the condition of drainage pipes, culverts and syphons.
ADC the specialist drainage company	The Silt Pusher	The perforated dozer blade is mounted to the Silt Pusher boat with hydraulic height and angle control, making clearance of differing drain widths very easy. The blade is pulled through water, or on top of silt, by a powerful winch within the boat and 300m of cable tethered to the embankment beside the excavator.
ADC the specialist drainage company	Pipe Re-lining & Restoration	The bottom line is:- minimised disruption to roadways and urban areas, quicker installation, elimination of heavy excavation vehicles.
Biffa	OneCall	Delivering emergency waste removal from a

		single point of contact, Biffa OneCall is a premium, on-demand service that supports all businesses from commercial managing agents, retail, leisure to business insurance to rapidly remove unplanned waste. From fly-tipping, to hazardous waste, Biffa OneCall operates nationwide, 24 hours a day, 7 days a week, 365 days a year and provides response times within 3 hours.
Marshalls	The Marshalls Water Management System	Marshalls is meeting the growing demand for more cost-effective and easy-to-install drainage channel systems with its wide range of products. Linear drainage solutions come in a range of sizes and materials to suit specific applications, as well as a wide range of grating options to complement any aesthetic. Consider Marshalls' linear and slot drainage products for projects of any size – from domestic driveways to airport runways – to be confident of consistently high standards in a range that can fit discreetly into any landscape.
Cunningham Lindsey	Flood Resilience Experts	Depending on the territory, we can provide and manage contractors who will provide emergency mitigation, restoration and repair for you and also undertake work to strengthen the property against common threats such as flood, asbestos, mold and fire.
FM Conway	Cleansing Services	The service includes: CCTV drain surveys using the latest vehicle-based camera and digital technology GPS and HADDMS (Highways Agency Drainage Data Management System) surveys to help customers efficiently plan maintenance and cleansing programmes, Interceptor cleaning and servicing, Soakaway maintenance, High-pressure water jetting for problems such as de-greasing, de-scaling, pipework cleansing and root cutting
Flex MSE	Vegetated Wall Systems	Flex MSE's Vegetated Wall System has several advantages over other wall materials and systems. One of them is superior drainage. Superior drainage and settlement tolerances make it perfect for areas with poor soils and water infiltration.
UK Sandbags	Sandbags	They maintain a stock of over 15,000 filled sandbags and delivery is fast and efficient, with the ability to handle emergency orders for the flood defence industry and local authorities. They can also lay the sandbags if required. They also provide filled, empty and self-inflating sandbags to the domestic market.
Beaver Schutzsysteme AG	Füllmexx sandbag filling funnels	The Füllmexx is a sandbag filling funnel that allows an individual person to manually fill sandbags. With this funnel, around 10 sandbags can be filled in a mere three minutes by a single

		individual. This means that 10 people can fill around 700 sandbags in just 30 minutes.
Beaver Schutz-systeme AG	Beaver inflatable dams	Once inflated, the dams can be readily placed in the desired position. They are then filled with water from a nearby body of water or from fire hydrants. A series of inflatable dams can be attached to each other using sleeve systems. This option allows for the creation of inflatable dams of any length that are optimally suited for the conditions under which they are being used. The height of inflatable dams can be increased in an emergency by attaching a third dam to both dams that are already filled with water.
Beaver Schutz-systeme AG	Lenoir water barrier	Portable Lenoir water barriers, which can be carried by just two people, meet all the requirements of water barriers for use in emergency situations. Swiss-manufactured Lenoir water barriers can be set up quickly on almost all surfaces of any length, and have already proven themselves in numerous emergency situations.
Beaver Schutz-systeme AG	Beaver Flood-Gate	Beaver Flood Gates provide a unique portable flood preparedness solution that can be installed in virtually any door or window opening. These elements are also very efficient when it comes to impounding fire-extinguishing water.
Lakeside Flood Solutions	Submersible Flood Pumps, Surface water flood pumps	The flood pump has an automatic float switch, and automatically switches itself on in the event of rising water to pump water out and away from the premises. The result is a robust automatic solution which will provide you with peace of mind. As the flood pump is submersible, it is permanently installed in a bespoke sump cast to house the flood pump. The pipework can be directed to the desired location to where the water needs to be pumped out.
Lakeside Flood Solutions	UPVC Flood Doors	UPVC flood doors are suitable for both single and double doors. With a wide range of styles and finishes, including an optional wood grain finish, the doors offer flood protection whilst maintaining the existing aesthetics of your property.
Lakeside Flood Solutions	Flood Windows	Lakeside are proud to introduce the first Aluminium Flood Windows in the UK. Manufactured as a bespoke flood protection product, our flood windows are extremely robust with a 20mm thick single glazed glass pane, yet still provide an aesthetically-pleasing passive flood defence solution for your premises. Lakeside Flood Windows have been recently tested and fitted to the prestigious Holme Eden Hall Grade II listed building in Carlisle, with extremely positive reviews from residents, Lead Consultant and Client.

Lakeside Flood Solutions	Anti-flood airbrick	It acts as a standard airbrick allowing unrestricted airflow underneath the property, yet under flood conditions it uses the rising water to automatically shut off, inhibiting water ingress through the airbricks and therefore flooding underneath the property.
Lakeside Flood Solutions	Waterproof Cabinets	Lakeside Waterproof Cabinets represent an exclusive flood protection device to protect existing telecom cabinets or electrical metre boxes. The Waterproof Cabinets can simply be retrofitted over the existing metre box to ensure a passive, 'automatic' flood protection solution. Manufactured from robust galvanised steel, the waterproof cabinets can be made to any size as required. Additional features include the option of 1 or 2 doors, and inner steel plates.
Lakeside Flood Solutions	Waterproof Wall Sealant	Lakeside Waterproof Wall Sealant is a transparent sealant applied to walls to prevent seepage of water thought the brickwork or stonework of walls. This is an important flood protection measure when flood water is longstanding against a property for a significant length of time. The wall sealant is simply sprayed or brushed on following any required remedial or re-pointing works to the walls.
Flood Protection Solutions Ltd	Flood Protection Solutions, Flood Consultants, Water Pumps, Temporary Flood Barriers and Flood Defence with the FM Approved Water-Gate Barrier.	Flood barriers are a popular flood defence method, and can be far more effective than traditional sandbags. These barriers often consist of a shield that can be fitted onto a doorway when necessary. They can help to reduce the amount of water that enters a residential or commercial property during a flood. Being flooded is horrible, filthy brown water devastates the ground floor of your house and insurance claims run into tens of thousands of pounds. There are a range of flood barriers available including building aperture barriers (such as door guards), permanent barriers (i.e a wall) and temporary/demountable barriers such as the Water-Gate barrier. We specialise in supplying temporary flood barriers, along with water pumps.
Vikoma	Flood Barriers	The Flood GuardianTM barrier is a self-supporting, frame free air and water filled demountable barrier made from neoprene. Available with a skirt that can be attached for increased stability. Vikoma's flood barrier, Flood GuardianTM , is a water and air filled temporary barrier ideally suited to protection from tidal and flood surge and can be attached to structures such as slipways and harbour walls. A unique, easy anchoring system which is quick and easy to install and pack away post flood for use next time.

Pietrucha Group	IBS - mobile flood protection system	IBS systems are an advanced and effective alternative to temporary solutions such as sandbags or wooden barrages. The quality and efficiency of IBS systems has been proved for many years when battling the forces of nature all over the world. The IBS system may also be used at industrial sites to construct tight barriers or temporary separating walls.
UK Flood Defences Ltd	Quick Wall	Their products versatility is a core strength as its application can be used within many industries. Originally it was designed a flood defence system but can be used in small or large infrastructure projects, civil and utility projects or as barrier protection in military and air situation protecting personnel, equipment and machinery. Quick wall high is an innovative temporary or semi- permanent flood system designed for fast reaction to imminent flooding. Quick wall surface is designed for surface water flooding of up to 1.4 meters.
Presray	Flood barriers and flood gates	The FB33 modular flood protection door barrier is perfect for doorways, loading docks, garage doors or any other openings in municipal, industrial or commercial facilities
Fluvial Innovations	Floodstop & FloodBlock™	Floodstop barrier provides a proven and effective flood prevention method. The barrier can be assembled to any length and be arranged to suit any direction and opening. The system can be rapidly deployed by one person.
Gravitas International Ltd	HydroSack, HydroSnake	The HydroSack® is a water-reactive temporary flood barrier for low-level flooding, constructed from a non-woven outer material with a super absorbent core. The HydroSack's® handles allow minimal contact, and facilitate positioning of the barrier, making the HydroSack® an ideal replacement for the traditional sandbag in forming a flood protection barrier. The HydroSack® is safe and easy to dispose of; and the super-absorbent polymer and pulp are both eco-friendly. The HydroSnake® is the new, modern method to create a highly effective barrier to the threat of floodwater for domestic and commercial properties and ideal for use in pollution control.
Gravitas International Ltd	FloodBuzz	FloodBuzz™ Water Escape Alarms have made monitoring your property for potential water damage incredibly simple. The four models in the FloodBuzz™ range cover the majority of possible leak conditions. There are no batteries to buy, buttons to push, and are completely wireless. Just position the FloodBuzz™ in an area of potential water escape and forget about it. When in contact with water the FloodBuzz™ will activate and emit an alarm that sounds up

		to 110dB.FloodBuzz™ alarms will last for up to 3 years and are reusable.
Ridgeway Marine	Rockbags	A Filter Unit Rockbag is produced by placing an empty Unit into a production frame and filling it with excavated stone or rocks. The Rockbag net is then drawn together at the top and the 6 hanging ropes are bound onto the single hanging ring according to the manufacturer's instructions.
StormMeister® Flood Protection	Rapid Assembly Flood Barriers	StormMeister™ Flood Barriers are tested to the industry standard of 600mm depth of water but in fact can be supplied to provide resilience for much greater depths of water.
Block Walls	Block Walls	Interlocking concrete Lego Blocks can be used to form aggregate segregation bays for waste separation or for recycling waste in transfer depots. They can also be used in civil engineering projects such as, retaining walls, temporary works, piling mats, permanent formwork, flood or sea defences. Retaining Walls can be built up to 6.4m high with Blockwalls.
Dameasy Flood Barriers	Flood barriers	Dam Easy's® USP is that it is an "off-the-shelf and ready-to-use product" which allows the product to be sold in most retail outlets. It is the only domestic flood barrier with a unique patented pneumatic pump action seal. One barrier covers four variants of our competitors barriers with the ability to extend from 780mm to 1100mm.
Blobel	Flood protection	Our flood water protection systems were originally developed from the containment systems. Their function and above all their sealing technology were a role model for numerous offers. Our original BLOBEL flood protection systems are generally characterized by their high quality, standardized materials, very careful manufacturing and extreme toughness.
Geoline Ltd	Flood Defence System	The Beaver Storm and Flood Protection System helps to prevent or at least reduce storm and flood damage and their economic costs. This flood defence system guarantees fast assembly of temporary flood barriers and their simple and flexible use.
Tiger dams	Flood Control Corp	This Tiger Dam™ System consists of elongated flexible tubes which maybe quickly stacked, joined end to end and filled with water. The pyramid shaped structure forms a barrier to protect buildings, resort properties and any other structures prior to the onset of a flood. The tubes can be filled with a 2 inch pump, a fire hydrant (fastest) or a garden hose. The tubes are capable of being stacked up to a maximum of 32 feet high and linked together seamlessly for miles.

		They can be virtually any length and take any shape. Each tube weighs 65 lbs dry and 6300 lbs when filled with water.
MegaSecur	Water-Gate barriers	The Water-Gate™ flood protection dam comes as a PVC roll. The design uses the weight of the incoming floodwater to deploy and stabilize itself. Water enters and accumulates at the bottom of the barrier as the water level rises, causing the barrier to unfold and swell. The lightweight design allows for timely intervention in remote or hard-to-access environments.
AGA Group	AquaBar temporary and portable cofferdam system	AquaBars can be arranged to create flood control barriers and flood water diversion channels. It can be a non-invasive way of protection by withholding flood water, they are held in place by the weight of water held within them. They save time over some conventional methods, are re-usable and are logistically more efficient, they pose little disruption to the land from heavy transport.
Flood Control International	Flood Prevenion Products	The flood barrier design varies from a simple modular 'stop-log' water barrier to automatic barriers that operate only when required. Flood defence heights up to 4m and unlimited lengths of flood wall systems are possible. The flood gates are designed for dependable flood defence whilst maximising access availability. Flood doors are designed to protect against flood and unauthorised entry and when a flood door is shut, it is flood proof.
J&J Carter	ECO_DAM	One of the main uses of the Eco-Dam is for Flood Protection. After the collapse of a sandbag wall, the Eco-Dam was deployed in less than 10 minutes and immediately prevented further erosion of the river bank.
CSI	Flood Prevention & Protection	They offer Hydrosacks and Hydrosnakes - eco alternatives to sandbags, Hessian Sand Bags - Traditional flood defence barrier, Air Brick Covers - prevents flood water entering houses or office buildings, Floodgate Flood Door Barriers - fits most door sizes, expansion options
Adfil Construction Fibres	Macro/micro synthetic fibres	Each micro and macro synthetic fibre type in the Adfil product portfolio has been developed and manufactured to provide optimum performance for each individual construction need. In addition to our regular fibres, we have the flexibility to produce synthetic construction fibres to our customers' own design requirements.
Platipus Anchors	The Percussion Driven Earth Anchor (PDEA®)	The Percussion Driven Earth Anchor (PDEA®) is a unique, modern and versatile device that can be quickly installed in most displaceable ground conditions. It offers a lightweight corrosion resistant anchor that can be driven from

		ground level using conventional portable equipment. It creates minimal disturbance of the soil during installation, can be stressed to an exact holding capacity and made fully operational immediately.As a completely dry system it also has minimal environmental impact.
LK Group	Flood Risk and Drainage	SuDS should mimic as far as possible the current reaction of a site to rainfall after development has taken place site, to avoid any increase of flood risk to the site or to others. It can alleviate capacity issues with existing drainage networks. It can be applied to 'greenfield' sites and redevelopments.
Concrete Canvas	Concrete Canvas	CC has a low alkaline reserve, a low washout rate and a low carbon footprint, minimising impact on the environment. CC can be used to reline existing concrete infrastructure in fisheries, canals or irrigation ditches. Time-critical remediation work can be completed quickly and easily.
London Rock Supplies Ltd	Construction Waste	Hazardous waste or hazardous muck away is defined as 'containing properties that may render it harmful to human health or the environment'. The European Commission Directive 91/689/EEC dictates how hazardous waste should be managed. For the constructor, today's complex legislation coupled with environmental and economic considerations, directly impact how businesses remove and dispose of hazardous waste. At London Rock, we will discuss step by step the procedures to identify, remove and dispose correctly.
AmbiSense	AmbiSense	Their technologies are non-invasive, require no operator involvement and provide a continuous flow of accurate data, accessible to customers on any device. As well as using sensor technology, customers can also utilise the AmbiSense platform to connect with existing sensors on flares, manifolds and engines, enabling remote monitoring of any kind of device from any location.
Hydro International	Flood Management	Flood hydrology entails the calculation of flood peaks or flood hydrographs for observed floods or for design floods for specified return periods. Flood mitigation is an essential component of the work that we undertake for FRAs. Mitigation ranges from the design of drainage measures such as soakaways through to the design of flood balancing reservoirs.
Hydro International	Hydro-Logic Services	We include a full site assessment to inform the design. With full knowledge of F&WMA, SuDS Standards and Planning regulations we can solve any drainage or flood problem you are encountering. Our water engineering related services include: engineering solutions to miti-

		gate flood risk down to an acceptable level, protecting properties plus infrastructure, Design of Sustainable Drainage (SuDS) to suit the SuDS Manual 2015 and National Standards for SuDS through to provision of maintenance services for proprietary SuDS.
Environmental Measurements Limited (EML)	Hydro-met system	If you need a simple wind measuring system to monitor your factory or a multi-sensor system for your building management system - we are the team to contact. Our qualified engineering team can work with you from project beginning to end. We can carry out a site survey, installation and commissioning visits to remove the hassle of your meteorological monitoring.
SSCS	Scour Control System	They design and manufacture Frond Mats at our UK base for all types of subsea foundations, cables, pipelines, templates and platforms. Their system is an effective way of protecting structures, whilst protecting natural habitats and attracting sea living plants and life
BSI Kitemark	Flood protection	Our product directory could help you to identify acceptable products for tenders and validation. It allows you to search for approved BSI Kitemark products with their model numbers and descriptions and it makes it easier to identify products and services with the Kitemark.
Aquaread	The LeveLine-EWS	This cost effective and extremely simple system requires no regular maintenance and no annual subscriptions. The water level sensor records changes in water level and temperature and will send SMS / email alerts when preset alert levels are reached. You can also send the device an SMS message requesting the current level so you can check the level at any time of day for added peace of mind.
HydroMaster	HydroMaster live-web	HydroMaster's customisable alerting functions enable you to take preventive actions: You set the thresholds for your places of interest, while HydroMaster provides reliable rain gauge and radar data as well as tools to evaluate all aspects of past, current or future precipitation events.
Miles Smith Insurance Group	Risk Management	The risks facing a business today are changing. Traditional threats still need be to be managed and controlled, along with developing risks such as increasing litigation, employment law, reputation, contract requirements, IT and telecoms dependency, supply chain and loss of key personnel, to name a few. Controlling it all is a challenge.
MeteoGroup	MeteoGroup	A combination of multiple data sources, skilled meteorologists, ground-breaking research and state-of-the-art technology enable us to provide the most accurate and up-to-date weather fore-

		casts and sophisticated solutions in the market. We continue to improve our forecasting techniques, monitor output quality and calibrate our systems to maintain our market-leading position.
Centre for Ecology and Hydrology (CEH)	Flood Risk Modelling	CEH flood models improve warning times of national flood forecasting systems and support flood management and incident response. Our state-of-the-art models have been extensively validated against historical flood records across the UK and overseas. CEH tools provide access, analysis and display of real-time spatial rainfall observation and forecast products. Rain gauge and radar rainfall data are integrated to yield improved gridded rainfall estimates.
Swale Oceanographic	The Acrobat	The Acrobat™ LTV-50X is a light, computer-controlled, vehicle designed to be towed behind small boats operating in shallow water. The Acrobat™ is capable of carrying a large variety of research instruments providing real-time data to a computer on the boat. Several available wing lengths offer customization for different maximum depth requirements. Instruments such as an LOPC, CTDs, fluorometers, transmissometers, oxygen sensors and many other instruments are easily carried by the Acrobat™.
Delta Fire	Water Delivery - Flowmaster 250 Flow Meter	The Flowmasters are used to determine which hydrants are working, the flow rate from the hydrant and the water main capacity helping to locate leaks and obstructions. The Flowmaster can be purchased in a digital format with a data logger allowing for complete data analysis and storage via the flash memory (no data is lost when switched off). The internal data logger will log both flow and pressure and has a 'start/stop' recording facility via a push button or automatic recording of flow events when trigger conditions are established.
Dorotea Mekaniska AB	Truxor	The Truxor DM 5045 is a professional high-performance machine. It has a Turbo diesel 45 hp motor. The larger motor with higher torque provides more power for the machine and its Tools. The Truxor DM 5045 has a hydraulic tank with a level gauge as well as an automatic motor stop when the oil level gets too low. This significantly reduces the risk of leakage, which is an advantage in water reservoirs and other sensitive areas where oil spills must be avoided.
Gibbs Amphibians	Gibbs Amphibians	High Speed Amphibian (HSA) technology is a group of enabling technologies and expertise that makes possible the creation of vehicles that can travel in excess of 30mph on water and reach land speeds equivalent to that of similar land vehicles. HSA technology represents over

		2.5 million man hours of development, advanced engineering, 2 decades of refinement and experience which has generated over 350 patents and patents pending worldwide. Gibbs IP strategy protects and maintains its leadership in the field. HSA technology has 4 key areas of innovation consisting of; Powertrain, Hull, Water Jet, & Suspension.
Powerhire	Rental Products	Our rental services include Generator hire, Distribution hire, Cable hire, Fuel Tank hire and Load Bank hire which can be delivered by our own Logistical team and installed and commissioned by our fully qualified and experienced Engineers. Powerhire's highly trained, dedicated team of rental engineers with their vast depth of knowledge are always available to offer advice on the supply, design and installation of any temporary power system to meet the needs of your Business or Event to ensure power is never interrupted.
Brokk	Demolition Machines	Brokk has over 40 years' experience from demolition/dismantling projects in hazardous environments around the world. The machine can be designed with a lot of different special equipment such as; camera, long arm, side angling device, cable drum and so on. Nothing is impossible! Special tools are designed for specific jobs and requirements at the Brokk nuclear department.
ISAR3	Equipment	ISAR3 can source and manage the supply, inspection and acceptance of equipment for our clients. Including; lifejackets, confined space breathing apparatus, amphibious tracked vehicles, and everything in between.
TMS Maritime	Flood Defences & Extreme Water	TMS constructs Sea Walls, reinforces River Banks, installs retaining piles and provides scour protection. Our services also include dredging and beach replenishment following extreme weather erosion. Clear-up operations inevitably require fast repair services, to ensure commercial and civilian disruption is minimised. TMS skilled personnel and specialist plant offer marine and civil engineering support services to ensure both public and commercial sector infrastructure is able to rapidly resume normal operations.
KISTERS	KISTERS Surface Water	The KISTERS Surface water solution gives you access to the protocols and formats of the world leading data logger manufactures. A rich library of formats and telemetry protocols makes you independent from the choice of your monitoring equipment. Monitoring data from remote outstations, data collection platforms or from other organisations can be automatically fetched and

		imported seamlessly into your KISTERS Surface Water Solution.
CorroVenta	Water Damage and Flooding	We possess the knowledge and the equipment for dehumidifying various building constructions so that every case of water damage can be dried out as quickly and efficiently as possible. The goal when we design our dehumidifiers, turbines and auxiliary equipment is to dry water damage in a home as safely and silently so that the people in the house will not need to move out during the drying process. This is something that can be invaluable since prompt action must be taken when water damage occurs.
SAYSO		
iTRACK	Real Time and Threat Detection	The project will foster technology development that enable more accurate real-time tracking and monitoring. iTRACK will enable threat detection and real-time reduction of exposure by features such as re-routing and re-scheduling. Tracking technologies will become an enabler of more efficient monitoring of assets as well as humanitarian needs and gaps.
Leonardo	TETRA	TETRA is the communications standard of choice for organisations or groups that require immediate access to reliable, secure communications. TETRA is perfectly suited to the support of scenarios where the security and reliability of communications is priority.
Leonardo	PUMA T4 HANDHELD TERMINAL	The PUMA T4 family introduces a new concept of handheld device, with a modular design combining reliable and secure communications with new value-added services that greatly enhance efficiency in daily operations and emergency situations. An Android based general purpose core provides computing, ancillaries and MMI functions integrated with radio communication provided by a modem component that can be delivered in different versions.
Leonardo	DMR	DMR is the ETSI standard for digital radio communications. It introduces a 2 slot TDMA channel access feature, doubling the communication capability and making simultaneous and data applications possible. DMR solutions operate on VHF ad UHF frequency bands, features a full-IP system architecture and are IOP certified for primary vendors DMR terminals.
Leonardo	CSP	CSP (Communication Service Platform) is an implementation of the Next Generation Network designed for the professional sector, including PMR/LMR users such as first responders, Police and defence. CPS aims to combine the best of both solutions, by delivering the features enjoyed by the commercial environment

		with the adaptability, scalability and performance of the professional environment.
Satways	ENGAGE IMS/CAD	Building upon ENGAGE's proven emergency call taking and incident data management platform, personnel can take actions through the real-time exchange of incoming and historical information. Platform includes: Call Taking, Incident Management & Dispatch, Operational Resource Management, Duty Rostering, Radio over IP, Resource Tracking, Integrated Map Editor, Simulations, Unmanned Aerial Systems Integration, Analytics & Reporting, System Administration, Mobile Data Integration.
IN-PREP	Mixed Reality Preparedness Platform	Interoperability of technologies – when technologies are different in and between organisations it affects the exchange and flow of information between emergency agencies. Communication can slow down wasting precious seconds in rescue operations. IN-PREP will create a tool called the Mixed Reality Preparedness Platform to facilitate interoperability, merge decision support mechanisms with 'at-a-glance' visualisation and integrate situational awareness with real time information.
Aqua Alta in Essen		
AquaFence	AquaFence	Constructed of marine grade laminate, stainless steel, aluminium and reinforced PVC canvas, AquaFence systems become stronger as floodwater pressure is applied. The unique design of the AquaFence perimeter flood protection barrier provides flexibility to navigate around obstacles. Adjacent (straight) panels can be articulated slightly to create gradual curves.
Mobildeich	Mobildeich	MOBILDEICH dykes are assembled out of 2 to 3 individual tube elements, that are available in a variety of different sizes and lengths. Standard modules are manufactured from 10m to 40m in length and can be stacked to a total height of 0.45 m to 3.50 m.
Atlas Copco	Atlas Copco	All models in this range of submersible dewatering pumps have outstanding power to weight ratios. Thanks to the light weight and compact design the pumps are easy to move around and handle.
Flexibox Container GmbH	Flexibox	Flood barriers based on big pack of containers.
European Flood Control GmbH	Tiger Dam	The Tiger Dam can be build up quickly and without any expert knowledge. It has a length of 15 meters if fulfilled with water and sizes 0,5 meters in height. If a higher defence is needed, you can build up the Tiger Dams as a pyramid to expand the defence level. Furthermore it can be used more than once, which sustainable pro-

		tects our environment, what sandbags can't afford. Tiger Dams are less expensive than the conventional use of sandbags. On average aid organisations charge a minimum of 2 € per sandbag. With an economisation of 550 sandbags by the use of Tiger Dams costs of 1.100 € would occur for the application of sandbags, exclusive transport costs.
ecoTech	Environmental Monitoring System	Our main focus in the field of hydrology is the in situ recording of water quality data. We offer optimized systems for mobile measurements, automatic long-term data logging, automatic depth profile logging and stationary monitoring. Typical devices include multi-parameter sondes from our established partner YSI, single parameter data loggers, water level data loggers and hand held instruments. Our range is complemented by equipment for measuring discharge and flow velocity from Sommer.
German Red Cross Event		
Doenges	Vehicles	-
Global Flood Partnership		
Deltares	Delft-FEWS	Delf-FEWS consists of a sophisticated set of configurable modules for building a hydrological forecasting system customized to the specific requirements of an individual organisation. Delf-FEWS was designed to support the flood forecasting process, but due to its flexible and modulate structure, it is also very well suited to support day-to-day operational management, real-time control and forecasting and warning in other disciplines, like water quality, reservoir management, hydropower, navigation, groundwater, drought and dike strength monitoring.
ERDC	Streamflow and Flood Map Forecasting	Benefits: - Ability to forecast flow and flood inundation estimates using globally-available data. This tool provides both military planners and personnel in the field with a responsive first look at predicted flood inundation estimates. - Provides river stage insights for tactical bridging deployments. - Flow and flood inundation forecasting in areas around the world is mutually beneficial for the military and partner nations. This can potentially improve relations and foster collaboration, as evidenced by presentations to NATO, World Bank, and interactions with water managers in the Philippines.
FloodTags	FloodTags	FloodTags monitors online media data in real-time, to detect new events and get immediate from-the-ground coverage. By scraping and analysing hundreds of thousands online articles,

		FloodTags detects and characterizes past events for hydro-meteorological model calibration, validation, baseline studies, trend-analyses. A variety of water management applications including water scarcity and drought, integrated water management, water supply, sanitation, pollution, water conflict, water-related diseases and nature development.
VanderSat	Soil moisture	It's the most accurate, consistent and scalable technology available, regardless of whether the alternative techniques considered are ground based, aerial (e.g. drone, aircraft) or satellite driven. Benefits: - monitor fields without soil moisture ground sensors. - long term time series to put natural events in perspective - key input for generating drought indices, monitoring saturation and for crop, irrigation and hydrological modelling applications
VanderSat	Land surface temperature	VanderSat can determine land surface temperature with satellites on any given field in the world. Their technology can see through clouds and vegetation, is unhindered by darkness and has a similar accuracy as weather stations. Benefits: - monitor fields without weather stations with a high spatial coverage - long term time series to put events in historical perspective - key input for generating drought indices, hydrological modelling and climate studies
VanderSat	Vegetation optical depth data	VanderSat has developed a new passive microwave based vegetation parameter named 'Vegetation Optical Depth' (VOD) that captures vegetation water content. It has the advantage that cloud and darkness are not a problem, and therefore one can always rely on this operational service at any place on Earth.
VanderSat	Inundation	VanderSat can observe inundation with satellites on any given spor on earth. It is the rising of a body of water and its overflowing onto normally dry land also known as flooding. Benefits: - high-resolution maps of water covering land that is normally dry - radar based and thus unhindered by clouds - ideal for generating insights into flooding, crop damage assessment, insurance underwriting, water management
The Global Flood Awareness System	The Global Flood Awareness System	Daily forecasts The ECMWF Ensemble Prediction System (ENS) is the operational ensemble forecasting

		product of the ECMWF and consists of 51-member ensemble global forecasts. The weather forecast component has a horizontal grid resolution of about 32 km for 10 days, increasing to 65 km from day 11 to 15. In the GloFAS system, ENS weather forecasts of the 00:00 UTC forecast are processed by the land surface module Reference climatology The ERA-Interim archive, a global atmospheric reanalysis produced by the ECMWF, contains gridded estimates of meteorological variables and surface parameters. It has horizontal resolution of about 80 km and covers the period from 1 January 1979 onwards. For the reference climatology used in GloFAS the ERA-Interim precipitation dataset has been bias-corrected using the Global Precipitation Climatology Project (GPCP). HTESSEL HTESSEL is the land surface scheme used by ECMWF in its operational weather forecast system. HTESSEL computes the land surface response to atmospheric forcing, and estimates the surface water and energy fluxes and the temporal evolution of soil temperature, moisture content and snowpack conditions. Operational ensemble forecasts of surface and sub-surface runoff (soil to groundwater percolation) are extracted from the daily output of the ECMWF forecasts and then resampled to 0.1° resolution to be used as input by the river routing model. Further, an offline simulation of HTESSEL forced by ERA-Interim near-surface fields and bias-corrected ERA-Interim precipitation was performed to derive a 21 yr climatology starting in 1990, including surface and sub-surface. Lisflood global Lisflood is a GIS-based spatially distributed hydrological model, which includes a one-dimensional channel routing model. The Lisflood model is currently running within the European Flood Awareness System (EFAS) on an operational basis covering the whole of Europe on a 5 km grid. In the context of global flood modeling, the transformation from precipitation to surface and sub-surface runoff is done by HTESSEL. For routing, Lisflood global is set up to simulate the groundwater and routing processes. Surface runoff is routed via overland flow to the outlet of each cell. Subsurface storage and transport are modeled using two linear reservoirs.
The World Water Atlas	The World Water Atlas	For all people and their leaders who want to understand and address the multifaceted risk related to water, The World Water Atlas is an

		interactive platform that marks water risk 'hotspots,' where challenges and opportunities collide. The Atlas is presented in compelling narratives backed by reliable open-source data.
Cloud to Street	Cloud to Street	Funded by Google Earth Outreach and in partnership with the Dartmouth Flood Observatory, Cloud to Street built The Global Flood Database (GFD), the largest database of spatialized flood data. The GFD analyses over 4 million satellite images from the past 40 years and contains extent and duration maps for thousands of flood events around the world (and counting) with an accuracy of 87%.
RED	Risk Engineering & Development	RED offers the most up-to-date modelling tools to produce tailored loss metrics (annual average losses, exceedance probability curves measuring the mean annual rate of exceeding a loss value, mean return period loss tables, event loss tables). RED's expertise in the field of earthquake and flood risk covers several regions of the World, under several scenarios of data availability and employing novel techniques for data processing and assimilation.
Other		
Inter Act Smart Solutions	TeleControlNet	During the past one and half decade Inter Act has developed a TeleControlNet SaaS, consisting of a central IoT-suite server and a series of TeleControllers.TeleControllers (edge controllers) are intelligent modems or remote terminal units, able to connect practically any smart remote device such as: PLC control units, sensors & measuring devices, remote databases, etc. TeleControllers can be added to third party control systems without changing their programs or configurations. TeleControllers store measurement data with small log intervals. With the edge computing intelligence of the TeleController, in-line data validation and data editing can be performed.
STAR-FLOOD	STAR-FLOOD	This project was awarded a grant of 5.4 Million Euros by the European Union (FP7). The project was focused on analysing, explaining, evaluating and designing policies to better deal with flood risks from rivers in urban agglomerations across Europe. The results of this ambitious project are highly relevant for policies and law at the European, national and regional level and for the development of public-private partnerships. STAR-FLOOD ran from 1 October 2012 until 31 March 2016.
TerraTransfer	TerraTransfer	Oxygen sensor for monitoring urban or industrial waste water, drinking water or surface water. Accuracy: +/-0,1ppm. SDI12 sensor for monitoring pH and Redox in ground and sur-

		face water. Pressure sensor for measuring groundwater and water levels. Multi parameter sensor by YSI for measuring water quality.

3.3 Lessons Learnt from Flood History and Management

In Europe, historic data on flood losses and casualties are neither comprehensive nor standardised, thus making long-term analyses at continental level difficult.[1] But flooding in Europe is not a recent phenomenon, and 21 there are multiple accounts of damaging flood events across the continent 22 going back centuries.[2] As a result, no standardised European approach or guidelines to flood frequency estimation exist. To understand geospatial and temporal distribution of floods it is important to know the basic qualitative and quantitative indicators of natural disaster at the global level and in the long run. The Emergency Events Database (EM-DAT) of the Centre of Research on Epidemiology of Disasters in Brussels (CRED) and United States Office for Foreign Disaster Assistance (OFDA) and NATHAN of Munich Re are two of the main public global databases for natural disasters. In the period from 1900 to 2013 there were 25,552 natural disasters and most of them were hydrological, then meteorological, geophysical, climatic and biological disasters.[3] During these disasters, 65,009,766 were killed, 15,221,227 injured, 13,566,647,548 affected, 337,112,287 people were left homeless. The total damage amounted to 5,066,645,713 US dollars. During this period, floods were the most frequent (8,331), while landslides and rockfalls were the rarest (110).[4] Processed and analysed data indicate a potential threat to national geographic space, despite the fact that Europe is in fourth place by the stated indicators of vulnerability to flooding. Also, research results indicate higher frequency and greater human and material losses in the last 14 years compared to other similar time equivalents in the observed period. Therefore, it is expected this trend will continue in the future, especially given the level of climate change and less material resources of society.

After examining the large number of international papers about floods, it can be concluded that a large number of authors dealt with the problem of geospatial and temporal distribution of floods: Chow[5] (1964), Yevjevich[6] (1972), Haan[7] (1977), Kite[8] (1977), Singh[9] (1987), Potter[10] (1987), Bobee i Ashkar[11] (1991), McCuen[12] (1993) and so on. They all aimed at ex-

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1 Barredo, J. I. (2007). Major flood disasters in Europe: 1950–2005. Natural Hazards, 42(1), 125-148.

2 Glaser, R., Riemann, D., Schonbein, J., Barriendos, M., Brazdil, R., Bertolin, C., Camuo, D., Deutsch, M., Dobrovolny, P., van Engelen, A., et al., 828 2010. The variability of European floods since AD 1500. Climatic Change 829 101 (1-2), 235-256.

3 Cvetković, V., & Dragicević, S. (2014). Spatial and temporal distribution of natural disasters. Journal of the Geographical Institute Jovan Cvijic, SASA, 64(3), 293-309. doi: 10.2298/ijgi1403293; Ivanov, A., & Cvetković, V. (2016). Natural disasters - Geospatial and temporal distribution: Fakultet za bezbednost, Skopje.

4 Cvetković, V. (2014). Spatial and temporal distribution of floods like natural emergency situations. Paper presented at the International scientific conference Archibald Reiss days Belgrade.

5 Chow, T.: *Handbook of Applied Hydrology. New York:* McGraw- Hill, 1964

6 Yevjevich, V.M.: *Statistical and Probability Analysis of Hydrologic Data, Part II, Regression and Correlation Analysis*, Sec. 8-II, *Handbook of Applied Hydrology, V.T. Chow, editor-in-chief, McGraw-Hilll Book Company, New York, NY, 1964.*

7 Haan, T.: *Statistical Methods in Hydrology*. Iowa State University Press, Ames, IA, 1977.

8 Kite, G.W.: *Frequency and Risk Analysis in Hydrology. Water Res. Publications,* Fort Collins, CO, 1977.

9 *Singh, V., Singh, K.: Parameter Estimation for TPLN Distribution for Flood Frequency Analysis,* Water Resources Bulletin, Vol. 23, No. 6, pp. 1185-1191.

10 *Potter, W.:Research on Flood Frequency Analysis, 1983-1986,* Reviews of Geophysics, Vol. 25, No. 2, 1987., pp. 113-118.

11 *Bobée, B., Ashkar, F.: The Gamma Family and Derived Distributions Applied in Hydrology,* Water Resources Publications, Littleton, CO, 1991.

amining the frequency of their occurrence. Realising the importance and utility of long-term datasets, flood hydrologists have increasingly turned their attention to historical flood information.[13] The only exceptions are extreme, supra-regional climatic events and conditions such as anomalous cold winters, similar to that of 1,784, which affected large parts of Europe and triggered flood events in several catchments as a result of ice-break at the beginning of the annual thaw. Four periods of increased occurrence of flooding, mostly affecting Central European Rivers, have been identified; 1540–1600, 1640–1700, 1730–1790, 1790–1840. The reconstruction, compilation and analysis of European-wide flood data over the last five centuries reveal the complexity of the underlying climatological causes and the high variability of flood events in temporal and spatial dimension.[14] Barredo (2017) presents a map and catalogue of the major flood events of the last 56 years in the European Union (EU), Bulgaria and Romania. This study is an effort to alleviate the lack of homogeneous and georeferenced information on flood disasters for large periods in Europe.[15] Pekarova et al. [16] analysis showed that without incorporating the historic floods from the years 1501, 1682, and 1787 the 1,000-year discharge calculated only with data from the instrumented period 1876– 2013 is 14,188 m3 s –1 , and it is lower compared to the 1000-year discharge of 14,803 m3 s –1 when the three historic floods are included. Also, they found the T-year discharge is higher throughout the whole spectrum of T-year discharges (10, 20, 50, 100, 200, 500-year discharge) when the three historic floods are included. Incorporating historic floods into a time series of maximum annual discharge seems to exert a significant effect on the estimates of low probability floods. This has important implications for flood managements and estimation of flood design discharge.

The June 2013 flood in the Upper Danube Basin was one of the largest floods in the past two centuries. The high precipitation, along with high antecedent soil moisture, gave rise to extreme flood discharges in a number of tributaries including the Tiroler Ache, Saalach, Salzach and Inn.

In August 2005, the Danube tributaries in western Tyrol and the south of Bavaria were flooded through extensive precipitation and high antecedent soil moisture.[17] In August 2002, a major flood hit the entire Upper Danube Basin. Damage was most severe at the northern tributaries of the Austrian Danube at the Czech border, in particular the Aist and Kamp rivers. At the Kamp, flood discharges were almost three times the largest flood in the century before.[18] Flooding was extensive along the entire Austrian Danube which resulted in the use of the term “century flood”. The preceding decades were relatively flood-poor at

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12 *McCuen, H.:. Microcomputer Applications in Statistical Hydrology,* Prentice Hall, Englewood Cliffs, NJ, 1993.

13 T. R. Kjeldsen, N. Macdonald, M. Lang, L. Mediero, T. Albuquerque, et al.. Documentary evidence of past floods in Europe and their utility in flood frequency estimation. Journal of Hydrology, Elsevier, 2014, 517, pp.963-973; Brázdil, R., Řezníčková, L., Valášek, H., Havlíček, M., Dobrovolný, P., Soukalová, E., ... & Skokanová, H. (2011). Fluctuations of floods of the River Morava (Czech Republic) in the 1691–2009 period: interactions of natural and anthropogenic factors. Hydrological Sciences Journal–Journal des Sciences Hydrologiques, 56(3), 468-485; Böhm, Oliver, and K-F. Wetzel. "Flood history of the Danube tributaries Lech and Isar in the Alpine foreland of Germany." *Hydrological Sciences Journal* 51, no. 5 (2006): 784-798; Macdonald, Neil. "An underutilized resource: historical flood chronologies, a valuable resource in determining periods of hydrogeomorphic change." IAHS PUBLICATION 306 (2006): 120.

14 Glaser, Rüdiger, Dirk Riemann, Johannes Schönbein, Mariano Barriendos, Rudolf Brázdil, Chiara Bertolin, Dario Camuffo et al. "The variability of European floods since AD 1500." Climatic Change 101, no. 1-2 (2010): 235-256;

15 Barredo, J. I. (2007). Major flood disasters in Europe: 1950–2005. Natural Hazards, 42(1), 125-148.

16 Pekárová, P., Halmová, D., Mitková, V. B., Miklánek, P., Pekár, J., & Škoda, P. (2013). Historic flood marks and flood frequency analysis of the Danube River at Bratislava, Slovakia. Journal of Hydrology and Hydromechanics, 61(4), 326-333.

17 BLU (Bayerisches Landesamt für Umwelt): August – Hochwasser 2005 in Südbayern (August 2005 flood in Southern Bavaria), Endbericht vom 12 April 2006, Bayerisches Landesamt für Umwelt, München, 49 pp., 2006

18 Gutknecht, D., Reszler, Ch., und Blöschl, G.: Das Katastrophenhochwasser vom 7. August 2002 am Kamp – eine erste Einschätzung (The 7 August 2002 – flood of the Kamp – a first assessment), Elektrotechnik und Informationstechnik, 119, 411–413, 2002.

the Danube aside from more minor floods in 1991, 1966 and 1965; however a very large flood occurred in July 1954 with major damage along the entire Upper Danube. The preceding decades were relatively flood-poor at the Danube aside from more minor floods in 1991, 1966 and 1965; however a very large flood occurred in July 1954 with major damage along the entire Upper Danube.[19] A detailed review of flood frequency estimation guidelines from different countries showed that the value of historical data is generally recognised, but practical methods for systematic and routine inclusion of this type of data into risk analysis are in most cases not available. Studies of historical events were identified in most countries, and good examples of national databases attempting to collate the available information were identified. The conclusion is that there is considerable potential for improving the reliability of the current flood risk assessments by harvesting the valuable information on past extreme events contained in the historical data sets. The analysis of global data revealed that floods occur every day around the world. However, the causes of their occurrence vary. Based on the collected and processed data on geospatial distribution from specified base it can be said that the highest number of floods in period from 1900 to 2013 occurred in Asia with 3,427 floods, and the lowest number in Oceania with 258. Bearing in mind all the continents, by number of flooding in the first place is Asia, then America, Africa, Europe and Oceania in the end (cf. Table 4).

[19] Blöschl, G., Nester, T., Komma, J., Parajka, J., & Perdigão, R. A. P. (2013). The June 2013 flood in the Upper Danube Basin, and comparisons with the 2002, 1954 and 1899 floods. Hydrology and Earth System Sciences, 17(12), 5197-5212.

Table 4: Number of floods in period from 1900 to 2013, sorted by continent (Source of data: EM-DAT).

Continent	Occurrence	No. of people killed	No. of people injured	No. of people affected	Homeless	Total affected	Estimated damage ($)
Africa	1,669	50,557	55,947	119,555,483	11,910,538	131,521,968	14,630,498
America	1,943	208,047	88,300	165,740,994	7,133,925	172,963,219	195,930,880
Asia	3,427	13,589,418	2,438,303	6,560,968,177	153,660,678	6,717,067,158	722,929,790
Europe	1,034	18,148	51,712	23,873,756	3,835,628	27,761,096	220,657,128
Oceania	258	1,016	184	2,126,518	214,970	2,341,672	28,954,750
Total	8,331	13,867,186	2,634,446	6,872,264,928	176,755,739	7,051,655,113	1,183,103,046

In percentage terms, in the period from 1900 to 2013, Asia had 41.14%, America 23.32%, 20.03% Africa, Europe 12.41% and Oceania 3.10% of floods (cf. Figure 6).

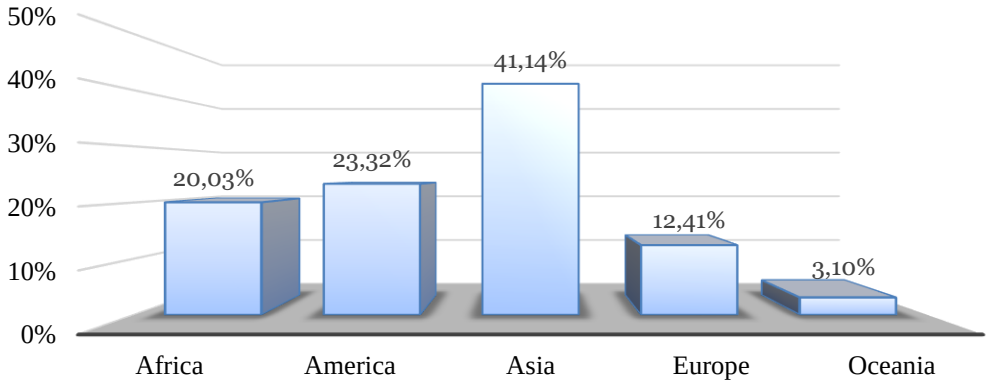

Figure 6: Percentage overview of the total number of floods in period from 1900 to 2013, sorted by continent (Source of data: EM-DAT).

Moreover, looking at the impacts of floods, the analysis revealed that in the period from 1900 to 2013 8,331 floods happened, with 13,867,186 of the killed, 2,634,446 of the injured, 6,872,264,928 of the affected and 176,755,739 of the homeless. Observed annually, it can be said there were 74.6 floods per month, 0.20 floods per day (cf. Table 5).

Table 5: Overview of the total number and impacts of floods in the period from 1900 to 2013, with reference to the annual, monthly and daily distribution (Source of data: EM-DAT).

Type	Occurrence	No. of people killed	No. of people injured	No. of people affected	Homeless	Total affected	Estimated damage ($)
Flood	8,331	13,867,186	2,634,446	6,872,264,928	176,755,739	7,051,655,113	1,183,103,046
Yearly	74	122,718	23,313	60,816,503	1,564,210	62,404,027	10,469,938
Monthly	6	10,226	1,942	5,068,041	130,350	5,200,335	872,494
Daily	0.20	340	65	168,934	4,345	173,344	29,083

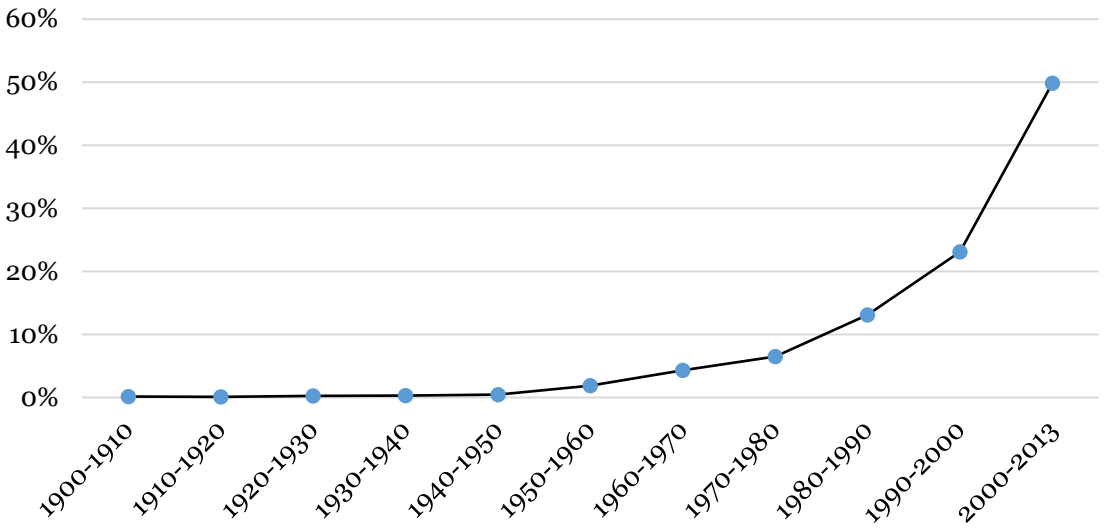

Figure 7: Percentage overview of the total number of floods in period from 1900 from 2013 year, classified by decades (Source of data: EM-DAT).

Up until 1980 the floods have occurred within a certain average of 10%. After this period it can be noticed a significant increase in the number of floods, and the culmination is the period since 2000 to 2013 when it happened 49.85% of the total number of floods for the period. The minimum number of floods occurred in the period from 1900 to 1910 and it is 0.17% (Figure 7). From the above, it is necessary to continue ongoing research phenomenology and monitoring methodology and forecasting floods as a kind of natural disaster, to normatively improve the system of preventive care especially in the area of more consistent compliance with urban planning standards of construction of buildings according to the risk assessment of vulnerability by floods and flash floods (e.g. prohibition of construction in the area of high water levels). Also, it is necessary to create conditions for greater proactive action through regulation of critical waterways, safe and high quality construction of hydroelectric plants (dams, reservoirs, retention basins), decision support systems subjects for subjects of protection and rescue system from national local level, awareness of the potentially affected population and higher level of training and equipping of forces for action in terms of elimination and mitigation of catastrophic flooding - specialised units of civil defence, fire and rescue units, mountain rescue and authorized and qualified entities for the protection and rescue in emergency situations such as water management, construction, utilities and other enterprises. Finally, special emphasis should be placed on improving the monitoring system of national, international and transnational watercourses and waterways that have torrential hydrological regime, and promoting international cooperation and action of national rescue forces outside of national geographic space, from the regional to the global level.[20]

For instance, speaking about the territory of the Republic of Serbia, we can say that the degree of vulnerability of the population and their material goods is not uniform, but varies depending on the type of natural disaster and expected potential damage.[21] Floods and torrential floods are the most frequent phenomena of the "natural risks" in Serbia. Their frequency, intensity and diffusion across the territory make them a continual threat to the ecological, economic and social spheres.[22] The potential floodable area, for the waters of a return period of 100 years, cover the surface of 16,000 km^2, affecting 500 larger settlements, 515 industrial objects, 680 km of railroads and about 4,000 km of roads. The most vulnera-

[20] Cvetković, V. (2014). *Ibidem.*

[21] Dragicević, S., Filipovic, D., Kostadinov, S., Zivkovic, N., Andjelkovic, G., & Abolmasov, B. (2011). Natural hazard assessment for land-use planning in Serbia. International Journal of Environmental Research, (5), 371-380.

[22] Petrović, A., Kostadinov, S., & Dragićević, S. (2014). The inventory and characterisation of torrential flood phenomenon in Serbia. Polish journal of environmental studies 23(3): 823-830.

ble area is northern part of Serbia (Vojvodina), where, in the coastal part of the Danube River (specifically the Tisa, the Tamis and the Sava), there are about 12,900 km2 of potentially floodable land. In the previous 10-year return period, a large number of floods were recorded in the territory of the Republic of Serbia. The territory of Serbia was affected by serious floods in the following years: 1999, 2000, 2005, 2006, 2007, and 2009.[23] Heavy rainfall over the area of Serbia, northern Bosnia and eastern Croatia in May 2014 caused large floods. These flooding events, according to their characteristics (size of affected area, duration, consequences, etc.) surpassed all the previous ones and caused serious consequences in the territory of Belgrade region and particularly in the Municipality of Obrenovac. The refusal of the population to be evacuated and the panic spread when the river overflew its banks, led to the situation where 25,000 residents were evacuated from Obrenovac in only two days. Such reactions of the population, but also failures of the local self-government to conduct evacuation, prompted the analysis of the level of awareness among population about vulnerability to flooding and their consequences in the Belgrade region, i.e. in the territory that is particularly susceptible to this natural disaster.

23 Cvetković, V., Lipovac, M., & Milojković, B. (2016). Knowledge of secondary school students in Belgrade as an element of flood preparedness. Journal for social sciences, TEME, 15(4), 1259-1273.

4 Reports from the Topic Working Groups

During the first DAREnet roadmapping cycle, six RDI subgroups were defined out of the whole amount of selected RDI Topics (cf. deliverable D1.1) and dealt within DAREnet TWG. These topics were:

- Civil Protection Training,
- Resilience of Citizens,
- Spontaneous Volunteers,
- Civil Protection Methods, Procedures and Technology,
- Communication,
- General Data Management.

The expertise within the TWG was collected through intensive research and with the help of the DAREnet National Contacts (DNC) through expert interviews with national actors of disaster management using a survey (cf. questionnaire in ANNEX). These data were subsequently reviewed and analysed under the aspects of:

- Relevance of the RDI Topic,
- Practitioner Needs,
- Available Solutions,
- Innovation Opportunities,
- Lessons Learnt.

In the following chapter, the results from these analyses are presented in detail. One should keep in mind that the findings from the survey are outcomes derived from a sample. Thus, the survey responses just indicate a trend, but do not represent robust results.

4.1 TWG "Civil Protection Training"

4.1.1 Relevance of the RDI Topic

Creating perception of safety and implementing civil protection (CP) tasks in a constantly changing social environment is challenging. It requires continuous capacity building and development of responder qualification, which needs to be reflected in training and cooperation programs, as well as in method development of the involved organisations. Through CP, training, preparedness and disaster response can be significantly enhanced.

4.1.2 Practitioner Needs

Nationally and internationally, there are many specific training programmes regarding rescue and use of technical equipment in floods, mainly organised by fire services, Red Cross and other volunteer, humanitarian and non-profit specialized associations for search and rescue, same as national civil protection authorities (also, as example, EU Civil Protection Mechanism Courses was listed). Specific topics of training programmes for practitioners that we decided to focus on within our TWG are: swift water rescue, use of boats in flood rescue, use of pumps as technical equipment, dyke defence (as flood prevention and damage reduction component of training) and flood rescue crisis management training for strategical and tactical level. Table 6 presents statistics how many interviewed practitioners are aware (and were engaged) in previously listed programmes. We can conclude that either some of them are not aware that they exist or there is a real lack of such programmes in participating countries of this survey.

Table 6: Number of interviewed practitioners being aware (and being engaged) in previously listed CP training programmes

	Yes	No
Swift water rescue	18	21
Use of boats in flood rescue	23	15
Use of pumps as technical equipment	23	15
Dyke defence	21	22
Flood rescue crisis management training for strategical and tactical level	17	23

From given results we can derive that it is necessary to develop and offer (nationally and internationally) additional programmes for operatives with emphasis on swift water rescue, to consider more prevention / damage reduction programmes which are lacking and representing very important components of civil protection flood systems (dyke defence) and of same importance – flood rescue crisis management training for strategical and tactical level because of awareness which needs to be present on every level of crisis responsibility. However, these results are not necessarily transferable to all parties involved in CP since the survey included a wide audience. From those not all have CP in their field of activity and thus, are aware of relevant CP training programmes.

4.1.3 Available Solutions

One entry within the knowledge base gave an interesting insight in the concept of "Flood Rescue Team" as one possible contribution to strengthen of EU civil protection capabilities in the field of water-related search and rescue. Building specialised rescue teams that can cooperate on international level and supporting national capacities is also a way of contri-

bution to resilience in Europe and across the world. Part of the efforts of the "WaterSave"[24] project is to establish standardised SOP's (standard operating procedures), training standards, address issues in the field of flood response and to set up an "European scientific network of experts" in this field which also overlaps with DAREnet effort of establishing multidisciplinary Community.

4.1.4 Innovation opportunities

"Training standards" can strengthen civil protection organisations and increase the overall quality of their training. Experience showed that even existing programmes are usually not "interconnected" in a way that they are harmonised ("tuned") to (multi-)national needs. On the scene, in case of real event, that kind of disharmony (incapability and different level of professional competence) can be hindering towards fast and efficient response and create "weak points (links)".

4.1.5 Lessons Learnt

It is undisputed that Civil Protection Training is one of the essential instruments to strengthen civil protection and prepare operational forces. This way responders can be prepared to react adequately in case of emergency/catastrophic events caused by floods. Response mechanisms and preparedness needs to be adjusted accordingly, providing opportunity for everyone (nationally or internationally) to implement (nevertheless institutional capacity or available founds in different organisations). Among practitioners, CP training needs are recognised and usually used where the possibility exists and that is a great motivator to develop and provide more programmes/courses for them.

4.2 TWG "Resilience of Citizens"

4.2.1 Relevance of the RDI Topic

The flood preparedness of individuals, households, and communities is very important for improving community resilience in the face of any natural hazards especially with regard to modern society being very vulnerable to floods. Generally, flood disaster preparedness is defined as a self-protective or precautionary behaviour. In real life, however, preparedness activities at the household level are usually not undertaken. There are a number of factors associated with flood preparedness at household and community levels which are very important for improving resilience of citizens. In the past few decades, scientists in the field of disaster risk management had significantly contributed to the establishment of basic theory of resilience concept. According to the 2009 International Disaster Risk Reduction Strategy, resilience is the ability of a system, community or society at risk to resist, absorb and respond to the effects of danger in a timely and effective manner and recover from them, including preserving and reconstructing its essential basic structures and functions. 'Resilience' encompasses the four 'A's': Awareness of flood risk, Alleviation of the effects of the flood, Avoidance of the risk where possible, and Assistance in the event of difficulties.[25] Societies as a whole or sub-units within a global society, can respond to catastrophes in different ways. They can absorb impacts of a disaster with little or no pre-designed action and rely on improvisation to meet immediate or long-term needs. However, as awareness of potential disasters within a given social unit is growing, the possibility of planned and formally-guided "adaptation" (i.e. attempts to distribute risk, modify impacts, or prevent the emergence of disasters) also increases. The degree of risk awareness as well as the type and

[24] Peter Glerum - European Flood Response Modules - The WaterSave Project

[25] Scottish Executive (2005) Final Report of the National Technical Advisory Group on Flooding, Edinburgh: Scottish Executive, http://www.scotland.gov.uk/Topics/Environment/Water/Flooding/16919/ntgfinalreport

the mix of responses adopted by society broadly vary with the types of risks they face, cultural orientations, the amount of knowledge about these risks or experiences with these risks, and resource bases on different levels of society. In common usage resilience typically relates to the ability of systems (and people) to effectively respond and adapt to changing circumstances and to develop skills, capacities, behaviours and actions to deal with adversity – 'resilience' can be described as a process of adaptation before, during and after an adverse event.

The consequences of natural catastrophes caused by flooding cannot be completely avoided. However, with an adequate flood management system (mitigation, readiness, response, and recovery) they can be minimized. The importance of improving the resilience of citizens to respond is especially evident in light of the trend of an increase in the number of natural disasters caused by floods. Resilience of citizens is directly related to their physical vulnerability, which implies the existence of a clear and unequivocal threat from the natural origin, which has the enough potential to endanger the vital interests of people and their communities. Citizens' resilience is relevant to the management of disasters caused by floods, as it enables effective functioning of the protection and rescue system. Improving citizens' resilience is directly related to their willingness to respond in such situations. Preparedness measures are helping citizens to recognize the threat and to take action, although there will always be a gap between what people are advised to do, what they say they will do, and what they really do in such situations. The preparedness is based on a quality of disaster risk analysis and a good connection with the early warning system, and includes activities such as: contingency planning, procurement of equipment and supplies, development of arrangements for coordination, evacuation and information of public, joint trainings and field exercises. A great number of social and individual factors play a role in improving the resilience of citizens for responding to a natural disaster. They directly or indirectly influence citizens' ability to implement, undertake or devise measures of readiness to respond in such circumstances. It is important to understand their influence in order to develop a way how to raise the level of their readiness. Preparedness to respond as a dependent variable is often operationalized through knowledge about the disaster, the mode of reaction; possession of oral/written plans for protection and rescue; information and interest for the implementation of preventive measures; possession of food and water supplies; possession of necessary equipment; abilities and skills to respond. Generally speaking, the most common obstacles for improving citizens' resilience relate to the lack of time to take such measures; neglecting preventive measures; attitudes about inability to design and implement preventive measures; lack of financial resources; lack of information and lack of training and courses; difficulties to obtain the information what to do, attitudes about the insignificance and inefficiency of such measures, etc.

4.2.2 Practitioner Needs

Out of a total of 46 respondents who answered the question regarding public information campaigns to raise general flood awareness, 70% of respondents point out that this information exists while 30% point that they do not exist (Table 7).

Table 7: Knowledge regarding public information campaigns regarding floods to raise general flood awareness.

	Frequency	Percent
Yes	32	70
No	14	30
Total	46	100

The question asked about public information campaigns to encourage people to prepare for floods as individuals was answered by 46 respondents. According to the obtained results, 65% of the respondents point out that they exist in relation to 35% which point out the opposite (Table 8). The results unambiguously show that there are public information campaigns about floods to encourage people to prepare for floods.

Table 8: Knowledge regarding public information campaigns regarding floods to encourage people to prepare for floods as individuals.

	Frequency	Percent
Yes	30	65
No	16	35
Total	46	100

In further analysis it was found that out of a total of 46 respondents who answered the question about education materials (e.g. guides, recommendations) for citizens regarding the preparation for floods to inform the citizens about available resources regarding floods (e.g. access to explained flood risk maps) 43% points out that there are available resources regarding floods compared to 57% of respondents who say they do not exist. Therefore, a slightly higher percentage of respondents indicate that there are no such materials (cf. Table 9).

Table 9: Knowledge about education materials (e.g. guides, recommendations) for citizens regarding preparation for floods to inform citizens about available resources regarding floods (e.g. access to explained flood risk maps).

	Frequency	Percent
Yes	19	43
No	25	57
Total	46	100

Regarding the knowledge about education materials (e.g. guides, recommendations) for citizens regarding preparation for floods to improve citizens‘ preparedness for floods 61% respondents claim that such materials do exist, while 39% claims that they do not exist (Table 10).

Table 10: Knowledge about education materials (e.g. guides, recommendations) for citizens regarding preparation for floods to improve citizens' preparedness for floods (e.g. checklists).

	Frequency	Percent
Yes	27	61
No	17	39
Total	46	100

When it comes to education materials (e.g. guides, recommendations) for citizens regarding preparation for floods for schools and teachers to educate children and teenagers to be prepared for floods 53% of respondents clam that they do exist, while 47 % have an opposite opinion (Table 11).

Table 11: Knowledge about education materials (e.g. guides, recommendations) for citizens regarding preparation for floods for schools and teachers to educate children and teenagers to be prepared for floods.

	Frequency	Percent
Yes	21	47
No	24	53
Total	46	100

Answers regarding available resources:

- There are certain materials provided by the federal states (or their authorities) that provide information how to behave or how to prepare. Some associations also provide informational material on different levels (children/adult citizens or even businesses/municipalities), the DWA[26] for example offers brochures (http://www.dwa.de/dwa/shop/shop.nsf/Produktanzeige?openform&produktid=P-DWAA-AA9CZ5&navindex=020000&kategorie=neu&ugruppe= or; http://www.dwa.de/dwa/shop/shop.nsf/Produktanzeige?openform&produktid=P-DWAA-A8JS5S&navindex=020000&kategorie=neu&ugruppe=) or even their audit program for municipalities.
- Flood protection self-provision: Fit for the emergency of the Bavarian State Office for the Environment (https://www.lfu.bayern.de/publikationen/index.htm)
- Information available on the SHMU[27] page (www.shmu.sk), FRS[28] (https://frs.gov.cz/de) and public TV and radio
- We have public information instruments paper and web
- A lot of cities and communities in flood endangered areas provide that kind of information
- Ro-risk platform: https://ro-risk.ro/webapps/riscuriNationaleCalitativ/
- Only very general: After extended floods, there are some public information as well as some information from assurance companies.

Answers regarding the improvement of preparedness:

- Information about basic personal equipment during floods
- ISO 22315 Societal security – Mass evacuation – Guidelines for planning http://www.isotc292online.org/publications/iso22315/
- https://www.bbk.bund.de/DE/Ratgeber/Handeln_in_Katastrophen/Hochwasser/Hochwasser.html,https://www.bbk.bund.de/SharedDocs/Pressemitteilungen/BBK/DE/2016/PM_Starkregen_Sturzfluten.html
- Project "Centers for raising public preparedness for flood response" funded under Operational Program "Environment 2014 - 2020"
- There were information materials spread in some regions of our country.
- Mobile app called DSU (available at google play and apple store), National platform for DRR: https://fiipregatit.ro
- https://www.risico-info.be/en/hazards/naturals-hazards/floods
- a lot of cities and communities in flood endangered areas provide that kind of Information, The Bundesamt für Bevölkerungsschutz und Katastrophenhilfe (BBK) provides general Information for citizens
- We have public information materials and procedures
- Croatian Platform for Disaster Risk Reduction (as part of NPRD) and NPRD provides materials - guides for citizens on Website (http://www.platforma.hr/građanstvo/upute-za-građane) same as leaflets.
- http://stari.duzs.hr/news.aspx?newsID=14637&pageID=134
- http://civilnazastitakraljevo.rs/
- General checklists provided by the BBK (https://www.bbk.bund.de/SharedDocs/Downloads/BBK/DE/Publikationen/Broschueren_Flyer/Fremdsprachliche_Broschueren_Ratg_u_fdNv/Disasters-alarm_Bro.pdf?__blob=publicationFile); The flood label as tool to improve buildings towards floods (https://www.floodlabel.com/)

[26] Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall e.V.

[27] Slovenský hydrometeorologický ústav

[28] Foreigners reservation system at the Ministry of the Interior of the Czech Republic

Answers regarding educational material for schools and teachers:

- Part of the curriculum and prevention learning – FRS
- Part of the school curriculum , prevention learning - FRS MoI
- I think there are some, but only general
- Project "Centres for raising public preparedness for flood response" funded under Operational Program "Environment 2014 - 2020"
- There were educational materials spread in some regions of Serbia.
- We have school programs and curriculum for the youths have we special program
- Every year NPRD organises training for school teachers and principals on Disaster Risk Reduction (based on Hyogo Framework for Action and Sendai Framework (UNISDR)) with aim of promoting DRR in school curriculum, ways how to reduce risk and assess it and educate children. Every year NPRD also organises "Primary and High school - Literature, Photography and Art Competition" themed on disasters, civil protection and emergency services (http://www.platforma.hr/images/dokumenti/Brosura_natjecaj_2011..pdf). Calendars are made which can afterwards be cut out in form of Guides for Kids: http://www.platforma.hr/images/dokumenti/Kalendar%20za%20klince%20i%20klinceze%202014..pdf
- http://civilnazastitakraljevo.rs/ Project: MALA CIVILNA ZASTITA / SMALL CIVIL PROTECTION
- There have been programs in the past to prepare pupils for disaster/emergency situations by the BBK (the YAPS project). The German Red Cross offers material for teachers to increase the resilience of children: (https://www.drk-nordrhein.de/angebote/kinder-jugend-und-familien/thea-und-louis-die-drk-minimacher/)
- Program enabling teachers to educate children in preparedness and advance their resilience.

4.2.3 Available Solutions

People are resilient to natural disasters thanks to their knowledge gained through experience in similar situations. Families and communities education in this regard are directed towards the development of competencies to recognize the characteristics of such phenomena, to protect themselves and others, and to respond appropriately in a given moment.[29] Every individual has the right and the obligation to be informed about the potential risks that exist in the area where they live or work and to be able to get ease access to this type of information. In this context, the role of the media is of particular importance. Mass media are a possible source for the efficient and quick communication about the onset and consequences of disasters. Disaster risk reduction should be systematically treated across the curriculum and through the grade levels at schools. The education must extend beyond the basic explanation of hazards and safety measures but need to consider prevention, mitigation, vulnerability and resilience. School education is essential in enhancing knowledge and perception in this framework, but even the family education is a vital element, too.

The awareness of the possibility to get exposed to flood threats plays an important role in disaster risk reduction.[30] Community flood education is becoming an increasingly important flood mitigation and disaster management mechanism and citizens who are informed on time about the upcoming disaster through the warning and notification systems will not feel such fear because they know everything will go according to the pre-established procedures. Besides fear, knowledge, previous hazard experience and feeling of threat of

[29] Ivanov, A., & Cvetković, V. (2014). The role of education in natural disaster risk reduction. Horizons - international scientific journal, X (16), 115-131.

[30] Bosschaart, A., Kuiper, W., Van der Schee, J., & Schoonenboom, J. (2013). The role of knowledge in students' flood-risk perception. Natural hazards, 69(3), 1661-1680.

those at risk are important factors in the recognition of different risks. Dufty[31] defines community flood education as learning process or activity that builds community resilience. He highlighted that community flood education encompasses both public communications, than information products and services e.g. publications, Internet sites, and displays, but also training, development and industry-or community-specific programs comprehending education plans e.g. school and university curriculum. In addition, he proposes a new approach that involves the participation of the learners, focused on building people resilience, links with the 'flood cycle' and other flood mitigation and resilience-building plans and methods but gave emphasis on the longevity and the evaluation of flood education programs. A lot of studies have been conducted to attempt quantification of the impacts of community flood education in minimising flood damages and assisting in emergency management.[32] Research results conducted in Scotland have shown that 38.1% of respondents informed about natural disasters over the neighbours, friends; 28.6% over the radio; 27.2% of the press; 28.5% over the national television; 36.7% through the competent authorities and 12.8% in other ways.[33]

The places or media from which the respondents obtained information about floods have emerged to be a primary factor of influence on the knowledge of respondents related to flooding as a natural disaster. Also, certain skills can be acquired through using media like watching television, using the internet, playing computer and video games, etc. There are several projects providing platforms and mobile applications for citizens, and other solutions. A selection is listed below:

- Public service application (FLOOD-serv) with the overall objective to provide a proactive and personalized citizen-centric public service application to encourage citizens' involvement. It will harness the collaborative power of ICT networks (networks of people, knowledge and sensors) to raise awareness on flood risks and enable collective risk mitigation solutions and response actions.
- Mobile App 'Wesenseit: Citizen observatory of water' which delivers a new Smartphone crowd sourcing apps, innovative low cost Disdro rain gauges, and autonomous soil-moisture sensors. It encourages citizen communities to upload, share, discuss and rate data and information on their water environment with a focus on minimizing the effects of pluvial flooding and poor water quality.
- Team Österreich App which is a personal preparation assistant that helps people to be better prepared by providing tips for disaster preparedness.
- Building Resilience Amongst Communities in Europe (emBRACE) Project with the primary aim to build resilience to disasters amongst communities in Europe through research knowledge, networking and practices, along with (1) private prevention, (2) ecological flood protection, and (3) communication and information as relevant activities to strengthen community resilience, (4) Indicators for resilience developed.
- Enhancing Synergies for disaster PRevention in the EurOpean Union (ESPREssO) Project with the aim to reduce the impacts of extreme events and increase resilience to disasters, particularly among vulnerable populations addressing both climate change adaptation and natural risk reduction issues.
- River Contract: an innovative methodology for water management as it is based on the active participation of local actors.

In flood risk management, a shift can be observed toward more integrated approaches that increasingly address the role of private households in implementing flood damage mitiga-

31 Dufty, N., 2008a, A new approach to community flood education, The Australian Journal of Emergency Management, Vol. 23 No. 2, May 2008

32 Shiwaku, K., Shaw, R., Chandra Kandel, R., Narayan Shrestha, S., & Mani Dixit, A. (2007). Future perspective of school disaster education in Nepal. Disaster Prevention and Management: An International Journal, 16(4), 576-587; Botzen, W., Aerts, J., & Van Den Bergh, J. (2009). Dependence of flood risk perceptions on socioeconomic and objective risk factors. Water Resources Research, 45(10).

33 Werritty, A., Houston, D., Ball, T., Tavendale, A., & Black, A. (2007). Exploring the social impacts of flood risk and flooding in Scotland: Scottish Executive Edinburgh.

tion measures.[34] Also, on the basis of protection motivation theory, a theoretical framework is discussed suggesting that individuals' high-risk perceptions need to be accompanied by coping appraisal to result in a protective response. Second, it is pointed out that possible feedback from already-adopted mitigation measures on risk perceptions has hardly been considered by current studies. In addition, we also provide a review of factors that drive precautionary behaviour other than risk perceptions. It is found that factors such as coping appraisal are consistently related to mitigation behaviour. The current focus on risk perceptions as a means to explain and promote private flood mitigation behaviour is not supported on either theoretical or empirical grounds.

There is currently a knowledge gap between flood experts and the general public about the extent of the perceived risk that the latter poses to high flood waters and how citizens should be warned of risk events, which affects the communication capabilities and efficiency of the warning process. People do monitor flood events, but they are unaware of essential guidance and communication mechanisms.[35] One aspect of flood awareness is people's recognition that their property is in an area that is potentially at risk of flooding. Quantitative analyses indicate that class to be the most influential factor in predicting flood risk awareness, followed by flood experience and length of time in residence. There are also significant area differences.[36] One common finding is that people usually show limited concern about flood risk for several reasons.[37] The first (and most intuitive one) is the lack of knowledge/information. To be worried, a person needs to know that he/she lives in a risky area. Often, the hazard associated with raising waters is "indiscernible", because there are no visual evidence that may indicate the presence of a risk: people do not see raising waters in their everyday life and, as a consequence, they assume that the hazard is negligible.

The low risk awareness of the residents living in flood-prone areas is usually considered among the main causes of their low preparedness, which in turns generates inadequate response to natural disasters. Results revealed that residents felt both slightly worried about flood risk and slightly prepared to face an event. Considerable differences were found between the evaluations of individual subjects as opposed to overall communities. There was also a clear discrepancy between the actual adoption of household preparatory measures and the willingness to take self-protection actions. The improvement of residents' knowledge about their environment and the residual risk seemed to be crucial to increase risk awareness, and the same was true for the strengthening of local support networks to foster preparedness.[38]

Kreibich et al.[39] (2011) found that many undertaken emergency measures were ineffective, since only 26% of all households knew how to react when the flood warning came, and only 9% of businesses had an emergency plan in place. Due to extreme flood, double-loop learning occurred in many households and businesses, so that many did implement precautionary measures. Only 10% of the households (n = 112), but still 29% of the businesses (n = 41) were unprepared before the flood in 2006. Significant improvement in flood preparedness activities is still necessary. Particularly for businesses, regulatory programs and programs encouraging proactive behaviour should be implemented. The focusing event framework proofed to be a useful tool for a differentiated analysis of the responses to and learning due to a disaster also in the commercial and private sector.

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34 Bubeck, P., Botzen, W. J., & Aerts, J. C. (2012). A review of risk perceptions and other factors that influence flood mitigation behavior. Risk Analysis: An International Journal, 32(9), 1481-1495.

35 Knocke, E. T., & Kolivras, K. N. (2007). Flash flood awareness in southwest Virginia. Risk Analysis: An International Journal, 27(1), 155-169.

36 Burningham, K., Fielding, J., & Thrush, D. (2008). 'It'll never happen to me': understanding public awareness of local flood risk. *Disasters*, *32*(2), 216-238.

37 Baan P, Klijn F (2004) Flood risk perception and implications for flood risk management in the Netherlands. Int J River Basin Manag 2:113–122; Burningham K, Fielding J, Thrush J (2008) It'll never happen to me: understanding public awareness of local flood risk. Disasters 31:216–238

38 Scolobig, A., De Marchi, B., & Borga, M. (2012). The missing link between flood risk awareness and preparedness: findings from case studies in an Alpine Region. Natural Hazards, 63(2), 499-520.

39 Kreibich, H., Seifert, I., Thieken, A. H., Lindquist, E., Wagner, K., & Merz, B. (2011). Recent changes in flood preparedness of private households and businesses in Germany. Regional environmental change, 11(1), 59-71.

Number principles emerge from the social psychology literature [40] and from the research on flood warnings reported in this paper, which may help improve flood warning response in the future:[41]

- Public flood communication and education is likely to work best if materials and approaches used create uncertainty in people's minds, causing them to wonder about their environment and to question their safety in it. Giving people something to mull over and to discuss with family and friends sparks the motivation which is the key to non-formal learning. Such an approach may increase the opportunity for non-formal learning amongst those living in flood risk communities and neighbourhoods.
- Successful public education campaigns: (1) raise questions creating uncertainty; (2) offer fairly simple answers, and, (3) feature authorities to provide additional information and reinforce the message. Again raising uncertainty can reinforce non-formal learning opportunity.
- Successful flood warning response campaigns are formulated for a diverse audience, including those with and without flood experience, age differences, gender and ethnicity differences and different levels of formal education. Campaigns may thus need to target specific audiences.
    - Evidence of unofficial flood warning systems suggests that there is sometimes a willingness among floodplain users to engage in flood risk management, and specifically in making flood warnings operate effectively. Where there are indications of willingness to engage, whether or not informal warning arrangements exist, opportunities exist to engage people further in warnings and warning response.
- Individuals are not generally motivated to change their behaviour by being told by others what they should or should not do. However, they are more likely to change their behaviour if they work out a solution themselves or with their peers with helpful information from specialists, and if they think that their own idea created the need to change.
- Individuals need trust in the process of flood warnings. Transparency in the decision-making process leading to a warning is therefore very important: steps should be taken to ensure transparency and to publicly admit to shortcomings in the decision-making process when this occurs (challenging as this may be to warning authorities).
- Ensuring that individuals and communities feel ownership of flood warning response and self-protection is very important. Publicly-provided flood protection is vitally important, but it is also associated with the message that the responsibility for protection can be delegated by the individual to public authorities. It is, therefore, crucially important to reinforce the message that flood risk management is a partnership between flood risk management agencies and individuals, and that individuals have responsibility for self-help and self-protection aided by authorities.

The 2004 report from the Federal Emergency Management Agency (FEMA), "*Are You Ready?*" describes US emergency management system as a pyramid, with citizens forming the base. As a result of their critical role within a larger disaster response structure, individual citizens have responsibility to take appropriate steps to protect themselves and their families, and to be self-reliant. Emergency managers assume that encouraging citizens to prepare is constructive, because preparing requires little time and effort and has no obvious down side. However, even if the individual costs of citizen preparedness are modest for some Americans, encouraging citizens to devote resources to this activity may not be risk free. First, families whose daily lives are dominated by concerns about poverty and unem-

[40] Mileti D, Nathe S, Gori P, Greene M, Lemersal E. 2004. Public Hazards Communication and Education: The State of the Art, Natural Hazards Informer Issue 2. Natural Hazards Research and Applications Information Center: Boulder, CO.

[41] Parker, D. J., Priest, S. J., & Tapsell, S. M. (2009). Understanding and enhancing the public's behavioural response to flood warning information. Meteorological applications, 16(1), 103-114.

ployment may consider government exhortations to prepare for an earthquake or terrorist attack as misguided at best, and out of touch at worst. There are also hypothetical reasons to worry that fostering individual preparedness could engender a false sense of security and encourage some families to ignore official guidance to evacuate because they can "ride out" the disaster. Highly self-reliant individuals may be inclined to make their own decisions rather than deferring to the advice of authorities.[42]

Citizen preparedness is not only ignored in much of the academic work on resilience; it may not even be recognized as a valuable strategy when it is considered. For example, in 2008 a group of experts representing multiple disciplines was asked to rank a variety of activities in terms of their effectiveness for building community resilience. Mass marketing of individual readiness was ranked well below most preparedness activities. A sizable minority (25%) of experts judged the activity to be "ineffective." The authors of this study asserted that there has been an overemphasis on citizen preparedness, when community rebound and recovery must rest on the connections between individuals. They also took issue with government initiatives that stress private citizens acting alone rather than in civic groups. In their view, stressing individual-level preparedness rather than concerted neighbourhood action hinders community resilience rather than enhances it.[43] Higher level of trust reduces citizens' perceptions of flood likelihood, which in turn hampers their flood preparedness intentions (cognitive route). Second, trust also lessens the amount of dread evoked by flood risk, which in turn impedes flood preparedness intentions (affective route). Moreover, the affective route showed that levels of dread were especially influenced by citizens' negative and positive emotions related to their previous flood hazard experiences. Negative emotions most often reflected fear and powerlessness, while positive emotions most frequently reflected feelings of solidarity.[44]

The results showed that the degree of preparedness for floods was determined by the level of fear of floods and the amount of damage sustained during the Tokai flood, especially for homeowners. However, the residents' preparedness did not depend on their anticipation of floods.[45] Although of increasing importance in a future of climate change, community flood education programs have generally been poorly designed and delivered in a relatively ineffective, 'top-down' manner. A new approach to flood education is promoted that broadens its focus from increasing awareness and preparedness levels to building flood resilient communities. Four functions of flood education are identified to help communities learn to build their resilience. Other features of the new approach are increased community participation in the design, implementation and evaluation of programs and effective ongoing education provision through local flood education plans.[46] Young adults have a lower understanding and are not as concerned about flood impacts. Increased exposure and perceived risk play a key role in shaping the way a person approaches flash floods. People do monitor flood events, but they are unaware of essential guidance and communication mechanisms. Finally, results suggest that the current method of warning about flash floods is not provided at an appropriate level of detail for effective communication.[47] The catastrophic flood occurred in Serbia in 2014 was one of the most critical events registered in the Balkan area in the last decades. The procedures for evacuation have been tough to manage indicating a low level of perception and preparedness towards flood events. Also, the

42 Federal Emergency Management Agency. (2004). Are you ready?: An in-depth guide to citizen preparedness.

43 Uscher-Pines, L., Chandra, A., Acosta, J., & Kellermann, A. (2012). Citizen preparedness for disasters: are current assumptions valid?. Disaster medicine and public health preparedness, 6(2), 170-173.

44 Terpstra, T. (2011). Emotions, trust, and perceived risk: Affective and cognitive routes to flood preparedness behavior. Risk Analysis: An International Journal, 31(10), 1658-1675.

45 Takao, K., Motoyoshi, T., Sato, T., Fukuzondo, T., Seo, K., & Ikeda, S. (2004). Factors determining residents' preparedness for floods in modern megalopolises: the case of the Tokai flood disaster in Japan. Journal of Risk Research, 7(7-8), 775-787.

46 Dufty, N. (2008). A new approach to community flood education. Australian Journal of Emergency Management, The, 23(2), 4.

47 Knocke, E. T., & Kolivras, K. N. (2007). Flash flood awareness in southwest Virginia. Risk Analysis: An International Journal, 27(1), 155-169.

failure in the response phase showed a gender unbalance, where information did not reach men and women equally.[48]

Table 12: Online education material, which practitioners can use.

Name	Type of education material	Source	Materials
Prepare for flooding	Website	https://www.dfes.wa.gov.au/safetyinformation/flood/Pages/preparеforflooding.aspx	Text regarding preparation, what citizens need to: • Understand the flood risk to your area • Prepare your home and property • Respond when water comes • Recover after a flood
How to prepare for a flood	Website	https://www.wikihow.com/Prepare-for-a-Flood	Four Parts: • Creating a plan • Preparing an emergency box for evacuation • Readying your home and documents in advance • Readying your home when floods arrive
How to prepare for floods and flooding and what to do before, during and after floods.	Website	https://www.redcross.org.uk/get-help/prepare-for-emergencies/how-to-prepare-for-floods-and-flooding	Steps in preparing: • Before flood • During flood • After flood
Flood safety tips	Website	https://www.nationalgeographic.com/environment/natural-disasters/flood-safety-tips/	Safety tips to prepare for rising water—and what to do once a flood has begun

[48] Cvetković, V., Roder, G., Tarolli, P., Öcal, A., Ronan, K., & Dragićević, S. (2017). *Gender disparities in flood risk perception and preparedness: a Serbian case study*. Paper presented at the European Geosciences Union GmbH - EGU General Assembly 2017, At Vienna, Austria, Volume: Vol. 19, EGU2017-6720: Session HS1.9/NH1.18 Hydrological risk under a gender and age perspective, Wiena.

Ready	Website	https://www.ready.gov/floods	• First part - Floods definition and types • Second part - Prepare NOW • Third part - Survive • Fourth part - Be Safe AFTER Associated content: • Flood Safety Social Media Toolkit (toolkit) • Flood Information Sheet (PDF) • National Weather Service Weather Ready Nation Spring Safety Outreach Materials (link) • American Red Cross (link) • The National Insurance Program (link) • Six Things to Know Before a Disaster (video) • When the cloud forms (video) • How to Prepare for a Flood (PDF) • Flood Playbook (PDF) • Flood Creative Materials (PDF) • National Creative Resources (PDF) • Answers to questions about flood insurance • National Flood Insurance Program Summary of Coverage • Your Homeowners Insurance Does Not Cover Flood
Keep yourself and your family safe with these 10 ways to prepare for a flood	Website	https://www.digitaltrends.com/home/10-ways-to-prepare-for-a-flood/	Have these parts: • Get a weather radio and learn to understand emergency notifications • Research Your flood risk • Prepare emergency supply kits for your home, work, and car • Establish your evacuation route • Have a plan for communicating with family members • Raise up appliances, other items to protect them from damage • Save your important documents • Protect your drains from increasing the damage • Stockpile emergency supplies • Manage your financial risk
7 Must-Do Steps for Flood Disaster Preparation	Website	https://efficientgov.com/blog/2017/08/23/7-steps-flood-disaster-preparation/	Disaster preparation for a flood includes gathering necessities, relying on local media sources and being aware of the dangers rising waters bring. • #1 Stockpile Bottles of Water • #2 Store Ready-to-Eat Canned Food • #3 Heed All Written and Broadcast Emergency Directions • #4 Follow Local Media for the Most Up-to-Date Information • #5 Safely Store Sensitive and Valuable Belongings • #5 Safely Store Sensitive and Valuable Belongings • #6 Use Precaution When Cleaning Up Flood Waters • #7 Be Prepared to Leave

Flood Safety Learn how to keep your family safe during a flood, and how to clean up a flooded home.	Website	https://www.redcross.org/get-help/how-to-prepare-for-emergencies/types-of-emergencies/flood.html	Prepare in advance of a flood • How to Prepare Before a Flood • Protecting Your Family • Protecting Your Pets & Animals • Protecting Your Home Right before a flood • Then, If You Can, Do This • If You Still Have Time, Do This • If You Have Pets or Livestock During a flood • Staying Safe Indoors • Staying Safe Outdoors
FloodSafe Guide - How to Plan and Prepare for Floods.pdf	PDF	https://www.ses.vic.gov.au/documents/112015/136923/FloodSafe+Guide+-+How+to+Plan+and+Prepare+for+Floods.pdf/a9ace500-609b-424a-b1bb-250eb48c75bb	A well prepared community can reduce the impact of flooding by up to 80%. People who are prepared are more likely to respond to floods appropriately and safely.
FloodSafe Benalla Region	PDF	https://www.ses.vic.gov.au/documents/112015/134882/Benalla+Local+Flood+Guide-pdf/b3da4c39-94ba-489c-9998-bb4de9b64ed4	How to plan and be prepared for floods.
How to Prepare For a flood	PDF	https://www.fema.gov/media-library-data/1409002852888-3c5d1f64f12df02aa801901cc7c311ca/how_to_prepare_flood_033014_508.pdf	How to Prepare for a Flood explains how to protect yourself and your property, and details the steps to take so that you can act quickly when you, your home, or your business is in danger.
Preparing for a flood: A guide for homeowners	PDF	https://www.wsask.ca/Global/Lakes%20and%20Rivers/Flood%20Watch/Preparing-for-a-flood.pdf	• To prepare for a Flood • To reduce the likelihood of flood damage If a flood is forecast • When there is immediate danger of flooding • During a flood • Special considerations for sewage systems
What to do before, during and after a flood	PDF	http://www.bom.gov.au/water/floods/document/What_todo_floods.pdf	Because floods have been a part of Australian culture, it can be easy to become complacent. However, much has been done by experienced emergency preparedness workers towards mitigating the effects, and to develop sound advice on what to do before, during and after a flood.
Be RedCrossReady	PDF	https://www.redcross.org/content/dam/redcross/atg/PDF_s/Preparedness___Disaster_Recovery/Disaster_Preparedness/Flood/Flood.pdf	Floods are among the most frequent and costly natural disasters. Conditions that cause floods include heavy or steady rain for several hours or days that saturate the ground. Flash floods occur suddenly due to rapidly rising water along a stream or low-lying area.

Flood Emergency Plans: Guidance & Template of National Planning Policy Framework (NPPF)	PDF	http://repo.floodalliance.net/jspui/bitstream/44111/1266/1/Flood%20Emergency%20Plans%20Guidance.pdf	It is essential to remember the issues surrounding people's safety in flood events. Further information on the preparation of a FEP to satisfy the Government's guidance can be found in the NPPF and the associated technical guidance note on flooding.
Flooding minimising the risk. Flood plan guidance for communities and groups. Practical advice to help you create a flood plan.	PDF	https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/292939/LIT_5286_b9ff43.pdf	Understanding the risk of flooding and preparing for it now will help save lives and minimise the damage and distress flooding can cause. Working together as a community or group will help you respond quickly and efficiently in a flood.
Family guide for prepare	PDF	https://www.osce.org/sr/serbia/118659?download=true	Instructions for disaster preparing

4.2.4 Innovation opportunities

Analysing the needs of practitioners, it has been established that they need educational materials that can be used in educating citizens in terms of improving their resilience. It is necessary to fill the knowledge base with all available publications (brochures, manuals) that might help in improving the level of resilience of citizens.

In terms of improving the knowledge of citizens, as one of the elements of resilience, in the knowledge base there are publications that consider the way and type of education of citizens. Thus, it could be an innovation opportunity to offer solutions in terms of the education curriculum. In terms of reducing the risk of flood disasters, schools should become increasingly important subjects for creating and improving the safety culture of young people, which also refers to their enabling for responding to natural disasters caused by floods. As such, they should play a key role in providing basic disaster information in a local community. [49] The importance of school education on disasters will grow, especially having in mind that children are the most vulnerable category in a society. Also, the school is the centre of education and the results of the education process themselves are transferred to their families and the local community.

Moreover, it is necessary to develop a unique international web platform (site) in which all relevant materials will be disseminated. It is necessary to develop a unique international web platform (site) for dissemination of all relevant materials.

The Knowledge Base (KB) contained 434 publications/projects. Results from the KB search have shown 222 tags related to the resilience of citizens. Most of the available solutions for the resilience of citizens provided in the KB are related to raise and increase of public

49 Cvetković, V., Tarolli, P., Roder, G., Ivanov, A., Ronan, K., Ocam, A., & Kutub, R. (2017). Citizens education about floods: a Serbian case study. Paper presented at the VII International scientific conference Archibald Reiss days.

awareness through media, education, but also active citizen's participation in flood management.

The main issue is to improve communication before, during and after a flood event so people are better informed and have an improved understanding of risk. It is important to have feedback for every situation where omissions and mistakes have occurred in any process of prevention, preparedness, response, recovery or mitigation. These data should be organized in a data base with opened content to be analysed to all practitioners interested. This would be the best possible way to learn from mistakes. The series of disasters showed changes of flood damage characteristics due to the social changes as well as the changes of meteorological tendencies: frequent localized torrential downpour, many floods and landslides at small and medium-sized rivers, many casualties among the aged and other people requiring help in times of disaster because of the aging society with fewer children, and weak local mutual-aid system because of local communities on the decline and decrease and aging of flood fighting team members. This should be implemented in ageing society in Serbia. Under such circumstances, the revisions of the flood fighting should be made to enhance the ability of local communities and local public bodies to competently deal with flood risks. Analysing socio economic characteristics of region should be considered as one of the parameters for improving emergency response. Demographic and economic attributes, behaviours and beliefs reflect gender power relations in the flood hazard context in Serbia. Failing to recognise it may lead to inefficient community-based risk management plans. Thus, there is a systematic need to investigate and acknowledge the role of gender dynamics without limiting gender as an isolated variable. This work will contribute raising further investigations on this topic especially in a country like Serbia where this topic was weakly investigated.[50] There is a need for comprehensive, standardised and georeferenced information on floods for political and economic decision-making. Relevant, accurate and up-to-date data is an important aspect for resource distribution, mitigation programmes, disaster monitoring and assessment.[51]

4.2.5 Lessons Learnt

By analysing the results it has been established that there are public information campaigns on floods to raise general awareness of the flood and to encourage people to prepare for floods as individuals. However, it is necessary to examine what kinds of such materials exist and what is the degree of their efficiency of dissemination of information and raising the awareness of citizens. When it comes to education materials (e.g. guides, recommendations) for citizens regarding the preparation of floods to inform citizens about available resources (e.g. access to Explained flood risk maps), more than half of respondents point out that they do not exist. The results obtained indicate a poor state of preparedness of citizens, bearing in mind that most of the respondents point out that they do not exist. On the other hand, with regard to education materials (e.g. guides, recommendations) for citizens regarding the preparation of floods to improve citizens' preparedness for floods, it has been found that a much larger number of respondents emphasize that such materials exist. Finally, in relation to educational materials (e.g. guides, recommendations) for citizens regarding the preparation of floods for schools and teachers to educate children and teenagers, it was found that slightly more respondents claim that they exist. In further analyses, it is necessary to examine what kind of material is being worked out, how the educational lessons are designed, etc. The research results indicate a great importance of education about natural disasters caused by floods, both in school and in the family. In view of that, the educational policy makers can use these findings to perform a thorough analysis of primary and secondary school curricula and determine to what extent the relevant content is incorporated in the curricula. Undoubtedly, it imposes on us an obligation to continue researching

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50 Cvetković, V., Roder, G., Tarolli, P., Öcal, A., Ronan, K., & Dragićević, S. (2017). *Gender disparities in flood risk perception and preparedness: a Serbian case study Ibidem.*

51 Barredo, J. I. (2007). Major flood disasters in Europe: 1950–2005. Natural Hazards, 42(1), 125-148.

this topic and find strategies of working with students in a way to enhance their preparedness for responding to natural disasters caused by flooding.[52] After floods, social networks can greatly facilitate the setting of priorities for the distribution of food and water aid. Surely, in order to fully exploit the full potential of social networks, it is also necessary to educate citizens how they can help emergency rescue services in the implementation of activities aimed at reducing the disaster risk. In relevant strategies, both national and local, consideration should be given to the ability of social networks to reduce the risk of disasters. It is necessary to continue with the implementation of the research in order to clarify as much as possible the doubts about the importance of social networks in the process of disaster management. In relation to preventive activities, social networks can be used to disseminate all information on disaster hazard characteristics at the local level. It is possible to introduce citizens with risk maps in the areas they live in. In addition, it is possible to develop interactive and online campaigns to improve the readiness of citizens to respond in such situations. On that occasion, it is possible to use educational videos, photos, and text in the context of the hazards characteristic of the area in which people live. In addition to preventive activities, social networks can be very helpful in responding and eliminating the consequences of the events that have occurred. Endangered people can photograph and record a large number of details important for making final decisions about the treatment of members of the emergency rescue services. The obtained results of the research showed a great interest in the respondents for the use of social networks in order to share information about disasters. Numerous factors influence the motivation of people to share information during disasters, and one of them is certainly a concern for the safety of other people.

[52] Cvetković, V., Lipovac, M., & Milojković, B. (2016). Knowledge of secondary school students in Belgrade as an element of flood preparedness. Journal for social sciences, TEME, 15(4), 1259-1273.

4.3 TWG "Spontaneous Volunteers"

4.3.1 Relevance of the RDI Topic

Discussions with practitioners and within the DAREnet consortium showed that the concept of spontaneous volunteers is not universally known. Especially, those countries with a strong voluntary involvement in organizations and institutions like fire or emergency services are familiar with the concept.

For clarification the DAREnet consortium agreed on the following differentiation between spontaneous volunteers and responders:

"Spontaneous volunteers are "just" citizens willing to help. They are not related to any organization and have not received any preparatory training nor equipment. Typical civil protection responders are either professionals or volunteers engaged in dedicated organizations. They also received proper training and preparation, as well as adequate equipment to reduce their personal risk."

This is in general following ISO 22319:2017[53], where a spontaneous volunteer is seen as "an individual who is not affiliated with an existing incident response organization or voluntary organization but who, without extensive preplanning, offers support to the response to, and recovery from, an incident. […] A spontaneous volunteer can also be referred to as a convergent volunteer, a walk-in volunteer, an occasional volunteer, an episodic volunteer, or a non-affiliated volunteer."

Spontaneous volunteers bear a huge potential to support during crisis situations such as floods. Experiences during past flood events (e.g. 2013 in Austria and Germany; 2014 in Croatia and Serbia) demonstrated this. While besides the directly involved residents, floods and the continuous reporting via various media also causes a high compassion and mobilizes more people from unaffected areas to help those in need.

In parallel deployed civil protection responders a confronted with multiple tasks during these events. Some of these do not need highly specialized trainings, but they are very labour intensive and would bind many responders for relatively easy to learn tasks, such as the filling of sand bags or carrying them to the place where they are needed via human chains.

For these tasks the coordinated involvement of spontaneous volunteers can be used to exonerate the civil protection practitioners' workload. However, this requires a good understanding of the potential as well as discussions about liabilities and insurances, preparation of civil protection personnel and concepts for their involvement.

Across the Danube river region spontaneous volunteers are known in most countries, however the understanding of voluntarism might differ. In some countries it is well known (e.g. Germany), or even strongly supported by organizations (e.g. Austria with Team Österreich), while in others (e.g. Romania or Bulgaria) spontaneous volunteers are not well-known or integrated.

Most countries witnessed the phenomenon of spontaneous volunteers; however, the experiences and implementation differ strongly. Huge challenges are the effective involvement and coordination of spontaneous volunteers.

Although spontaneous volunteers have the potential to be a valuable asset, one must not forget that they are not trained and equipped in a way a typical practitioner is. This means also they will not be familiar with hierarchical structures as implemented by coordination, command and control systems (e.g. ICS[54] or DV100[55]) as well as the commands given as

53 ISO 22319. Security and resilience - Community resilience - Guidelines for planning the involvement of spontaneous volunteers. s.l. : ISO, 2017. ISO 22319:2017(E)

54 FEMA. Incident Command System Resources. [Online] [Cited: 08 24, 2018.] https://www.fema.gov/incident-command-system-resources

55 Feuerwehr Dienstvorschrift 100: Führung und Leitung im Einsatz (in German). 1999

orders, which might cause tensions. Therefore, well thought concepts are needed to prepare commanders and practitioners to coordinate spontaneous volunteers. These concepts must integrate open jurisdictional and liability questions, as well as possible task catalogues describing tasks and necessary precautions information (such as what protective equipment is needed, or which tasks can be fulfilled with limited protective equipment).

In some cases clear organizational statements might be already helpful to provide commanders and decision makers on-site with the needed certainty to decide if and how they can integrate SV to reduce the workload on their assets.

Further, the integration and coordination of spontaneous volunteers also requires specific tools to reach out to them and coordinate or register/administer them. To sum up, practitioners need to be prepared for these situations.

4.3.2 Practitioner Needs

The possible involvement of spontaneous volunteers comes along with certain needs and requirements from the practitioner side:

- Integration of spontaneous volunteers into civil protection operations,
- Mutual understanding for each other,
- Liability questions,
- Concepts for the cooperation with spontaneous volunteers.

4.3.2.1 Integration of spontaneous volunteers into civil protection operations

SV can be a valuable addition to the deployed responders and therefore their integration should be considered. However, most likely spontaneous volunteers are not familiar with procedures, vocabulary and common tasks used by civil protection organizations. As practitioners are usually trained to work on a professional level, SV need to be prepared for these situations as well.

4.3.2.2 Mutual understanding for each other

During the floods in Germany in 2013 a huge compassion caused many SV to travel into the effected regions to help paralleled by continuous media broadcasting. In some cases this led to a conflict with responders, since well-trained practitioners, especially those who are also volunteering as responders, lacked the understanding why they were not deployed and remained as a reserve while SV were integrated into operations. Here, a better awareness for the potential benefit from practitioner side and a sensitization for the interaction with SV are needed.

4.3.2.3 Liability questions

While responders are well trained and equipped, SV usually lack training, safety instructions and equipment. Commanders, who are sensitized for safety rules on-site, are likely to have questions and possibly uncertainty to what degree they are safe to integrate SV or delegate tasks to them. In this case, clarification of open questions regarding safety regulations and responsibilities are needed and should be accompanied by recommendations and guidelines.

4.3.2.4 Concepts for the cooperation with spontaneous volunteers

As mentioned, SV are not used to follow command chains or do not know about such structures and whom to approach. Therefore, easy to access and use tools are necessary to reach out to SV and coordinate their action. This could be the cooperation with mediator organizations (e.g. KOKOS project[56]) to avoid direct contact to each individual SV, or concepts to train practitioners in concepts like sheep herding, i.e. train abilities to instruct and guide

[56] Unterstützung der Kooperation mit freiwilligen Helfern in komplexen Einsatzlagen (in German). [Online] [Cited: 9 20, 2018.] http://www.kokos-projekt.de/

SVs. Another important aspect of these guidelines and according trainings is to sensitize practitioners for the needs, behaviour and motivation of SVs.

4.3.3 Available Solutions

Over the course of the last years several projects focused on spontaneous volunteers. The authors are aware of almost exclusively Western European Initiatives; however in the USA and Australia guidelines on the involvement of spontaneous volunteers have been published as well. The scope of these studies and projects was addressing multiple aspects, from becoming aware of the SVs motivation, opportunities to connect to them, models to coordinate them and even soft- and hardware development, or more general guidelines.

Mostly analysing past involvements of volunteers and concept (ideas) how to interact with the spontaneous volunteers

4.3.3.1 Guidelines

The International Standardization Organization published a standard entitled "Guidelines for planning the involvement of spontaneous volunteers"[57] providing a general guideline naming the most important steps necessary to implement SV support into response operations.

Beside this very universal guideline, there have been more detailed concepts by Federal Emergency Management Agency (FEMA; USA[58]), Department for Environment, Food and Rural Affairs (DEFRA; UK[59]) or the Department of Family Affairs, Housing Community Services and Indigenous Affairs (Australia[60]).

4.3.3.2 Projects

There were some projects dedicated to the topic of spontaneous volunteers. In Table 13 we introduce 6 Austrian and German projects. Interestingly, the linkage between them and continuous development of previous results is not obvious.

Table 13: Projects dealing with "Spontaneous Volunteers".

Acronym	National/international (Funding Body)	SV main aspect	Tools developed	Training concepts	Available Resources
ENSURE[61]	German (BMBF)	yes	Apps and Coordination System	Yes, pilot concept by the German Red Cross	Training concept
PRAKOS[62]	German (BMBF)	One as-	no	Pilot at the THW train-	Not known

57 ISO 22319. Security and resilience - Community resilience - Guidelines for planning the involvement of spontaneous volunteers. s.l. : ISO, 2017. ISO 22319:2017(E)

58 FEMA. Incident Command System Resources. [Online] [Cited: 08 24, 2018.] https://www.fema.gov/incident-command-system-resources

59 Department for Environment, Food & Rural Affairs (UK),. *Spontaneous volunteers: Involving citizens in the response and recovery to flood emergencies.* 2015

60 Australian Government - Department of Families, Housing, Community Services and Indigenous Affairs,. *Spontaneous Volunteers Management Resources Kit.* 2010

61 Ensure - Enablement of Urban Citizen Support for Crisis Response (in German). [Online] [Cited: 08 27, 2018.] https://ensure-projekt.de/wordpress/

62 PRAKOS - Praktiken und Kommunikation zur aktiven Schadenbewältigung (in German). [Online] [Cited: 08 27, 2018.] https://www.vfdb.de/forschung/prakos/

		pect		ing centre Neuhausen	
RESIBES[63]	German (BMBF)	yes	Apps/adhoc networks	Not known	Not known
KOKOS[64]	German (BMBF)	yes		Quick training for mediating organizations	Short manuals
REBEKA[65]	German (BMBF)	One aspect	App; public displays; ad hoc networks	yes	Not known
Team Österreich[66]	Austria (ARC/Ö3)	yes	App	yes	App
RE-ACTA[67]	Austria (BMVIT)	yes	App; crowd tasking management system; reporting tool	Not known	Neighbourhood Aid Demonstrator; results fed back to Team Österreich

4.3.3.3 Apps for communication and coordination of spontaneous volunteers

RESIBES, REBEKA, ENSURE and Team Österreich (Austrian Red Cross) introduced apps to warn, inform or coordinate SVs (cf. section 4.3.3.2). However, to our knowledge only Team Österreich uses the tool on a regular base, the other aforementioned are not freely available and therefore not established among citizens.

The Austrian Re-ACTA project dealt with the design of a crowd tasking process to enable an efficient workflow management between professional organizations and loosely coupled non-trained / spontaneous volunteers. Results of RE-ACTA will be incorporated into Team Österreich to develop it further.

4.3.3.4 Mediating organizations

Most projects focused on the direct involvement of SV in their operations, while KOKOS[68] is proposing the involvement of mediating organizations who maintain the direct contact and coordination of spontaneous and unbound volunteers. This way, tasks can be delegated to the mediators and they coordinate the spontaneous volunteers.

63 RESIBES - Resilienz durch Helfernetzwerke zur Bewältigung von Krisen und Katastrophen. [Online] [Cited: 08 27, 2018.] https://www.resibes.de/

64 Unterstützung der Kooperation mit freiwilligen Helfern in komplexen Einsatzlagen (in German). [Online] [Cited: 9 20, 2018.] http://www.kokos-projekt.de/

65 REBEKA - Resilienz von Einsatzkräften bei eigener Betroffenheit in Krisenlagen (in German). [Online] [Cited: 08 27, 2018.] http://www.rebeka-projekt.de/

66 Austrian Red Cross. Team Österreich (in German). [Online] [Cited: 09 25, 2018.] https://www.roteskreuz.at/mitmachen/mitarbeit/freiwillige-mitarbeit/team-oesterreich-digital/

67 Austrian Institute of Technology. RE-ACTA. [Online] [Cited: 09 25, 2018.] https://www.ait.ac.at/en/research-fields/crisis-and-disaster-management/projects/re-acta/

68 Unterstützung der Kooperation mit freiwilligen Helfern in komplexen Einsatzlagen (in German). [Online] [Cited: 9 20, 2018.] http://www.kokos-projekt.de/

4.3.3.5 Training concepts

ENSURE[69], and PRAKOS[70] led to two training concepts in Germany. However, it is questionable if these are well known among the majority of the practitioners, yet.

The Hungarian Civil Protection Association also offers a training concept and some guidelines/recommendations for their trainers.

4.3.3.6 Psychological support and first aid

Psychological first aid and support is an important factor for the well-being of the individuals involved in response, as we learned from incidents in the past (e.g. Eschede train accident[71]). The project "Psychological first aid and Psychological support in complex emergencies (PFA-CE)"[72], funded by the EC, focussed on improving disaster response capacities of European emergency and volunteer organizations by strengthening Psychological First Aid (PFA) and Psychosocial Support (PSS) competencies of staff and volunteers. Further, a handbook was developed in order to enhance activities in disaster response through better coordinated involvement of spontaneous volunteers.

4.3.3.7 "Semi-spontaneous" Volunteers

Some projects reach out to interested volunteers and provide some basic training upfront, without fully integrating the volunteers in their organization, e.g. Team Westfalen[73] a spinoff of Team Österreich[74] by the German Red Cross Branch Westfalen. Here, these volunteers only participate in basic training and declare to be available for disasters, instead of becoming fully associated to the Red Cross and participate in regular trainings and services.

4.3.4 Innovation opportunities

The following innovation opportunities were identified by our TWG:

- The universal common understanding of the term "spontaneous volunteers" as defined by ISO 22319:2017[75] should be fostered. Distinct concepts, based on the standard or other projects, are available. It should be thoroughly reviewed if they are fully applicable to individual responding agencies and organizations or if there are adaptations from the practitioner side needed.
- Training and preparation of responders to interact efficiently with spontaneous volunteers should be broadly implemented. However, country or organization specific aspects need to be evaluated and respected in future approaches.
- These might be questions on liabilities and responsibilities of the agencies and organizations involved, as well as general open jurisdictional and organizational questions, such as, who is in charge to interact with SVs, or who pays for required infrastructures (such as mobile phone applications).

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69 Ensure - Enablement of Urban Citizen Support for Crisis Response (in German). [Online] [Cited: 08 27, 2018.] https://ensure-projekt.de/wordpress/

70 PRAKOS - Praktiken und Kommunikation zur aktiven Schadenbewältigung (in German). [Online] [Cited: 08 27, 2018.] https://www.vfdb.de/forschung/prakos/

71 Hüls, E. & Oestern, H.-J. Die ICE Katastrophe von Eschede. Erfahrungen, Lehren, Konsequenzen. *Notfall &Rettungsmedizin*. 1999, 2

72 European Commission. Psychological First Aid and Psychosocial Support in Complex Emergencies (PFA-CE). [Online] [Cited: 09 25, 2018.] http://ec.europa.eu/echo/funding-evaluations/financing-civil-protection-europe/selected-projects/psychological-first-aid-and_en

73 Westfalen, Deutsches Rotes Kreuz LV. Team Westfalen (in German). [Online] [Cited: 08 27, 2018.] https://www.drk-westfalen.de/aktuell/projekte/team-westfalen.html

74 Austrian Red Cross. Team Österreich (in German). [Online] [Cited: 09 25, 2018.] https://www.roteskreuz.at/mitmachen/mitarbeit/freiwillige-mitarbeit/team-oesterreich-digital/

75 ISO 22319. Security and resilience - Community resilience - Guidelines for planning the involvement of spontaneous volunteers. s.l. : ISO, 2017. ISO 22319:2017(E)

- International exchange of lessons-learned and best practices regarding spontaneous volunteers' involvement and the according training concepts. This should also include a synthesis of latest research results and identification of innovative and practicable approaches.
- Widespread implementation of structures to be activatable in case of an emergency or disaster like Team Österreich.

4.3.5 Lessons Learnt

The initial exchange within the consortium and various practitioners has been difficult in the beginning since there was no universal understanding of the term "spontaneous volunteers". Although there have been widespread experiences and many research projects on this topic, it seems like an overarching analysis and exchange of experiences is urgently needed.

Moreover, existing training concepts should be promoted stronger towards the practitioners.

Although, the establishment of a smart phone application could be helpful, it should be evaluated why the created ones, with the exception of Team Österreich Digital, did not receive a broad uptake or distribution.

4.4 TWG "Civil Protection Methods, Procedures and Technology"

4.4.1 Relevance of the RDI Topic

Practitioners highly depend on the presence of appropriate methods, techniques and procedures in case of floods. On the one hand, good procedures provide a way to effective communication by applying consistent standards and practices. On the other hand, by implementing the best and innovative techniques, methods and solutions we could improve flood risk management.

In a world of innovation, identifying the best technical solutions for successful mitigation of flood damage and ensuring civil protection should not miss out. There are a large number of technical solutions, but not all proved to be effective in case of flood emergency situations. Regarding the great challenges, the most suitable solutions associated with flood event monitoring (e.g. water level, dyke monitoring), dyke enforcement and people evacuation/rescue are worth to be considered.

In terms of flood monitoring, in large basins like Danube and its tributaries which generally include slow-onset floods, it's important to receive accurate information regarding upstream water level and dyke security. These kinds of information are necessary in order to proper manage the operational stage from flood risk management plan in case of flood events. Usually water level measurements are performed in fixed locations through hydrometrical gauge stations that could be automatically or not. Dyke monitoring could highlight the insecure sections and are usually done by trained inspectors who make visual observations whilst walking the dyke.

In case of flood emergencies, in low-land areas and flood plains which are devoid of dykes, the practitioners must be able to find solutions in order to prevent overflowing the river banks. The most common solutions consist in a rapid building of sandbags dikes or artificial barriers from other materials.

In terms of flood risk it's already known that human safety is the first on the list. When a flood strikes a place, it can leave peoples stranded in cars, buildings or high-land area surrounded by water. In this cases rescue operations are carried out. Nevertheless, operations in flooded area could be extremely dangerous so it's important to know the hazards and to have a well prepared plan, including the most appropriate vehicles for intervention.

4.4.2 Practitioner Needs

Based on previous experiences, the applied questionnaires are very effective tools for addressing the needs of practitioners. Based on the generally results derived from the analysis and interpretation of questionnaire answers and phone interviews received from practitioners, it can be mentioned that the main needs in terms of civil protection are technical solutions. In Table 14 presents the practitioners' needs related to sub-topics associated with the topic "Civil Protection Methods, Procedures and Technology".

Table 14: Practitioners' needs related to "Civil Protection Methods, Procedures and Technology".

Subtopic	Practitioners' needs
Water level monitoring	• Upgrading of the existing hydro-technical network • Adequate and sufficient resources (devices/tools/techniques) • A better telecommunication infrastructures • Expanding real-time communications networks
Dyke monitoring	• Personnel availability • Well-trained staff • Innovation in terms of existing solutions

Dyke defence/ enforcement	• Decentralised material and logistic support in vulnerable areas • Response capacity building • Well-trained staff and more training activities • Volunteers
Rescue equipment/ techniques	• Decentralised material and logistic support • Response capacity building • Well-trained staff • adequate and sufficient resources (devices/tools/techniques);

On the other hand, the practitioners have revealed other general needs:

- Adequate inter-institutional and transboundary cooperation;
- Optimisation/compatibility of flood prevention measures;
- Adequate communication and coordination.

4.4.3 Available Solutions

4.4.3.1 Water level monitoring

In almost all the riparian countries of the Danube Basin water level monitoring is performed in fixed locations with automatic or non-automatic gauge station. There is always a close collaboration between water management systems and meteorological administrations since the atmospheric factors are generally responsible for flood events. Water level monitoring is an important step in case of warnings, because when the water level upstream is rising fast, the practitioners are going to organize periodically or constant downstream water level monitoring, in order to take the proper mitigation measures in advance. In Serbia the lack of automatic stations raises some problems as a result of the lack of real-time warning communication. In other situations, the number of stations does not adequately meet the requirements, or in some context are affected by floods, therefore fast and reliable solutions are needed. At THW (Technisches Hilfswerk[76]) there are distinct groups equipped with mobile water gauges and the required IT equipment. This equipment provides temporary water level observation when the installed gauges are failing. The so called "Mobiler Hochwasser-Pegel-Trupp" is a small unit that can operate with a van-sized vehicle and provide water level data (including updated maps) for staffs or command posts. The used equipment is a THW in-house solution, developed by THW volunteers (e.g. https://pg-deich.thw.de/einsatz-im-hochwasser/mobiler-pegel/).

4.4.3.2 Dyke monitoring

The dyke monitoring is made to establish the flood protection phase, related to the river water level, and the risk situations to the flood defence lines. When upstream water level are becoming increasingly alarming, periodically or constant dyke monitoring are developed by practitioners, in order to highlight potential vulnerable sections.
In some countries, like Germany, THW or other providers (Akademie Hochwasserschutz or DWA) established methods are usually applied in terms of dyke monitoring. THW also has dedicated training programs to train their personnel in this issue. In Hungary, Civil Protection and Disaster Management Associations from different regions includes volunteer water level control guard.

4.4.3.3 Dyke defence/enforcement

In emergency situations, in exposed low-land areas the most used rapid solutions to cope with floods consist in building of the temporary sand bag dykes. In Germany basic knowledge in sand bag handling is transmitted during the basic qualification to each THW practitioner. Further, techniques are offered in specified training courses for multipliers to enhance the qualification of the volunteers/responders. Only a few countries have reported that include organized groups of volunteers for such situation (e.g. Germany, Hungary). On

[76] a civil protection organisation controlled by the German federal government

the other hand, in EU countries the dyke defence measures and their enforcement are established in Basinal Flood Risk Management Plans.

4.4.3.4 Flood rescue

Proper equipment, trained personnel and fast response in case of emergency situations is the best way to ensure safety and security for the people. In case of flood emergency situation with peoples stranded in areas surrounded by water the rescue team (usually firefighters, military staff or well-trained volunteers) operate with the most appropriate means according to the hazard characteristics. Usually, this kind of intervention is performed by boats or big wheel transporter unit.

In some country like Bulgaria, there is a procedure to request additional boats and personnel from other districts if necessary and in Slovakia a "national water rescue module for floods using the boats" is available. In Slovakia the people rescue could be done also using helicopter or floating transporter.

Croatia National Protection and Rescue Directorate operational forces are evacuating with support of firefighters (local, non-disaster events) or in catastrophic event (national level) with professional FD, Croatian Mountain Rescue Service, and military. Boats are also use to transport food, drinking water and medicines to affected areas and evacuation of affected population.

In Germany the boat operators - the German Live Saving Association (DLRG), the Federal Police and the Wasserwacht (GRC water rescue branch) - are trained in basic evacuation techniques and have Air Rescue Specialists being deployed or winched from helicopters of the federal police to rescue or evacuate via air.

SMURD is an emergency rescue service based in Romania. The name is the Romanian acronym for "Serviciul Mobil de Urgenţă, Reanimare şi Descarcerare", which means Mobile Emergency Service for Resuscitation and Extrication. It deals with diverse worst emergency cases, all in a very good collaboration with the regular Ambulance Service, including flood rescue operations with helicopters.

Table 15: Summary of available solutions related to "Civil Protection Methods, Procedures and Technology".

Subtopic	Available solutions
Water level monitoring	• Fixed hydrometrical gauge stations • Mobile automatic water gauges in some countries
Dyke monitoring	• Visual observations • Methods which are usually applied in terms of dyke monitoring • Volunteers in some countries
Dyke defence/ enforcement	• Sand bag dykes • Flood barriers from other materials • Dyke defence measures from Basinal Flood Risk Management Plans in EU countries • Training activities • Volunteers in some countries
Rescue equipment/ techniques	• Boat, helicopter, floating transporter, big wheel transporter unit • Trained staff • Training activities

4.4.4 Innovation opportunities

Table 16 summarises the innovative solutions that we derived from our findings related to the RDI subgroup "Civil Protection Methods, Procedures and Technology".

Table 16: Summary of innovative solutions related to "Civil Protection Methods, Procedures and Technology".

Subtopic	Innovative solutions
Water level monitoring	• The automatic water level monitoring with sensors that offers real time capability and transparency with high water and level alerts. A good solution is related to scalable sensors. This proves to be low cost, ease of install and an efficient solution. When water rises to meet a predetermined level the sensors can send out a warning alert via SMS or email to the end user. Also the data collected could be easily viewed on the dedicated APP or Web Dashboard allowing you to stay informed anywhere, anytime (https://www.kingspan.com). • Systems for mobile measurements coupled with automatic long-term data logging.
Dyke monitoring	• Remote sensing could be used to make dyke inspection faster and cheaper. The quality of the peat dykes can be evaluated by remote sensing data. Remote sensing provides useful information for soil moisture evaluation for dyke inspection and may be useful for dyke quality inspection. • Together with Landustrie, VolkerWessels Telecom has developed the DMC (Dyke Monitoring and Conditioning system). DMC system monitors the condition of dykes and intervenes where necessary. Compared to traditional dyke strengthening, savings on the total cost of ownership can amount to 75%.
Dyke defence/ enforcement	• The use of sandbags is a fast and efficient solution for flood defence. Self-inflating sandbags can be more efficient as well as the Füllmexx sandbag filling funnel that allows an individual person to manually fill sandbags. With this funnel, around 10 sandbags can be filled in a mere three minutes by a single individual (https://www.beaver-ag.com/). An alternative to the sandbags are the IBS movable flood-defence walls. In case that the sandbags are not effective an Eco-Dam can be used preventing further erosion of the river bank. • Inflatable dams which are filled with water. • Portable water barriers - can be set up quickly on almost all surfaces of any length. • MOBILDEICH dykes assembled out of 2 to 3 individual tube elements being available in a variety of different sizes and lengths. These elements can easily be combined with each other, to enable maximum protection with various combinations, for any situation. • Flood barriers based on big pack of containers.
Rescue equipment/ techniques	• Accurate, reliable and secure communication system for critical situations (e.g. TETRA, PUMA T4 HANDHELD TERMINAL, DMR). • Drones have obvious advantages when it comes to flood disasters. Due to their small size, drones can fly in tighter spaces then helicopters, and hover closer to the action. They can also fly without the aid and dedicated pilot. Also, they are cheaper and are already owned by a many people. In a recent study of news reports, DJI, concluded that drones were responsible for helping save one life per week.

4.4.5 Lessons Learnt

Taking into account the fact that the practitioners highly depend on the presence of appropriate methods, techniques and procedures in case of floods it is very important to identify the best solutions.

Based on answers from the questionnaire and phone interviews the main needs of the practitioners in terms of civil protection technical solutions (related to water level monitoring; dyke monitoring; dyke defence/enforcement and rescue equipment/techniques) was identified: upgrading of the existing hydrotechnical network, adequate and sufficient resources (devices/tools/techniques), a better telecommunication infrastructures, expanding real-time communications networks; personnel availability, well-trained staff, innovation in terms of existing solutions; decentralized material and logistic support in vulnerable areas, response capacity building, well-trained staff and more training activities, volunteers; decentralized material and logistic support, response capacity building, well-trained staff, adequate and sufficient resources (devices/tools/techniques).

The results obtained from the RDI Monitoring activity, including literature review and DAREnet KB search, have shown that currently, the available solutions for water level monitoring are generally classical including well-known fixed hydrometrical gauge stations and only in a few places mobile water level gauges. In terms of dyke monitoring the available solutions are the visual observations, while regarding the dyke defence/enforcement the sand bag dykes are generally used. Relating to rescue equipment/techniques, the boats, helicopters, floating transporters and big wheel transporter units are available solutions.

Results from the synchronization of practitioner needs and solution monitoring it was identified some gaps which can be seen as innovation opportunities. The main solutions identified as innovative for this TWG are given below:

- Water level monitoring: automatic water level monitoring with sensors and systems for mobile measurements;
- Dyke enhancement: self-inflating sandbags, inflatable dams filled with water, MOBILDEICH dykes;
- Dyke monitoring: remote sensing for dyke monitoring;
- Rescue equipment/techniques: drones, accurate, reliable and secure communication system for critical situations.

4.5 TWG "Communication"

4.5.1 Relevance of the RDI Topic

Using effective and secure communication system is important during incidents and crisis situations because it is vital for information exchange and situation awareness for all PPDR entities involved in field and remotely in command centres. Ineffective communications or breakdowns in the information conveying channels is considered to be one of the most significant reason for inadequate or failed response to natural disasters such as flooding. The interoperability among different systems has to be ensured to avoid problems with equipment incompatibility and to provide a way for inter-organization and cross-border collaboration. Except technical issues including different frequency bands or various radio interfaces, formats of exchanged data and even a language or terminology can pose a problem for the reliable communication among first responders. Interoperability among radio systems is also a way to increase the communication availability (the resulting coverage is a superposition of coverages from all networks) and reliability (even if some networks are unavailable, the others can provide services). The interoperability does not assume that all services and applications have to be portable among systems. In majority of cases voice communication is a sufficient service to protect citizens, provide relief and to ensure safety during disasters. However, data exchange has become more and more importance for fast multimedia data exchange (e.g. maps, plans and images from action theatre). That is why there is a tendency to deploy broadband PMR systems. Such systems have to provide both voice and data services with mission critical guarantee.

4.5.2 Practitioner Needs

According to the information gathered the most common problem regarding communication technologies is the connection itself. The respondents enumerated the following gaps:

- Signal outrages and interruptions,
- Communication breakdowns,
- No transfer rate,
- Capacity problems during large scale incidents,
- No secured non-public communication system,
- Disconnection of fixed and mobile public networks,
- Infrastructure failure (landlines or electricity),
- Communication systems are not linked between institutions (practitioners).

There were also other problems identified, for example different responding forces on local and regional level are not well interlinked due to different modes of operation, warning systems, incompatible technology. This might be connected with another problem, which is an unequal access to information due to the availability and knowledge of modern technologies.

Apart from the survey, there were also needs identified during face-to-face meetings, discussions and researches. Currently, a choice of devices to gain immediate access to the information is demanded. The major practitioners' needs include:

- Interoperability for voice and data transmission between different systems and also between systems of the same standard that are manufactured by different producer;
- Broadband data transmission;
- Mission critical services, especially for voice;
- Communication procedures that are common for all organizations;
- Broadband frequency channels;
- Business models for optimal acquisition of new networks to find a trade-off between cost and features:

  - Dedicated networks — an organization builds its own network infrastructure, or the build is done by a commercial operator based on a turnkey contract. the new network can be operated by the organization or by a commercial operator,
  - Commercial networks — commercial operator(s) use(s) public network(s) operated in order to provide services with a required quality of service (QoS),
  - Hybrid networks— any mix of the above;
- High reliability and availability of networks and services;
- Uninterruptible power back-up for more than 30 hours;
- Challenges we have to face refer to flow of information, especially:
  - Data from a control centre to personnel attending an incident,
  - Data from an incident scene back to a control centre,
  - Communication between vehicles and an incident scene,
  - Communication between individuals on site,
  - Communication inside tunnels, buildings or basements,
  - Access to information from the internet or other external data sources.

4.5.3 Available Solutions

There are some communication systems currently available on the market. These are for example:

- **TETRA** is the communications standard of choice for organisations or groups that require immediate access to reliable, secure communications. TETRA is perfectly suited to the support of scenarios where the security and reliability of communications is priority.
- The **PUMA T4** family introduces a new concept of handheld device, with a modular design combining reliable and secure communications with new value-added services that greatly enhance efficiency in daily operations and emergency situations. An Android based general purpose core provides computing, and MMI functions integrated with radio communication provided by a modem component that can be delivered in different versions.
- **DMR** is the ETSI standard for digital radio communications. It introduces a 2 slot TDMA channel access feature, doubling the communication capability and making simultaneous and data applications possible. DMR solutions operate on VHF at UHF frequency bands, featuring a full-IP system architecture and are IOP certified for primary vendors DMR terminals.
- **CSP** (Communication Service Platform) is an implementation of the Next Generation Network designed for the professional sector, including PMR/LMR users such as first responders, Police and defence. CSP aims to combine the best of both solutions, by delivering the features enjoyed by the commercial environment with the adaptability, scalability and performance of the professional environment.
- **IN-PREP** will create a tool called the **Mixed Reality Preparedness Platform** to facilitate interoperability, merge decision support mechanisms with ‘at-a-glance’ visualisation and integrate situational awareness with real time information.

4.5.4 Innovation opportunities

The most important and immediate need is to improve the quality and reliability of the signal to avoid outrages and connection failures. First responders who understand and trust their communication networks feel safer and more confident.

Apart from the questionnaire, there have been a couple of possible innovations identified:

- MCPTT functions in mobile systems - more strict requirements for such a transmission have been defined as additional QoS Class Identifiers (QCI) as compared to ones existing now for VoLTE services,
- Voice service for group calls and D2D communication on the basis of IP protocol,
- Multimedia Push-to-X services,
- Mobile Virtual Network Operator (MVNO) for sub-set of services,
- Repeater/relay stations,
- Interoperability gateways,
- Systems based on 3G/4G/5G standards,
- Encryption,
- Uninterruptible Power Supply (UPS),
- Frequency management.

4.5.5 Lessons Learnt

To summarize the Communication section of the questionnaire, there was 49 responds in this topic when the total number of responds was 52. Respondents shared information about the warning systems used in their organisation or country on different levels, what kind of system it is, what kind of application is necessary to use this communication solution. There was also question about the experiences related to the communication technologies and solutions and problems with misinformation or even fake news.

As with the warning systems, the most entities use electronic sirens, radio, TV, means of public information, other inform about crisis situation via phone and e-mail and specific application such as Nina or MoWaS App. The systems work on various levels: local, regional, national, international. The following diagram shows the number of warning system on each range level.

The communication systems used in the respondents' organizations and countries vary. For voice communication the most commonly used is public fixed telephone networks and public mobile networks, while for data communication local area network and wireless local area. Figure 8 presents the summary of communication system used in respondents' organisations and/ or countries.

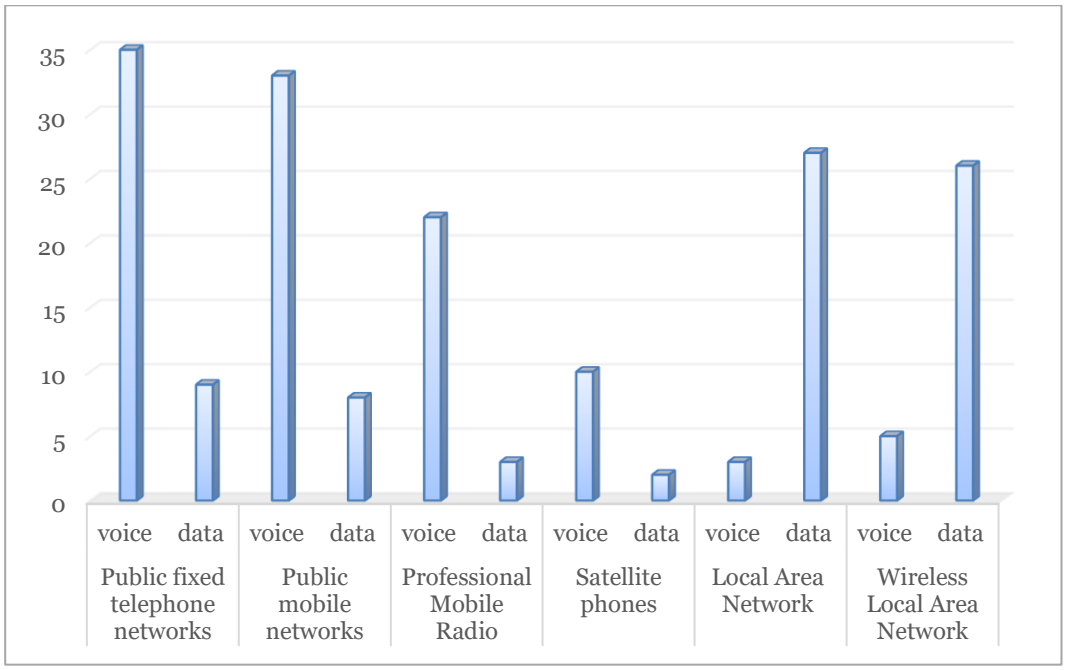

Figure 8: Communication systems used.

In the survey there was a question regarding the PMR technology and the most popular is TETRA disaster management. Respondents enumerated also LAN, PMR446, ASTRID, analogue-digital system and DMR system.

The respondents were also asked to indicate the applications for which communication solutions are used. The great majority used public fixed telephone networks, public mobile networks, and professional mobile radio and satellite phones for Situational Awareness. Local area network and wireless local area network were used mostly for the access to databases. Another conclusion can be drawn, that the satellite phone are used the least in general while landlines and mobile networks the most often. The summary of the answers are presented in Figure 9.

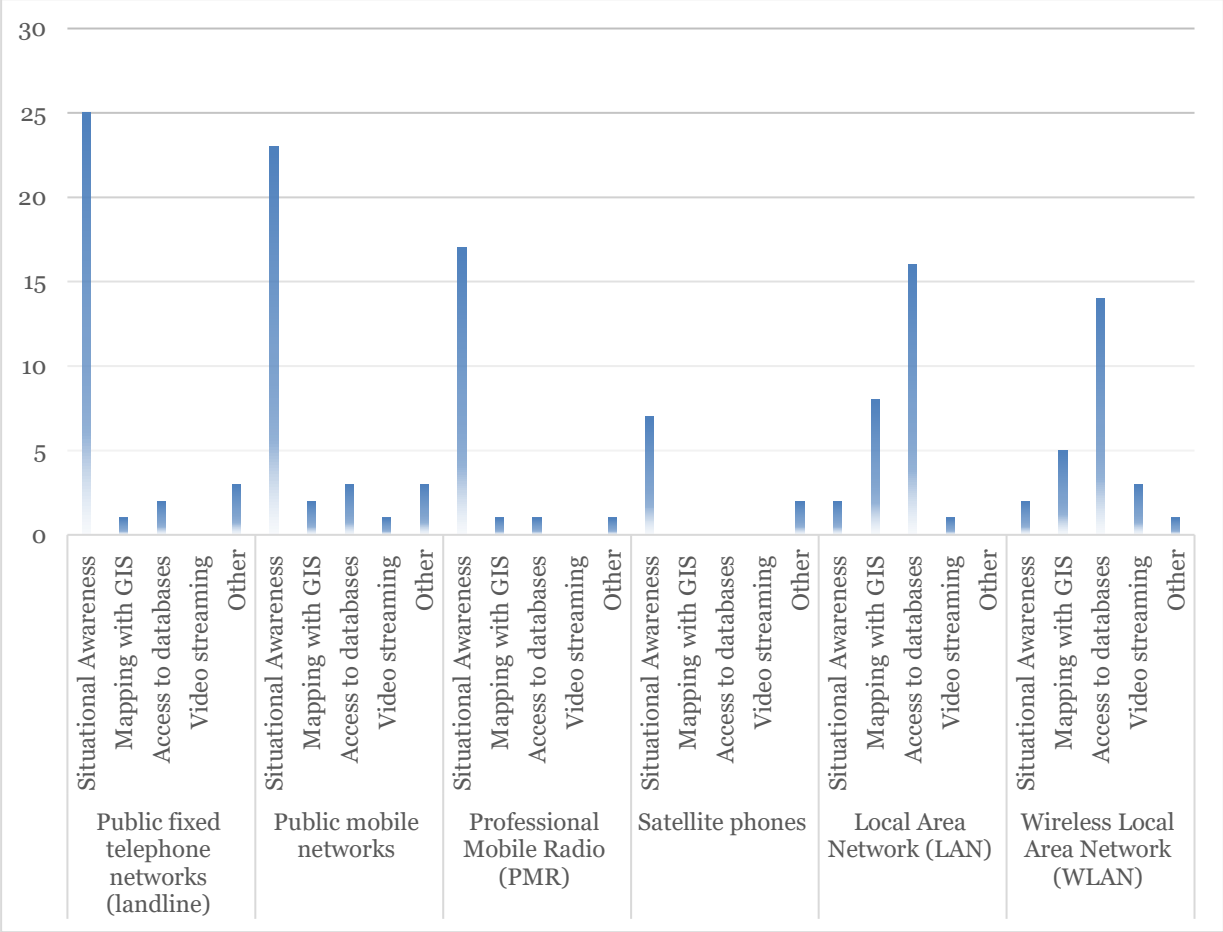

Figure 9: Applications for which communication solutions are used.

According to the questionnaire results, only 29% of the respondents involved in the survey have ever used satellite-or airborne based information about flood events such as images, processed data of flooded areas or digital terrain models. These are systems such as:

- Copernicus system,
- Flood warning and forecasting system (Povapsys – SHMÚ),
- SRTM 1 Arc-Second Global elevation,
- Landsat images,
- Digital terrain models,
- UAV images and video,
- GIS based data, within the MHP.

Another fact established thanks to the survey is that intentional or unintentional misinformation, or so called ”Fake News” are quiet often since as much as 30% respondents encountered this kind of situation. Since these outcomes are derived from a sample, the survey just indicates a trend, but doesn’t represent robust results.

4.6 TWG "General Data Management"

4.6.1 Relevance of the RDI Topic

Efficient decision support tools in flood management highly depend on reliable information. Especially in response to floods, a fast and sound assessment of the current situation as well as forecast regarding upcoming actions must be accessible by those at the scene. Therefore, a lot of various data is needed to enhance the process of decision making. Managing and sharing data respectively information is a key challenge for all PPDR entities either in the field or remotely in command centres in all phases of disaster management. However, invalid or outdated information, inefficient or misdirected information distribution, or missing information are the most significant examples of issues that entities are faced with when dealing with data management and thus, are considered to be main reasons beside communication issues (cf. section 4.5.1) for inadequate or failed response to natural disasters such as flooding.

Further aspects of inefficient data management often refer to the availability of different data sources, which can lead to problems when information is not consistent or – in worst case scenarios – is mutually contradictory. In this context, the occurrence of rumours and so called "Fake News" increased significantly in the last few years and thus, posed additional challenges for the PPDR entities when assessing the actual situation on the scene.

Beside organizational and content-related issues, also technical issues play an important role in data management. Crucial ones are different formats of exchanged data, another language or terminology that can raise problems for the interoperability between different systems and thus, for a reliable data exchange between various stakeholders.

4.6.2 Practitioner Needs

According to the responses gathered from the practitioner's survey, communication and data management are strongly interlocked. For this reason, a lot of respondents mentioned communication-related gaps such as 'communication breakdown' (e.g. failure of mobile network/WiFi connection), 'redundant network of communication', 'insufficient speed and data flow capacity', or even 'communication' itself as problems when asked for issues they have encountered in case of sharing data or information. Directly related to the topic of general data management, the respondents enumerated the following issues for which they see potentials for improvements:

- Availability of information,
- Validity and actuality of information,
- Reliability of information,
- Selection and filtering of relevant information,
- Supply of information to the right addressee at the right time,
- Different data formats and sources,
- Interoperability and connectivity between various systems.

Other problems that relate specifically to the topic of flood management were identified as well, as for instance the lack of knowledge about flood data, which makes it difficult for unexperienced practitioners to interpret data or information even if they are available, and the lack of software based simulation tools to model flooding and its progress. According to this, a lack of training or workshops, but also a lack of (modern) equipment and (experienced) staff were mentioned as well.

Apart from the survey, Table 17 enumerates practitioner needs that were identified during face-to-face meetings, discussions and researches. Since these issues relate to different aspects of data management, we decided to cluster them according to the following subtopics:

- Accessibility,
- Pooling,

- Management,
- Standardisation,
- Visualisation.

Table 17: Summary of practitioner needs related to "General Data Management".

Subtopics	Practitioner Needs

Accessibility	• Availability and reliability of data / information
	• Access control, identification, authentication and authorization procedures
	• Availability of reliable and resilient telecommunication infrastructures
	• (Personal) terminals /devices to ensure data flow between personnel at the scene and the control centre
	  ○ to distribute data from a control centre to personnel attending an incident
	  ○ to provide data from an incident scene back to a control centre
	  ○ to gain immediate access to information from the internet or other external data sources
	• Operated /maintained interfaces to secure data exchange
	• Intuitive user management (usability / handling)

Pooling	• Accessibility to a (centralized) data pool • Diversity of data respectively accessibility to multi-sided trans-sectoral data markets (containing e.g. water level data, geo-referenced (infrastructural) data or social/demographic data) • Reliability of data / information (avoiding "Fake News")
Management	• Intelligent management systems • Support of information distribution • Data exchange on national and transnational level • Integrated systems supporting information collection (storage) and compiling processes
Standardisation	• Standardisation of data formats • Provision and usage of (common) open standards • Consideration of global context (exchange formats, languages, consistency, compatibility, etc.) • Interoperability between different systems • Extension and optimisation of existing standards
Visualisation	• Technical front-end / user-interface with adequate visualisation • Independence from operating systems and languages (multi-lingual interface) • Following user experience (UX) principles: responsive design / intuitive handling • Provision of 3D visualisation, virtual / augmented Reality • Real-time visualisation

4.6.3 Available Solutions

Based on researches and literature review, we identified the following solutions which are already available on the market related to the subject of "General Data Management" – here again, we clustered our findings according to the subtopics mentioned in section 4.6.2:

4.6.3.1 Accessibility

- General Principles:
  - **Access Control:** Access control is a security feature to control, restrict, monitor and protect communication and interaction between users (subjects) and systems / resources respectively between different systems/resources among each other. Subjects are active entities (i.e. not only human users, but also programs and processes) that request access to a resource (e.g. computer, database, file, and another program) or the data within a resource. Common access control practices are for instance: access deny to systems by undefined users or anonymous accounts, limitation and monitoring of users by administrators, enforcement of strict access criteria and password rotation.
  - **Security principles**: Identification, Authentication and Authorization are security principles. Identification describes a method to ensure that a subject is the entity that it claims to be (e.g. a specific user name or an account number). Authentication is a method to prove the subjects identity (e.g. by providing a password, a passphrase, a personal identification number (PIN), memory cards and smart cards, as well as more often biometrics such as fingerprints or other unique personal attributes or behaviours). And authorization is a method to control the access of objects by the subject (e.g. restrictions that prevent a user from deleting particular files).
  - **Data Licences**: A central element of data management is the definition of conditions under which data are to be shared. These conditions are specified by a data licence or terms of use for each data set. A data licence should cover three aspects:
    - Attribution, i.e. citation of the owner of the data on products in which they are used),
    - Modification, i.e. conditions that users of the data must comply with when altering the data set or combining it with other data) and
    - Redistribution, i.e. permissions that users have to redistribute the data or any derived works once they have accessed them, and whether they may be used for commercial purposes.
  - **Open Source Software**: Open source software is software with source code that anyone can inspect, modify, and enhance.[77] However, Open Source does not just mean access to the source code. The distribution terms of open-source software must comply with specific criteria as defined by the Open Source Initiative[78].
  - **Open Data**: Open data and content can be freely used, modified, and shared by anyone for any purpose.[79]
  - **Big Data**: Big Data technologies are a combination of several analytical techniques and processing methods and enable the analysis of vast quantities of information within useable and practical timeframe. Some key technologies that enable Big Data analytics are predictive analytics, knowledge discovery tools, stream analytics, NoSQL databases, in-memory data fabric,

[77] https://opensource.com/resources/what-open-source

[78] https://opensource.org/osd

[79] http://opendefinition.org/od/2.1/en/

distributed storage, data virtualisation, data integration, data pre-processing and data quality analytics.[80]

- **NoSQL Databases**: NoSQL databases are utilised for reliable and efficient data management across a scalable number of storage nodes. NoSQL databases store data as relational database tables, JSON docs or key-value pairings.[81]
- **Internet of Things (IoT):** The Internet of Things is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.[82]
- **Cloud Computing**: Cloud computing is a general term for the delivery of hosted services over the internet that enables companies to consume a compute resource, such as a virtual machine (VM), storage or an application, as a utility rather than having to build and maintain computing infrastructures in house.[83]

- **GeoNode** (www.geonode.org): GeoNode is a web-based application and platform for developing geospatial information systems (GIS) and for deploying spatial data infrastructures (SDI). It allows users to browse and search for geospatial data and web services, to upload, manage, and share geospatial data and to create and share interactive maps with other users. The software is free of charge but requires installation and customisation. Metadata authoring tools are also included.
- **CKAN** (http://ckan.org/): CKAN is a web-based data and metadata-sharing platform. It makes data accessible by providing tools to streamline publishing, sharing, finding and using data.
- **QGIS** (www.qgis.org/): QGIS is a desktop-based GIS software that provides features for data editing, manipulation and conversion. Free extensions can be used to automate some parts of metadata creation.
- **ArcGIS** (http://www.arcgis.com/): ArcGIS is a mapping and analytics platform provided by the Environmental Systems Research Institute (ESRI). It offers location-based spatial analytics and provides contextual tools to visualise and analyse imagery and remotely sensed data, and allows the collaboration and information sharing with others user via maps, apps and reports.

4.6.3.2 Pooling (centralised data pools)

- **EM-DAT** (https://www.emdat.be/): In 1988, the Centre for Research on the Epidemiology of Disasters (CRED) launched the Emergency Events Database (EM-DAT). The main objective of the database is to serve the purposes of humanitarian action at national and international levels. The initiative aims to rationalise decision making for disaster preparedness, as well as provide an objective base for vulnerability assessment and priority setting. EM-DAT contains essential core data on the occurrence and effects of over 22,000 mass disasters in the world from 1900 to the present day. The database is compiled from various sources, including UN agencies, non-governmental organisations, insurance companies, research institutes and press agencies.
- **DesInventar** (https://www.desinventar.net/): DesInventar is a conceptual and methodological tool for the generation of National Disaster Inventories and the construction of databases that capture information on damage, loss and general effects of disasters. It can be used as Disaster Information Management System to collect,

[80] https://www.marutitech.com/big-data-analytics-will-play-important-role-businesses/

[81] https://www.marutitech.com/nosql-big-data/

[82] https://internetofthingsagenda.techtarget.com/definition/Internet-of-Things-IoT

[83] https://searchcloudcomputing.techtarget.com/definition/cloud-computing

document and analyse data and thus, to evaluate the disaster trends and their impacts in a systematic manner. DesInventar is an open-source initiative with various instances installed over the world.

- **GAR Risk Data Viewer** (https://risk.preventionweb.net/capraviewer/): The GAR Risk Data Viewer is an interactive web-based data platform that provides the global risk data from the Global Assessment Reports on Disaster Risk Reduction released by the UNISDR every two years. The global risk analysis presented is based on a joint effort by leading scientific institutions, governments, UN agencies and development banks, the private sector and non-governmental organizations.
- **PREVIEW** (http://preview.grid.unep.ch/): The PREVIEW Global Risk Data Platform is a multiple agency effort to share spatial data information on global risk from natural hazards. Users can visualise, download or extract data on past hazardous events, human & economical hazard exposure and risk from natural hazards. It covers tropical cyclones and related storm surges, drought, earthquakes, biomass fires, floods, landslides, tsunamis and volcanic eruptions.
- **Aqueduct** (http://floods.wri.org/): The Aqueduct Global Flood Analyzer is a web-based interactive platform which measures river flood impacts by urban damage, affected GDP (Gross Domestic Product), and affected population at the country, state, and river basin scale across the globe. It also allows users to project future flood risk with three climate and socio-economic change scenarios.
- **Hazards Mapper** (http://sedac.ciesin.columbia.edu/mapping/hazards/): The Hazards Mapper is provided by the Socioeconomic Data and Applications Center (SEDAC). It enables users to visualize data and map layers related to Socioeconomic, Infrastructure, Natural Disasters, and Environment and to analyse potential impacts and exposure. The web application mashups layers from various sources including SEDAC, NASA LANCE, NASA GIBS, USGS, NOAA, ESRI, and others. SEDAC provides also the **Data Visualization and Access Tool** that lets users view and download the "Global Man-made Impervious Surface" (GMIS) and "Global Human Built-up And Settlement Extent" (HBASE) data sets by country, tile, shapefile, rectangle or polygon. Data are available at 30m, 250m, and 1km resolutions in either geographic or UTM projection.
- **Global Hazard Atlas** (https://disasteralert.pdc.org/disasteralert/): The Global Hazard Atlas is provided by the Pacific Disaster Center. However, this data viewer allows access to near real-time and historical data on natural hazards around the globe including tropical cyclones, volcanic eruptions, earthquakes, tsunamis, floods, and wildfires. Users can combine this hazard data with a range of other information such as population, infrastructure, and critical facilities.
- **NOAA** (https://maps.ngdc.noaa.gov/viewers/hazards/): The NOAA Global Natural Hazards Data Viewer allows spatial visualisation of tsunami events, tsunami observations, significant earthquakes, and significant volcanic eruptions. Data is sourced from the National Centers for Environmental Information (NCEI), which archives and assimilates tsunami, earthquake and volcano data to support research, planning, response and mitigation.
- **DFO** (http://floodobservatory.colorado.edu/): The Dartmouth Flood Observatory (DFO) conducts global remote sensing-based fresh water measurement and mapping in near real-time and records such information into a permanent archive. The DFO collaborates with humanitarian and water organisations in partnerships for gathering such information. By using both remote sensing and modelling, the DFO performs also hydrological research in the area of surface water variability and develops flood maps based on sensor data from various institutions (e.g. NASA MODIS[84], Landsat[85], ESA's Sentinel-1 and Sentinel-2[86], Radarsat[87], COSMO-SkyMed[88], EO-1[89]).

84 https://modis.gsfc.nasa.gov/data/

85 https://landsat.gsfc.nasa.gov/data/

86 https://sentinel.esa.int/web/sentinel/home

- **GDACS** (http://www.gdacs.org/flooddetection/): The Global Flood Detection System (GDACS) monitors floods worldwide using near-real time satellite data. Surface water extent is observed using passive microwave remote sensing. When surface water increases significantly, the system flags it as a flood. Time series are calculated in more than 10,000 monitoring areas, along with small scale flood maps and animations.
- **EAA** (https://www.eea.europa.eu/): The European Environment Agency provides information on the environment for those involved in developing, adopting, implementing and evaluating environmental policy, and also the general public. In close collaboration with the European Environmental Information and Observation Network (Eionet) and its 33 member countries, the EEA gathers data and produces assessments on a wide range of topics related to the environment. Data products provided include for example:
  - *European Past Floods*[90]: Dataset contains information on past floods in Europe since 1980, based on the reporting of EU Member States for the EU Floods Directive (2007/60/EC) and combined with information provided by relevant national authorities and global databases on natural hazards. Reported data have been assessed and processed by the European Topic Centre on Inland, Coastal and Marine waters[91] (ETC-ICM) and the EEA.
  - *WISE EIONET Spatial Data Sets*[92]: The Eionet spatial data sets include information about European river basin districts, river basin district sub-units, surface water bodies, groundwater bodies and monitoring sites. The data sets are part of the Water Information System for Europe (WISE), and compile information reported by the 39 EEA Member and cooperating countries to the European Environment Agency (EEA) since 2001.
  - *WISE WFD reference Spatial Data Sets*[93]: The Water Framework Directive[94] (WFD) reference spatial data sets include information about European river basin districts, river basin district sub-units, surface water bodies, groundwater bodies and monitoring sites used in the first and second River Basin Management Plans (RBMP). The data sets are part of the Water Information System for Europe (WISE), and compile information reported by the EU Member States and Norway to the European Commission (EC) and the European Environment Agency (EEA) since 2010.
- **Eurostat** (https://ec.europa.eu/eurostat/data/database): Eurostat is the statistical office of the European Union and provides statistics from a wide range of themes for Europe. Eurostat's key role is to supply the Commission and other European Institutions with data so they can define, implement and analyse Community policies. For this purpose, Eurostat offers a whole range of data that governments, businesses, the education sector, journalists and the public can use for their work and daily life.
- **ECMWF MARS** (https://www.ecmwf.int/): The Meteorological Archival and Retrieval System (MARS) is provided by the European Centre for Medium-Range Weather Forecasts (ECMWF), which is both a research institute and a 24/7 operational service, producing global numerical weather predictions and other data for their members and co-operating states as well as the broader community. The Cen-

87 http://www.asc-csa.gc.ca/eng/satellites/default-eo.asp and http://www.asc-csa.gc.ca/eng/satellites/disasters.asp

88 http://www.e-geos.it/cosmo-skymed.html

89 https://eo1.gsfc.nasa.gov/

90 https://www.eea.europa.eu/data-and-maps/data/european-past-floods

91 https://icm.eionet.europa.eu/

92 https://www.eea.europa.eu/data-and-maps/data/wise-eionet-spatial

93 https://www.eea.europa.eu/data-and-maps/data/wise-wfd-spatial-1

94 http://ec.europa.eu/environment/water/water-framework/index_en.html

tre has one of the largest supercomputer facilities and meteorological data archives in the world. The ECMWF operates two services from the EU Copernicus Earth observation programme: the Copernicus Atmosphere Monitoring Service (CAMS) and the Copernicus Climate Change Service (C3S); and also contributes to the Copernicus Emergency Management Service (Copernicus EMS). It is foreseen that data from the GloFAS system can be directly downloaded from ECMWF MARS from Q4 2018 on.

- **Copernicus CDS** (https://cds.climate.copernicus.eu/#!/home): The Copernicus Climate Data Store (CDS) is a service provided by Copernicus EMS. It provides a single point of access to a wide range of quality-assured climate datasets distributed in the cloud. CDS datasets include observations, historical climate data records, estimates of Essential Climate Variables (ECVs) derived from Earth observations, global and regional climate re-analyses of past observations, seasonal forecasts and climate projections. Access to data is open, free and unrestricted. Along with the data, the CDS includes a set of tools for analysing and predicting the impacts of climate change. Users of the CDS can access these tools to develop their own applications online.

4.6.3.3 Information Management Systems

- **Copernicus EMS** (http://emergency.copernicus.eu/): The Copernicus Emergency Management Service (Copernicus EMS) provides information for emergency response in relation to different types of disasters, including meteorological hazards, geophysical hazards, deliberate and accidental man-made disasters and other humanitarian disasters as well as prevention, preparedness, response and recovery activities. The Copernicus EMS is composed of an on-demand mapping component providing rapid maps for emergency response and risk & recovery maps for prevention and planning and of the early warning and monitoring component which includes systems for floods, droughts and forest fires:
  - Copernicus EMS – Mapping,
  - European and Global Flood Awareness System (EFAS and GloFAS),
  - European Forest Fire Information System (EFFIS),
  - Drought Observatory.
- **EFAS** (https://www.efas.eu/): The European Flood Awareness System (EFAS) is an European system monitoring and forecasting floods across Europe. EFAS is an operational service under the umbrella of Copernicus EMS and is fully operational since October 2012. It provides complementary, flood early warning information up to 10 days in advance to its partners: the National/Regional Hydrological Services and the European Response and Coordination Centre (ERCC). It consists of four centres executed by different consortia:
  - EFAS Computational centre – executed by European Centre for Medium-Range Weather Forecasts (UK) – provides forecasts and hosts the EFAS-Information System platform;
  - EFAS Dissemination centre – executed by Swedish Meteorological and Hydrological Institute, Rijkswaterstaat (NL) and Slovak Hydro-Meteorological Institute – analyses EFAS on a daily basis and disseminates information to the partners and the ERCC;
  - EFAS Hydrological data collection centre – executed by REDIAM (ES) and ELIMCO (ES) – collects historic and real-time discharge and water level data across Europe;
  - EFAS Meteorological data collection centre – executed by KISTERS AG and Deutscher Wetterdienst – collects historic and real-time meteorological data across Europe.
- **GloFAS** (http://www.globalfloods.eu/): The Global Flood Awareness System (GloFAS) combines state-of-the art weather forecasts with a hydrological model. With its continental scale set-up it provides downstream countries with information on upstream river conditions as well as continental and global overviews. It produces dai-

ly flood forecasts in a pre-operational manner since June 2011 and is able to predict floods up to two weeks in advance.

- **UNIDSR** (https://www.unisdr.org/we): The United Nations Office for Disaster Risk reduction (UNISDR) provides practical services and tools such as the risk reduction website PreventionWeb, publications on good practices, country profiles and the Global Assessment Report on Disaster Risk Reduction which is an authoritative analysis of global disaster risks and trends.
- **PreventionWeb** (https://www.preventionweb.net/): PreventionWeb was launched by the UNISDR and provides a platform for the disaster risk reduction community to find and share information and to connect with the community, including the development of information exchange tools to facilitate collaboration. The platform also provides a Knowledge Base including a collection of global reports on disaster statistics as well as disaster data and risk profiles that can be filtered by hazards or regions respectively countries.
- **WISE** (https://water.europa.eu/): The Water Information System for Europe (WISE) is a partnership between European Commission (DG Environment, Joint Research Centre and Eurostat) and the European Environment Agency. It provides a gateway to information on European water issues and comprises a wide range of data and information collected by EU institutions. WISE fosters the following central access points to related data pools:
  - The *Water Data Centre (*www.eea.europa.eu/themes/water/dc), hosted at the European Environment Agency (EEA), provides a central access point to several web-services: interactive maps, data viewers, European datasets and indicators. These services are mostly based on reporting from countries as part of implementation of EU directives or via the Eionet framework.
  - The *Water Statistics* website hosted at Eurostat (https://ec.europa.eu/eurostat/web/environment/water) gives access to the results of the reporting from countries to the Eurostat/OECD Joint Questionnaire on Inland Waters.
- **ESS** (https://ec.europa.eu/eurostat/web/european-statistical-system): The European Statistical System (ESS) provides reliable and comparable statistics at EU level. The ESS is a partnership between the Community Statistical Authority (i.e. the EU Commission namely Eurostat), and the National Statistical Institutes (NSI) and other national authorities responsible in each EU Member State for the development, production and dissemination of European statistics. The Member States collect data and compile statistics for national and EU purposes. The ESS functions as a network in which Eurostat's role is to lead the way in the harmonization of statistics in close cooperation with the national statistical authorities. ESS work concentrates mainly on EU policy areas – but, with the extension of EU policies, harmonization has been extended to nearly all statistical fields.

4.6.3.4 Standards

- **OGC Standards** (www.opengeospatial.org): The Open GeoSpatial Consortium (OGC®) is an international non-profit organisation providing open standards for the global gepospatial community for the purpose to improve sharing of geospatial data. OGC standards are already common practice in Emergency Response and Disaster Management and are used by a variety of organisations such as government, commercial organisations, NGOs, academia and research institutes.
- **ISO Standards**: The International Standardisation Organisation (ISO) provides international (world-wide) standards (so called ISO standards) on a wide range of subjects. Among them also standards related to disaster management (e.g. ISO/TR 19083-1:2016(en), “Intelligent transport systems — Emergency evacuation and disaster response and recovery — Part 1: Framework and concept of operation”) and emergency management (e.g. ISO 22320:2011, “Societal security – Emergency management – Requirements for incident response” or ISO 22326:2018(en), “Security and resilience — Emergency management — Guidelines for monitoring facilities with identified hazards”). ISO standards provide requirements, specifications,

guidelines or characteristics that can be used to ensure that materials, products, processes and services meet their purposes.

- **EN Standards:** The Comité Européen de Normalisation (CEN) provides European Norms (so called EN standards), which have the characteristic of an independent standard if it is not possible to adopt existing ISO standards in an unmodified form (see ISO EN standards). EN standards related to disaster management are for example EN 1846-2:2009+A1:2013, "Firefighting and rescue service vehicles – Part 2: Common requirements – Safety and performance" or EN 16836-1:2016, "Communication systems for meters – Wireless mesh networking for meter data exchange – Part 1: Introduction and standardization framework".
- **National standards (e.g. DIN Standard)**: National standards such as standards from the German Institute for Standardisation (DIN) or the American National Standards Institute (ANSI) exist for products, services and processes that are not addressed by standards at international (ISO/EN) level or in case if there is no requirement to have such a standard at international level (i.e. for specific national demands). For instance a DIN standard exists for German terms and definition in firefighting and fire protection (DIN 14011, "Feuerwehrwesen – Begriffe").
- **EN ISO / DIN ISO / DIN EN / DIN EN ISO Standards**: These standards are standards that have been adopted unchanged at European level from ISO (EN ISO), or at national level (e.g. Germany) from ISO (DIN ISO, DIN EN ISO) respectively from EN standard (DIN EN). For instance: EN ISO 19157:2013, "Geographic information – Data quality (ISO 19157:2013)" and EN ISO 19128:2008, "Geographic information – Web map server interface (ISO 19128:2005)".

4.6.3.5 Technical Front-end support solutions

A variety of open-access front-end solutions providing visualisations for end-users is already available on the market. Most of them are services from the above mentioned information and data management systems:

- EFAS Map Viewer
  http://new-efas-test.ecmwf.int/efas_frontend/#/home
- GloFAS Forecast Viewer
  http://www.globalfloods.eu/user-information/forecast-viewer-info/
- GAR Risk Data Viewer
  https://risk.preventionweb.net/capraviewer/
- PREVIEW Global Risk Data Platform
  http://preview.grid.unep.ch/
- Aqueduct Global Flood Analyzer
  http://floods.wri.org/
- SEDAC Hazards Mapper
  http://sedac.ciesin.columbia.edu/mapping/hazards/
- Global Hazard Atlas
  https://disasteralert.pdc.org/disasteralert/
- NOAA Natural Hazards Viewer
  https://maps.ngdc.noaa.gov/viewers/hazards/
- DFO River Watch
  http://floodobservatory.colorado.edu/AMSR-E%20Gaging%20Reaches/IndexMap.htm
- GDACS Global Map
  http://www.gdacs.org/flooddetection/global_map.aspx
- Copernicus EMS Mapping
  http://emergency.copernicus.eu/mapping/

4.6.4 Innovation opportunities

The use of data and information during disaster management is increasing rapidly since an understanding of location and place is a vital component of effective decision making. From

the research on available solution we found out that a lot of needs, which practitioners raised in relation to the topic 'General Data Management' within our survey, are already covered by solutions on the market. The evolution of technology has allowed public and private sector organizations to capture, store, and analyse data in a structured way, open data initiatives foster the access to various data sources and standardization efforts have been undertaken in order to harmonize the data formats and system structures (cf. section 4.6.3). However, from the survey we recognised that different countries are at very different stages in terms of the development, sophistication and use of their data / information infrastructures. This is likely due to the reason that the usage of adequate solutions highly depends on the national framework and its interconnected national limitations from legal, resource and financial constraints. There is a risk that not all countries are or will be in a position to invest in and realise the full potential of data and information management for governments, businesses and citizens. International institutions such as the United Nations have an increasingly important role in helping to minimise this risk, communicating the value and importance of **investing in and developing an authoritative and maintained (centralised national and international) data base** and reducing the prospect of any 'digital divide' emerging. Corresponding approaches such as the Emergency Events Database EM-DAT, the UNISDR PreventionWeb or the Water Information System for Europe (WISE) are already operationally deployed.

A number of important technology driven trends are likely to have a major impact in the coming years, creating previously **unimaginable amounts of location referenced information**. For instance, citizens with no recognised expertise in geospatial information, and who are unlikely to even be familiar with the term, are increasingly using and interacting with geospatial information; indeed in some cases they are contributing to its collection – often in an involuntary way (so called crowdsourcing effect). Good examples are the mapping service OpenStreetMap[95] or the disaster management related tool CrowdTasker[96], which was developed by the Austrian Institute of Technology and which contributes to information collection during actual disaster events by volunteers who send up-to-date information (e.g. free text, photos, and assessments) from the scene.

The huge quantities of data that are already generated, and the increasing amounts of data that are likely to be created, will bring a **requirement for enhanced data management systems**. An associated trend to address this problem is the increasing use of and reliance on 'Big Data' technologies, i.e. **technologies that enable the analysis of vast quantities of information within useable and practical timeframes**. Technology is already available to deal with big data, but the reliance on this kind of technology must grow in the next years. The **demand for real-time information and real-time modelling** increases and presents major challenges. Nevertheless, techniques such as graphical processing units (GPUs), NoSQL and powerful in-memory SQL databases will meet the demand for integrated spatial and non-spatial analytics in orders of magnitude less elapsed time. Moreover, **massively-scalable, distributed systems for processing unstructured and semi-structured data** emerge. Use of these technologies will facilitate the effective use of raw data being generated by the increasing number of sensors, eliminating the bias of excessive data and **enabling to locate the right information at the right time**, thus driving effective and well-informed decision-making. Again, there is a risk of a digital innovation divide emerging. Technologies, and the financial resourcing required to access such technologies, are not available equally across the globe. Although many developing nations have bypassed in areas such as mobile communications, the **lack of fibre-optics and core processing power** may inhibit from taking advantage of the opportunities offered by some of these technologies.

The developments highlighted offer significant opportunities but also present **challenges, both in terms of policy and in terms of law**. Meeting these challenges and ensuring

95 https://www.openstreetmap.de/

96 https://crowdtasker.ait.ac.at/

that the potential benefits can be realised by all countries will be important in ensuring that the full value of available data and information can be maximised in the upcoming years.

Ensuring that the full value of data and information management is realised in the coming years will also rely on having the necessary training mechanisms in place. **New and changing skills will be required to manage the increasing amount of data / information** that is likely to be created and to ensure that the maximum value is secured from it.

Governments will continue to have a key role in the provision of relevant data and information in case of disaster management and be substantial users of those data; however, governments' role in data management may change. Building bridges between organisations, collaborating with other areas of the community and **providing frameworks with trusted, authoritative and maintained data**, will be crucial to ensure that users have **access to reliable information** and have confidence when using it (avoiding rumours and "Fake News"). This information is vital to inform decision making, from long-term planning to emergency response, and to ensure that the potential benefits of a fully spatially enabled society are realised. In this context, organisations – at both national and international level – responsible for the **development of standards for use in acquiring, implementing, maintaining and using data**, play an important role as well. At an international level these are led by the Open Geospatial Consortium (OGC®) and the International Organization for Standardization (ISO®) in partnership with many broader technology standards organisations to ensure interoperability. The standards developed by these organisations enable **interoperability throughout the community and improve access to data across the world**. Development of additional standards and complementary tools to best use these standards will be required to keep pace with changing technologies and practices.

Regarding the access to information, open-source solutions are likely to grow significantly as a viable alternative to proprietary suppliers. The open source geospatial community, for instance, already has a well-established infrastructure through the Open Source Geospatial Foundation (OSGeo)[97]. The drive by governments towards **greater acceptance of open-source solutions** may remove many of the perceived barriers to wider adoption, as the value will grow as more users adopt these solutions and will feed back improvements.

The trend of moving from two dimensional (2D) **mapping through to three dimensional (3D) and on to four dimensional (4D) visualisations** is both user- and technology-driven. Users are likely to expect ever more complex and realistic 3D models, particularly of cities, to enable effective planning and management and to optimise resources. The use of the fourth dimension is also likely to increase in geographic information systems (GIS) with providing **'time' functionality as an additional dimension** alongside conventional x-, y- and z-coordinates. This provides users the ability to view the past **in order to understand change that has already taken place**, but **will also enable predictive modelling of future trends**. Effectively managing real-time information, but also effectively archiving time-referenced data, will become an increasingly important technique in the management of data over the coming years.

To sum up, despite the solutions already available on the market according to "General Data Management", we could identify a whole bunch of possible innovation opportunities. The following list includes technologies and main aspects that can be seen as innovation opportunities in an aggregated way:

- Opportunities in technology and data creation, maintenance and management
  - Big Data, No SQL
  - Linked data and Internet of Things
  - Cloud Computing
  - Open Source
  - Open Standards
  - 3D and 4D visualisation

97 https://www.osgeo.org/

- Data quality
- Opportunities in legal and policy developments
  - Open Data
  - Investment, funding, licensing, pricing
  - Privacy concerns
  - Standards and policies
  - Liability and data assurance
- Opportunities in skills requirements and training mechanisms
  - Formal mechanisms for skill development
  - Visualisation skills
  - Education and advocacy
  - Research and Development
- Opportunities in the role of the private and non-governmental sectors
  - Open access
  - Crowdsourcing
  - New technologies and models
  - Partnerships
- Opportunities in the role of governments in data provision and management
  - Coordination and collaboration
  - Connectivity and interoperability
  - National data/information infrastructures and data bases
  - Trusted, authoritative and maintained data / information

4.6.5 Lessons Learnt

4.6.5.1 Results from the Survey

From the survey and the responses dedicated to “General Data Management” we found out that practitioner currently mostly share data and information via ‘Voice’ (i.e. one-to-one conversation or using telephone) or ‘Text’ (i.e. messages, printed documents). Only a few actually use Software for this purpose (cf. Figure 10). The same applies for the usage of Software as support for situational awareness and decision making (cf. Figure 11).

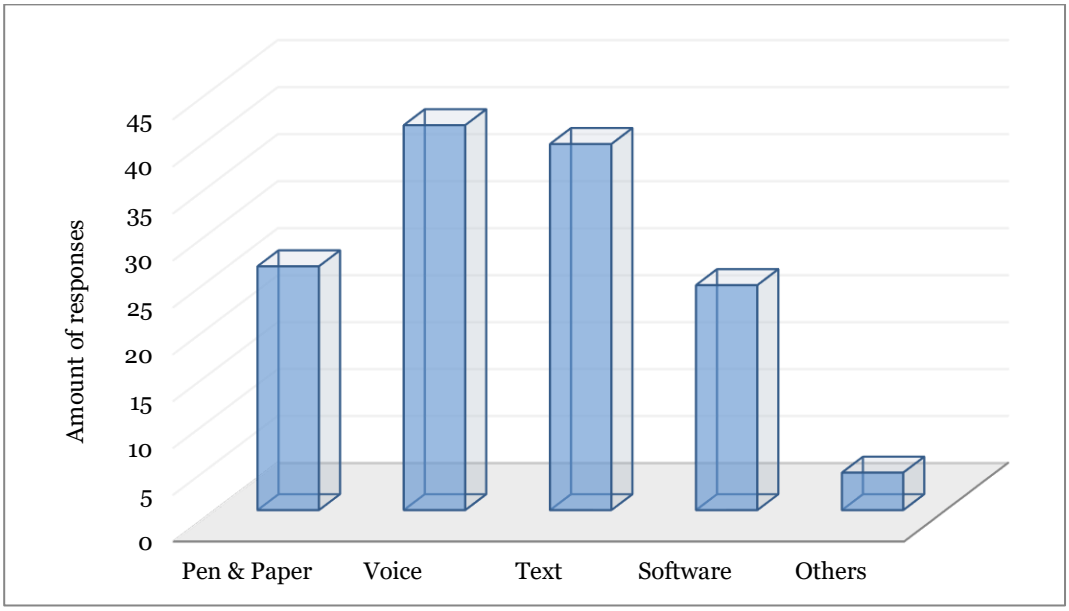

Figure 10: Responses to survey question “How do you share data / information during flooding events?”

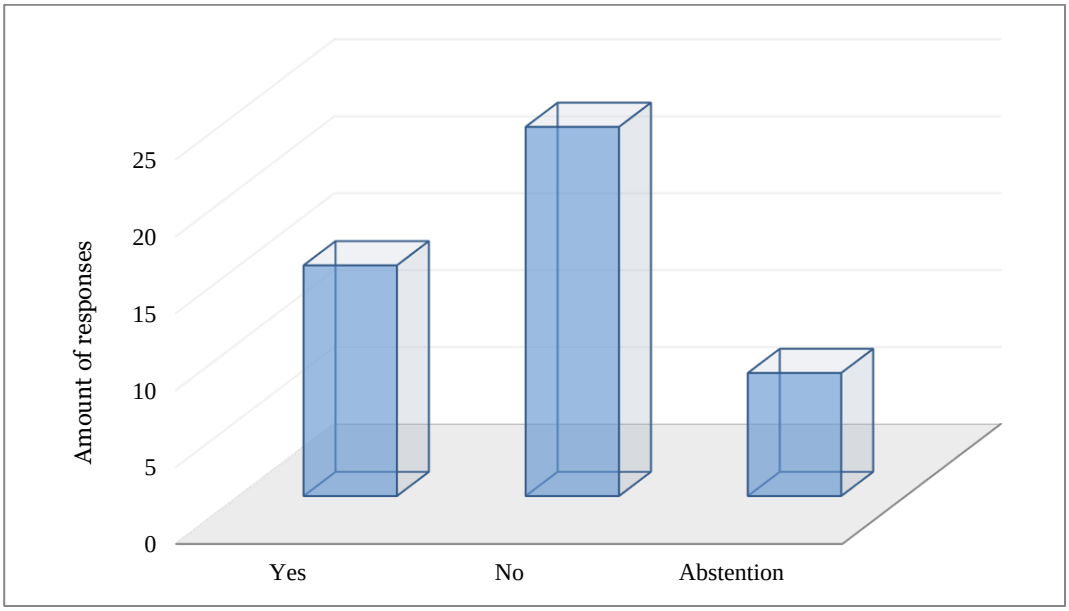

Figure 11: Responses to survey question "Do you use support software for situational awareness or decision making?"

Looking at these results, it was not surprising that in most cases, the practitioners mentioned the availability of information as a major issue that they encounter during operation respectively where they see needs for improvements.

A further lesson learnt was the way practitioners actually visualize available data and information (cf. Figure 12). On the scene, most of them use classical graphical tools such as sketches, but also smart phones and tablets to visualize information they get from the command post. In the command post, practitioners still prefer analogue tools such as paper maps and white boards, followed by (TV) screens. In the situation rooms paper maps and white boards are also used, but for a better situational awareness (TV) screens and screen walls are preferably used by most of the practitioners.

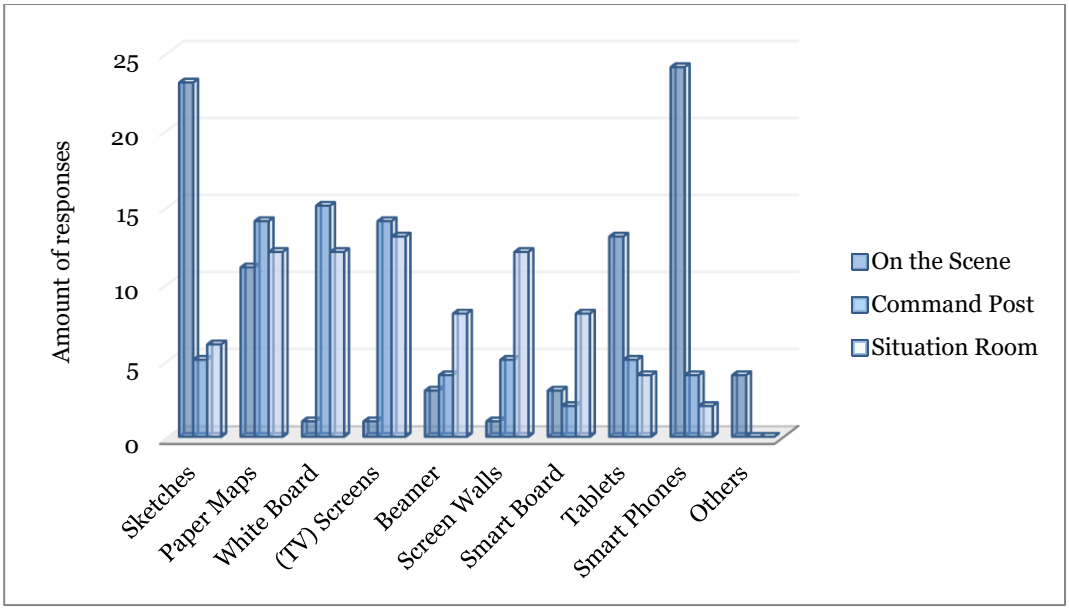

Figure 12: Responses to survey question "How do you visualize the data / information?"

Information visualisation and presentation enhances the situational awareness and understanding of current situations. A lot of solutions are already available on the market. However, regarding the practitioner's responses in the survey, it seems as if practitioners feel a

lack of solutions that address their specific requirements and national specialities which results in the usage of classical tools as support for the visualization of the current situation.

In this context, it was also obvious from the survey that for example different responding organizations and forces on local and regional level are not well interlinked due to different modes of operation and incompatible technology. This might be connected with another problem, which is an unequal access to data and information due to the availability and knowledge of modern technologies. This issue is also evident when comparing the practitioner's responses from the different countries that were involved in survey (cf. Table 18).

Table 18: Practitioner responses from survey related to "General Data Management" and separated by countries.

Country	Survey Responses from Practitioners
Bulgaria	- No support SW for situational awareness/decision making - Information / data sharing mainly by 1.) Voice, 2.) pen&paper, 3.) Text and SW - On the scene: no tablets/smartphones on the scene - At command post: paper maps and screens are mostly used - In the situation room: paper maps and white boards are mostly used
	Needs: no special issues / needs mentioned
Croatia	- Support SW for situational awareness/decision making is partly used (GIS, e.g. ZeOS, and River Water Level Monitoring) - Information/data sharing by 1.) voice, 2.) text, 3.) pen&paper and 4.) SW - On the scene: sketches as well as smartphones are mostly used - At command post: white boards and paper maps are mostly used - In the situation room: screens and screen walls are mostly used
	Needs: availability of communication network, validity/relevance of information, communication network performance (data flow, speed, interoperability, connectivity), information sharing
Germany	- Support SW for situational awareness/decision making is partly used, but varies considerably according to sector - All information/data sharing possibilities are used similarly - On the scene: sketches and paper maps are mostly used - At command post: white boards and screens are mostly used - In the situation room: screen walls are mostly used
	Needs: availability of communication network, standardized data formats and sources, actuality and validity/relevance of information
Hungary	- Support SW for situational awareness/decision making is partly used (GIS, e.g. GIS Arcview) - Information / data sharing by 1.) pen&paper, 2.) voice and text, 3.) SW (seems to be used only on strategic command level) - On the scene: sketches, smartphones and tablets are mostly used - At command post: paper maps and screens are used - In the situation room: paper maps, white boards, screens and screen walls are used
	Needs: visualisation (e.g. pictures and videos) of damaged area/location
Romania	- Support SW for situational awareness/decision making is only used in research field (GIS, e.g. Sahana Eden) - Information / data sharing by 1.) text, 2.) voice, 3.) SW (research!), 4.) pen&paper - On the scene: smartphones, tablets and sketches are used - At command post: screens and paper maps are used - In the situation room: white boards, paper maps and screens are used
	Needs: availability of communication network (Telephone and internet), connectivity with other services (e.g. Sahana Eden Database with ArcGIS)

Serbia	- Support SW for situational awareness/decision making is partly used (GIS, e.g. Google Earth) - Information/data sharing by 1.) voice and text, 2.) pen&paper and 3.) SW - On the scene: smartphones, tablets and sketches are used - At command post: paper maps and screens are used - In the situation room: paper maps, screens and white boards are used
	Needs: relevance of information, pre-selection of information, more education/training/workshops, more (modern) equipment, more competent staff
Slovakia	- Support SW for situational awareness/decision making is used (GIS, e.g. Flood Maps, Flood Plans, Risk Maps) - Information/data sharing by 1.) voice and text, 2.) pen&paper and 3.) SW - On the scene: smartphones and tablets are mostly used - At command post: white boards are mostly used - On the situation room: paper maps and screens are mostly used
	Needs: flood process modelling and simulation tools

4.6.5.2 Conclusion

Access to data and information is critical to successful flood management since they play a key role in understanding the impacts and costs of disasters. Systematic data collection and analysis can be used to support decision making process, to help reduce disaster risk and build resilience. The availability of systematic data helps to ensure that the disaster response process is both effective and impactful. However, disaster management is an extremely data-intensive process, when looking at the different types and possible sources of data (e.g. geospatial data, imagery and remote sensed data, infrastructure data, population data, socio-economic data, weather forecast, meteorological and hydrological data, etc.), and may involve accessing information from a wide range of stakeholders, including mapping agencies, scientific and technical ministries from across government, universities, research institutions and the private sector. Therefore, it is crucial to efficiently organise and manage the data as they come in, as well as to efficiently distribute the results to relevant participants and stakeholders. For this purpose, data management must also govern the process by which data are gathered from participating entities, the technical and quality standards to which new data will be produced, how data will be maintained, and the means by which the output data will be shared or secured.

Improper data management or limiting access to data can lead to duplication of effort (e.g. other organisations may be recreating data that already exist). A well-structured and organised data management can help encourage stakeholders to share their data and ensure that the processes for sharing data are effective and transparent. This will increase the value of the investment in the data and build trust in the results of the disaster management process based on this data.

5 Conclusions

The present deliverable D4.2 describes the current status of entries within the DAREnet Knowledge Base separated according to the relevant topics “Solutions from Research and RDI Projects”, “Solutions on the Market”, “Best Practices and Lessons Learnt” as well as “Flood History and Background Information” at the end of the first DAREnet roadmapping cycle. Moreover, the deliverable gives the final findings of work from each DAREnet Topic Working Group related to the selected RDI Topics of the first cycle. These topics are “Civil Protection Training”, “Resilience of Citizens”, “Spontaneous Volunteers”, “Civil Protection Methods, Procedures and Technology”, “Communication” as well as “General Data Management”. The results are summarized in form of detailed reports that are clustered under the aspects of “Relevance of the RDI Topic”, “Practitioner Needs”, “Available Solutions”, “Innovation Opportunities” and “Lessons Learnt”. The expertise within the TWG was collected through intensive research and with the help of the DAREnet National Contacts (DNC) through expert interviews with national actors of disaster management using a survey. The data were subsequently reviewed and analysed.

A key result from the work of WP4 within the first DAREnet roadmapping cycle is the derivation of innovation opportunities, which will provide a direct input for the next step in the roadmapping cycle, where the identified results will be taken up by the Innovation Assessment done in WP5. The main goal of WP5 is to assess and prioritise the innovation opportunities in the DAREnet Knowledge Base and to prepare the first version of the RDI Roadmap.

From the findings presented within the present deliverable, we could derive a set of criteria for evaluating the relevance of potential innovations, which we want to recommend as basis for the assessment process done in WP5. These criteria are:

- Relevance,
- Availability,
- Comprehensibility,
- Reliability,
- Actuality,
- Interoperability,
- Connectivity,
- Compatibility,
- Scalability,
- Sustainability,
- Usefulness,
- Suitability.

The enumerated criteria are more or less generally applicable quality measures that offer benchmarking regardless of innovation type or character.

Annexes

Survey for DAREnet's First Roadmapping Cycle

Questionnaire for DAREnet's first cycle.

Fields marked with * are mandatory.

Welcome practitioner!

DARE net

Danube River Region Resilience Exchange network

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 740750.

DAREnet is a five year project funded under the European Commission's Horizon 2020 framework programme. DAREnet will bring together flood management practitioners across the EU Danube River region and from different disciplines and will support them to deepen and broaden their Research, Development and Innovation related collaboration.

DAREnet's main objectives are:

Establishing a Practitioner Community in the Danube region

DAREnet will build a dynamic multi-disciplinary community of practitioners, operating in a network of civil protection organisations. The network will be supported by a broad range of stakeholders from policy, industry and research. Together they will build an interdisciplinary ecosystem to foster synergies, innovation and its uptake across the Danube Region.

Connecting National Practitioner Networks

DAREnet will be organised as a network of national Practitioner networks, led by DAREnet National Contacts (DNC), in charge of mobilising and involving their national communities into the region-wide DAREnet Community.

Facilitating Innovation Strategies to Enhance Region-Wide Flood Resilience

1

DAREnet will deliver an annual roadmap highlighting promising innovation opportunities to cope with the main environmental and societal challenges of the region. The DAREnet Roadmap will lay the basis for concrete innovation initiatives, practitioner-driven and "bottom-up", building a unique portfolio of joint innovation concepts for the Danube river region. Both, Roadmap and Initiatives, will be proactively promoted towards national and European Policy Makers to support future innovation strategies in the region.

To be successful it is vital for DAREnet to get intouch with the practitioners and become aware of their needs.

About this survey

What is this survey about?

You have been contacted in your capacity as a practitioner in the field of flood management. At this time, we are interested in your knowledge and opinions about questions regarding

- Civil Protection Methods, Procedures and Technology;
- Civil Protection Training;
- Communications;
- General Data Management;
- Spontaneous Volunteers;
- and the Resilience of Citizens;

in the context of flood management (especially river floods and flash floods).
Your knowledge will help us to compile an overview of already available solutions and identify possible gaps, since this is a major aim of the DAREnet project. Even if you provide input only to single aspects, this will be a huge contribution aiming at a sustainable improvement of the resilience towards floods.

Who is carrying out the survey?

This non-commercial survey is conducted by the DAREnet project, intended for the use within the project and its acquisition of knowledge, needs and challenges to identify innovation opportunities. If you have any questions regarding this project or this survey, please feel free to contact the Project Coordinator using the email specified below.

How will the collected data be used?

The information collected in this survey will be used for the ongoing DAREnet project. Based on the data provided by you, current gaps and future innovation opportunities will be identified. Any personal data will be anonymized. The personal data that you provide allows us

- to inform you of the results from the questionnaire,
- ask specific questions regarding your answers if needed
- or send you other relevant DAREnet project results.

Personal information you provide will not be published. You will also have the option to respond anonymously if preferred. The anonymised and compiled data will be available to DAREnet stakeholders as well as all participants who wish to participate in this collaborative effort via the Community Management Tool (referred to as the CMT). More information concerning the CMT can be found at https://cmt.eurtd.com/ as well its Terms of Service, which can be found at https://cmt.eurtd.com/terms.

2

How will my privacy be maintained?

All collected personal data will be treated confidentially and in accordance with the European General Data Protection Regulation 2016/679 ('GDPR'). Personal data will be stored securely, with access granted only to those responsible for handling/processing this data. The collected raw data will be anonymised before being used in any project reports, resulting publications or before being uploaded onto the CMT. Consequently, reports and publications will not contain any information which can identify any individuals. At the end of the project's timeframe (the project runs from 01/09/2017 until 31/08/2022), all collected data will either be deleted or anonymised. Anonymised data might be kept for an unlimited period of time.

Further, as a participant you have the right to withdraw from the survey at any time, without providing us with any reason for your withdrawal.

Why should I participate?

Darenet aims at a sustainable improvement of flood resilience. Therefore, DAREnet should become aware of your (practitioner) needs as well as already existing solutions to match these among the countries / civil protection organisations in the Danube river region. This way DAREnet can communicate needs towards decision makers and identify innovation opportunities and support practitioner starting new initiatives / projects.

Further information

If you have any further questions about this survey or wish to find out more about our project, do not hesitate to contact:

DAREnet Project Coordinator
Dr Christian J. Illing
THW Headquarters
Provinzialstr. 93, 53127 Bonn, Germany
Email: Project.DAREnet@thw.de

By ticking the box below, I confirm the following:

- I have read and understood the introduction with the participant information, and wish to participate in the described study;
- I understand that I can stop the survey at any time;
- Data from it may be used as described above;
- I do not expect to receive any benefit or payment for my participation;
- I have been enabled to ask any questions I may have and understand that I am free to contact the project contact person with any questions that I may have in the future.

☐ *I accept your Terms

Personal Information (voluntarily)

Your private details may be helpful when searching for certain needs or solutions. For future DAREnet activities we also plan to involve members of the Community to participate in workshops and meetings, and if we know how to reach out we may get in touch you.

3

In general these information will not be shared publically and the statistical evaluation of the data will be fully anonymous.

Here you can provide your name:

And your email address:

Civil Protection Experience

This information will be kept strictly anonymous.

However, for the evaluation of the questionnaire we will need get an idea of the experience and expertise of the responding community. Therefore, please provide your personal civil protection, crisis management or flood management background.

Thank you!

Please name the country your contributions are referring to:

- Germany
- Austria
- Slovakia
- Hungary
- Croatia
- Serbia
- Romania
- Bulgaria
- None of the above mentioned (-> International)

Please be so kind and provide the country you are referring to:

* Please name your organisation

* Indicate your experience as practitioner

- less than 2 years
- 2-5 years
- 5-10 years
- 10-15 years
- 15-20 years

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- ○ more than 20 years

On which command/operational level are you usually serving?

- ○ operational (e.g. on-site responder)
- ○ operational (command; e.g. on-site leader/commander)
- ○ tactical (command; e.g. at command post or silver level)
- ○ strategic (command; e.g. at situation room; crisis management staff or gold level)

*What is your primary role regarding flood management?

- ○ Flood Protection (e.g. dyke defense)
- ○ Firefighting
- ○ Coordination, Command and Control
- ○ Search and Rescue
- ○ Water Rescue
- ○ Emergency Medical Service
- ○ Sheltering and Care
- ○ Law Enforcement
- ○ Administration / Policy Making
- ○ Private consultant
- ○ Industry Representative / Provider of Commercial Solutions
- ○ Research
- ○ Other

If your role is not mentioned above, please describe it:

50 character(s) maximum

Do you have additional roles regarding flood management? *(multiple selections are possible)*

- ☐ Flood Protection (e.g. dyke defense)
- ☐ Firefighting
- ☐ Coordination, Command and Control
- ☐ Search and Rescue
- ☐ Water Rescue
- ☐ Emergency Medical Service
- ☐ Sheltering and Care
- ☐ Law Enforcement
- ☐ Administration / Policy Making
- ☐ Private consultant
- ☐ Industry Representative / Provider of Commercial Solutions
- ☐ Research

Civil Protection Methods, Procedures and Technology

5

Practitioners highly depend on the presence of appropriate methods and procedures in case of floods. On the one hand, good procedures provide a way to effective communication by applying consistent standards and practices. On the other hand, by implementing the best and innovative methods and solutions we could improve flood risk management.

Do you know distinct methods / procedures / technologies within your organization to cope with floods with regards to:

	yes	no
...water level monitoring?	○	○
...dyke monitoring?	○	○
...dyke defense/enforcement?	○	○
...evacuations from flooded areas using boats?	○	○
...evacuations from flooded areas using other assets?	○	○

Good to hear that there are already existing concepts. Please provide some more information to enable a comparison within the Danube river region.

More information on:

...water level monitoring:

...dyke monitoring:

...dyke defense/enforcement:

...evacuations from flooded areas using boats:

6

...evacuations from flooded areas using other assets:

Did you encounter any issues using these methods/procedures/technologies?

- yes
- no

If so, please name the method/procedure/technology and describe the issue briefly:

Civil Protection Training

The implementation of civil protection tasks in a constantly changing social environment requires continuous capacity building. The challenge of educating qualified personnel needs to be addressed with training and concepts for using proper equipment.

Do you know any specific training programme regarding…

	yes	no
… swift water rescue?		
… use of boats in flood rescue?		
… use of other vehicles in flood rescue?		
… use of technical equipment (here chainsaws)?		
… use of technical equipment (here pumps)?		
… flood prevention and damage reduction (dyke defense)?		
… sheltering of evacuees / responders during floods?		
… flood rescue crisis managment training for strategical and tactical level?		

7

Good to hear about these trainings!

Please be so kind and provide some more information (especially; Provider; title of the training; duration)

Further Information on:

...swift water rescue:

...use of boats in flood rescue:

...use of other vehicles in flood rescue:

... use of chainsaws:

...use of pumps:

... flood prevention and damage reduction (dyke defense):

sheltering of evacuees / responders:

... flood rescue crisis managment training for strategical and tactical level:

8

Communications

Using effective and secured communication systems is vital for information exchange and situational awareness in flood management.

Are warning systems used in your organization or your country to alert the public and responders?

- ☐ local level (municipality)
- ☐ regional level
- ☐ national level
- ☐ international level

Please name those warning systems used on...

...local level (municipality):

...regional level:

...national level:

...international level:

What communication systems do you use? *(select all that apply)*

	voice communication	data communication
Public fixed telephone networks (landline)	○	○
Public mobile networks	○	○
Professional Mobile Radio (PMR)	○	○
Satellite phones	○	○
Local Area Network (LAN)	○	○
Wireless Local Area Network (WLAN)	○	○

9

Please indicate the PMR technology(e.g. wavelength or TETRA, etc) used by your organization:

Please indicate the applications for which you use those communication solutions:

	Situational Awareness	Mapping with GIS	Access to databases	Video streaming	other
Public fixed telephone networks (landline)	○	○	○	○	○
Public mobile networks	○	○	○	○	○
Professional Mobile Radio (PMR)	○	○	○	○	○
Satellite phones	○	○	○	○	○
Local Area Network (LAN)	○	○	○	○	○
Wireless Local Area Network (WLAN)	○	○	○	○	○

Have you encountered any gaps with regards to communication technologies or solutions in the past?

Have you ever used satellite-or airborne based information about flood events such as images, processed data of flooded areas or digital terrain models?

- ○ yes
- ○ no

If 'yes', please specify:

During your duty, have you ever encountered intentional or unintentional misinformation, or so called "fake news"?

- ○ no
- ○ yes

How have you dealt with this?

10

General Data Management

Efficient decision support tools in flood management highly depend on reliable information. Especially in floods, a fast and sound assessment of the current situation as well as forecast regarding upcoming actions must be accessible by those at the scene. Therefore, a lot of various data sets are needed to enhance the process of decision making. Managing these data sets is a key challenge and thus, requires further exploration.

How do you share data / information during flooding events?

- ☐ pen & paper
- ☐ voice
- ☐ text (e.g. SMS, instant messaging, e-mail)
- ☐ software applications
- ☐ others

if you choose others please explain briefly:

How do you visualize the data / information?

	on the scene	at the command post	in the situation room
Sketches	○	○	○
Paper maps	○	○	○
"white board style" situation maps	○	○	○
(TV) screens	○	○	○
beamer	○	○	○
screen walls	○	○	○
Smart board	○	○	○
Tablets	○	○	○
Smart phones	○	○	○
others	○	○	○

if you choose others please explain briefly:

11

Do you use support software for situational awareness or decision making?

- yes
- no

Please share the name and provider of the software with us:

What issues have you encountered when sharing data / information? What needs improvement in your opinion?

Spontaneous Volunteers

Flood management and response entails many labour-intensive and enduring tasks. This often challenges civil protection structures. Therefore, spontaneous volunteers can be a huge relief to responders.

Note: Spontaneous volunteers are "just" citizens willing to help. They are not related to any organization and have not received any preparatory training nor equipment. Typical civil protection responders are either professionals or volunteers engaged in dedicated organizations. They also received proper training and preparation, as well as the adequate equipment to reduce their personal risk.

Do you have any experience with spontaneous volunteers?

- yes
- no
- I am not familiar with the concept of spontaneous volunteers

If yes, did you encounter any problems or challenges?

- yes
- no

Please describe briefly

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Are there any trainings/procedures to prepare you for the involvement of spontaneous volunteers that you know of?

- yes
- no

Please provide some more information on trainings/procedures to prepare for the work with spontaneous volunteers (e.g. Name of the course, provider and duration)

Resilience of Citizens

Enhanced flood resilience allows better planning to reduce disaster losses. Through effective flood precautionary measures hazards can be minimized. To reduce the negative impacts of floods, proactive investments and policy decisions are needed to reduce loss of lives and costs. According to this, enhancing the resilience of citizens is of major importance.

Do you know about any public information campaigns regarding floods?

	yes	no
… to raise general flood awareness?		
… to encourage people to prepare for floods as individuals?		

Do you know about education materials (e.g. guides, recommendations) for citizens regarding preparation for floods?

	yes	no
… to inform citizens about available resources regarding floods (e.g. access to explained flood risk maps)?		
… to improve citizens' preparedness for floods (e.g. checklists)?		
...for schools and teachers to educate children and teenagers to be prepared for floods?		

In case that you are aware of such materials, please be so kind and provide some more information. (at best; title, provider, URL, etc.)

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...to learn about available resources:

...to improve the preparedness:

...educational material for schools and teachers:

Anything you want to add?

Thank you so much for your valuable time!

As the very last part of this long questionnaire we offer you the opportunity to provide us with any information that you would like to share with us.
This might be any need, challenge or even idea to improve flood management in the region for the future.

If you share an idea, make sure that you leave your contact details. This way we can get in touch when we start supporting practitioner driven initiatives.

Your comments:

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