Secure Dynamic Cloud for Information, Communication and Resource Interoperability based on Pan-European Disaster Inventory

Deliverable 2.1 **Overview of Disaster Events, Crisis Management Models and Stakeholders**

Revised version

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Executive summary

SecInCoRe Deliverable *D2.1 Overview of Disaster Events, Crisis Management Models and Stakeholders* provides a first overview of disaster events, crisis management models, and stakeholders.

The work documented here begins to develop criteria for the kinds of disaster events that would be useful to include in a pan-European inventory that forms the basis for the design of a common information space and the kind of information about the disasters that should be incorporated. The aim is to assemble an initital list of categories, definitions and criteria for the production of a pan-European disaster inventory and to develop a deeper understanding of the context in which the SecInCoRe project is to make a productive, ethically, legally and socially circumspect, innovative and useful contribution to collaborative and cross-border disaster response. The insights, categories, and definitions for the inventory developed in this deliverable are produced through a mixed methods approach that combines literature reviews with reviews of existing disaster databases, analyses of disaster events, crisis management models and stakeholders undertaken by members of the project consortium in previous collaborative national and EU projects, and construction of a selective collection of reports about disaster events across Europe and relevant non-European disasters.

At the heart of the document is a series of 19 case studies structured by an information template we have designed based on a comparative analysis of the case studies, literature reviews and practitioner incident report sheets. The categories in this template capture a varying range of information about the disaster, including stakeholders, crisis management models, types of data used or needed, problems encountered, lessons learned and general overviews and timelines of past disaster responses. From these case studiescases and the literature reviews we have conducted, we have identified a set of core themes and insights into collaboration difficulties, communication problems, and information needs – especially inter-agency and cross-border response efforts in relation to major incidents, serious or catastrophic emergencies and disasters. These themes are discussed in relation to one another in chapter three, and they generate a first list of relevant factors to consider when developing a research programme for the Pan-European inventory of disaster events, including crisis management models and processes, information flows, stakeholders, business models and ethical, legal, and social issues (ELSI). Drawing on the case studies as well as relevant academic literature, some key lessons learned and ELSI are identified so they can help structure the inventory design with a view to supporting the creation and use of common information spaces by practitioners, supported by advanced ICT, including the SecInCoRe secure dynamic cloud concept for information, communication and resource interoperability.

The document ends with a first conceptualization of potential shapes the SecInCoRe Pan-European inventory might take, who its users might be, and what modes of use they may bring to the inventory. There are four main ideas, ranging from a more qualitative database of past disasters to complement existing database resouces such as the Emergency Events Database (EM-DAT), the CAST project Database on Emergency Response Major Incidents (DERMI), the European Major Accident Reporting System (EMARS), ARIA: Lessons Learnt From Industrial Accidents and

ZEMA Informationssystem zum Stand der Sicherheitstechnik (Information System about the Status of Safety Technology) to a community resource, gateway, and library of potentially useful information systems and data-sets. These concepts directly respond to the challenges, gaps and problems identified in this overview of disaster events, crisis management models, stakeholders and cross cutting ELSI. They are meant to contribute to the design of technological solutions and a conceptual integration of technologies that can support construction of common information spaces and enable first responders to cooperate more effectively, to mobilise and utilise relevant stakehoders and information dynamically and to practice situated and 'just-in-time' learning.

The work presented first of all provides input for the development of a Pan-European Inventory, including:

- A first set of contents for the **Pan-European Inventory** along with criteria for what disasters and details will be useful to include in such an inventory
- A deeper understanding of the user needs the inventory responds to, the socio-technical context into which the inventory should fit, and opportunities and challenges for its design and implementation that match these needs and contexts.

It also contributes to the other three high-level objectives of the project, by providing:

- A baseline overview of current practices and current difficulties of establishing and utilising **Common Information Spaces**,
- Insight regarding current (and future!) technological limitations, user needs, and affordances for **Conceptual Integration of Available Technology**
- A first set of criteria to evaluate the usefulness of SecInCoRe socio-technical innovation as part of the **Validation and Evaluation** efforts in the project.

Table of contents

1 Introduction

For many Europeans, just-in-time lifestyles involve a seemingly frictionless supply of goods and services. But complex and highly interdependent energy, transport, finance and communications infrastructures and networks are required to make this possible (Melucci 1997; Urry 2002; Urry 2007). Many of these infrastructures are ageing and beyond capacity, the responsibilities for their co-ordination and maintenance are fragmented, and the contexts for their operation are becoming more volatile. Together with an increase in extreme weather events, technological and geo-political complexity and the occurrence of accidents and crime, this has resulted in increased frequency of disasters worldwide, and the 21st Century has been characterised as the Century of Disasters following a Royal Society report (eScience 2012). Within the EU alone, each year since 1997 has seen over 20 environmental disasters, with over 90 occurring in 2000, 2002 and 2005 (Figure 1, see also Edwards 2009).

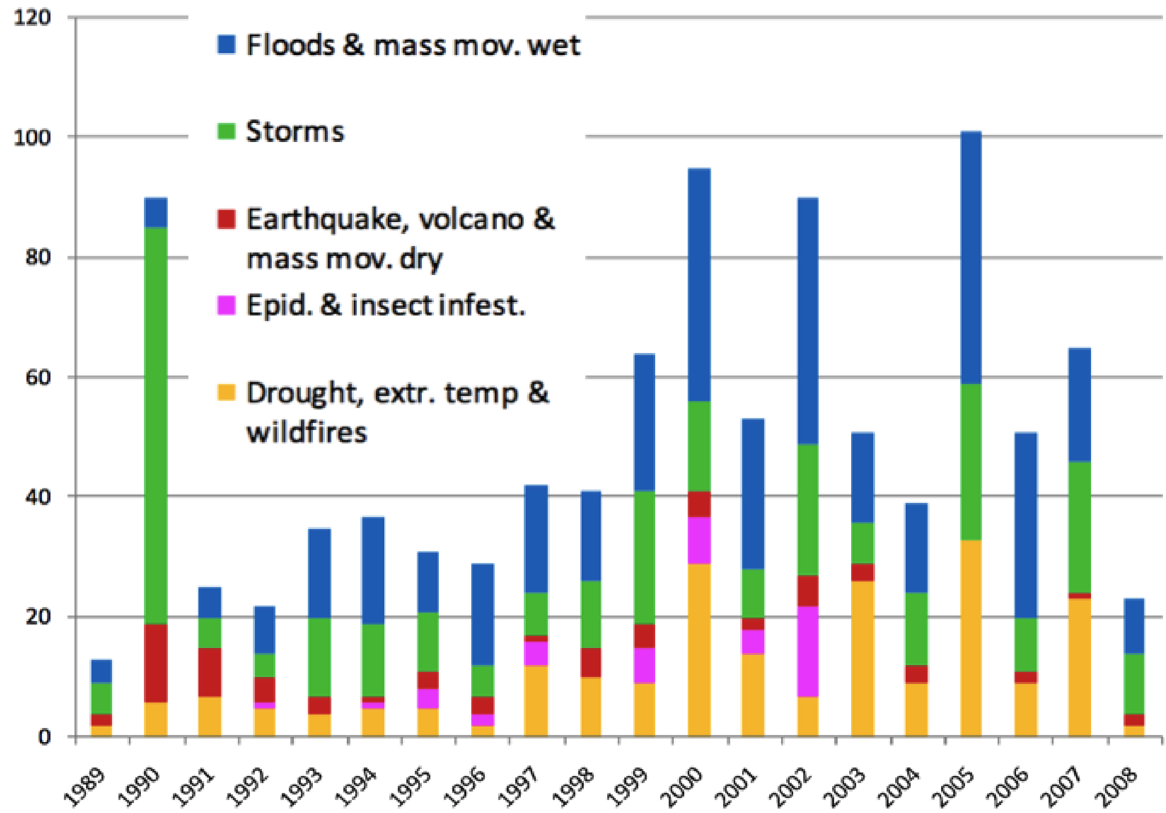

Figure 1 Occurrence of Disasters in Europe, 1989-2008

Source CRED-EM-DAT 2009, from Rademaekers et al. (2009).

The figures are compiled by the Emergency Events Database (EM-DAT), an initiative sponsored by the WHO Collaborating Centre for Research on the Epidemiology of Disasters (CRED). It stems from various sources, including UN agencies, non-governmental organisations, insurance companies, research institutes and press agencies.

While disasters may have been increasing in number, how to respond to them, how to agree on whether a situation should be classed as a disaster, who are first responders and what their responsibilities are, are contested issues reflecting different cultures of understanding. These cultures – let us call them official and public response for the time being – meet during disasters to work together. Official and public responders may have different definitions. For instance, in the UK, official first responders are the police, fire and medical emergency services. They might term the situation a 'major incident', which includes providing, via special arrangement, emergency services to alleviate threats of serious damage to human welfare in a place, to the environment of a place, or the security in general of the United Kingdom (e.g. UK Government, Civil Contingencies Act 2004). But the communities concerned might consider the situation a disaster because their lives have been uprooted and recovery will not easily return them back to what was previously normal (Henderson 2011; Easthope & Mort 2014). In other cases the variations are more nuanced, where health workers and firefighters, while both first responders to the scene, each have their own basis for defining an event and significant aspects (Knowles 2011; Superstorm Research Lab 2013). These differences of definition can complicate the sharing of information during the response efforts in ways that hinder collaboration. We expand on this in Section 2.1.

At the same time, there has been a digital 'tsunami' in relation to disaster events. This is a term coined by an EU Commission 'Future Group', who observe how – within an increasingly connected world – people's and object's attributes, actions, behaviours, and movements can be mapped, tracked and interrogated for commercial, social, public, and security purposes (see also Thrift 2011). There is environmental, geospatial and geographical information system (GIS) data, data from sensors, cameras and remote monitoring systems. There is also socio-economic data and data about many aspects of people's everyday lives, including location, health and social media data. During disasters, this has led to an increase in the amount of data being produced and regarded as potentially useful, data that was heretofore missed or ignored because it neither fits in with older systems nor seemed necessary to the practices of individual organizations. Disaster response capacities could be enhanced by more information, information sharing, and more collaboration between agencies with relevant knowledge and skills, which is important in light of the increased frequency and cross-boundary nature of disasters today. Developing new information systems that can support the production and use of information and multi-agency collaboration, for example by facilitating the production of common information spaces, and developing criteria for what information to include in systems and an inventory of how disasters are being responded to in real world practice, will increase the ability to bring different stakeholders in a disaster onto the same page and to allow them to produce and maintain a common operating picture.

The digital turn provides significant opportunities for an 'informationalization' of services in general and emergency services in particular (Lash and Urry 1994). In a world where personal and official post disaster reviews routinely highlight a lack of coordination (ENISA 2012), the response to the triple disaster in Japan 2011 provides an example that stands out. Amongst the many factors that contributed to successful collaboration, the disaster 'proved the cloud's ability, efficiency and advantages' (Katsumi cited in Moss 2013). For example, many local governments' data repositories and IT infrastructures had been damaged. In addition, despite the damage, in order to best respond to the emergency, the data had to be shared between agencies or over municipal, jurisdictional, or national boundaries. When public authorities needed to provide information, such as radiation measurements, these limited resources received an unmanageable surge of demand. Cloud service providers such as Fujitsu, IBM, and others offered free mirroring, which meant that central and local governments could survive the access storm. Moreover, 'Relief/rescue stuff/goods were enough, but supply-demand matching was impossible without IT: [the] cloud worked!' (Katsumi 2013). Customer Management Software (SaaS), again offered for free, allowed Non-Governmental Organisations (NGO) to share information on victims and resources. This supported 'agility, scalability, ubiquitous access and remote collaboration' (Katsumi 2013). This was the first time cloud computing augmented not only business/service continuity for individual providers, but also coordination between different agencies involved in disaster response. Since 2011, this potential has prompted a surge of development in cloud computing for disaster response worldwide. However, this potential has been accompanied by a surge of privacy and other ethical, legal and social concerns. Experts recognize that utilizing the cloud is also a question of morality, but there is a lack of research that can inform more ethically circumspect innovation. Similarly complex potentials and risks arise around other technological innovations that can underpin an informationalization of emergency response, including GIS, geospatial information, social media, mobile technologies, decision support and artificial intelligence, robotics, and unmanned aerial vehicles, to name but a few.

SecInCoRe, as a whole, addresses the potential, premises and risks of designing a disaster inventory for ICT supported disaster response, especially responses that require inter-agency or cross-border collaboration, by addressing four key objectives:

- Constructing a **Pan-European Inventory** of information management processes, data sets, information systems, business models and ethical, legal and social issues (ELSI) arising in the use of advanced ICT for emergency response.
- Constructing a **Common Information Space**, including definition of a taxonomy of data sets, standards, processes and information systems, design of knowledge base and network enabled communication system concept, design of a secure dynamic situation-aware disaster cloud infrastructure, seamless federation of heterogeneous information systems.
- Working towards **Conceptual Integration of Available Technology**, with implementation of pilot cloud services and provision to end-users, implementation of communication system and that has the potential for integration in end-user environments.
- **Validation and Evaluation** of socio-technical innovation around these technologies, concepts and their impacts, including a review of emerging new crisis management and business models.

1.1 Purpose of this document

This deliverable provides a baseline first overview of disaster events, crisis management models, information flows, stakeholders, and ethical, legal, social issues in practice for the SecInCore project, drawing from Tasks 2.1 and 2.2. The results of the work summarised in this document include an initial set of criteria for the creation of a Pan-European inventory of disaster data (WP2 and WP3) and some insights into the overall context and common information and communication problems and practices that can inform the design and use of a common information space (WP4 and WP5). It is written to be paired with deliverable 3.1 which describes how the issues and criteria developed within this document are approached methodologically in order to expand knowledge about them and to fold insights into the design and use of the inventory as well as technological support for the production of common information spaces.

1.2 Methodology and Validity of this document

To develop a disaster inventory that can be useful in the context of 21st Century crisis management from a European perspective, we need to address a set of five key research questions:

- What is known about past disasters and disaster response efforts?
- What are key challenges and opportunities in contemporary disaster response?
- What can be learned from past disasters and past disaster response efforts?
- Who might use a pan-European disaster inventory, for what purposes, and how would they use it?
- How can the design of the inventory support optimal use and learning?

This deliverable provides a first set of answers to these questions, which are to be developed throughout the project, utilising *inter alia* the methodologies outlined in D3.1. To find first answers through this overview, we have used a mixture of methods, including:

- A review of publicly available official post-disaster 'after-action' reviews related to a set of key disaster events, also using, media reports and online resources related to these specific disasters.
- Academic literature reviews on topics as wide ranging as European crisis management policy and practice, academic analyses of disasters and disaster response in specific incidents (complementing the above), emergency and IT ethics, ethical, legal and social issues (ELSI), information and communication theory, disaster sociology, science and technology studies.
- Intial reviews of existing disaster databases, including *The International Disaster Database (EM-DAT)*, operated by the Centre for research on the Epidemiology of Disasters (CRED), and the CAST project *Database on Emergency Response Major Incidents* (DERMI).

- Production of a selective collection of case studies, where we distilled key information from the reviews above into reports about past disaster events.

From this work we have constructed an overview of disaster events, crisis management models and stakeholders, specified relevant ELSI factors, and we have begun to derive criteria for the kinds of disaster events that would be useful to include in a pan-European inventory and the kind of information about them that should be incorporated.

In the following list we propose some criteria that can be used to measure the quality of this document in line with the scientific point of view with which it was produced. These address questions about the qualitative and quantitative parameters against which the Deliverable should be measured and suggest a gauge for judging what constitutes 'good enough' in view of the purpose of this document.

List of criteria that can be used to measure the quality of this document:

- Assembles an initial set of disaster case studies that range in geographical region and spread.
- Identifies different emergency management models used within Europe
- Includes at least two-cross border and cross-agency crises
- Identifies information systems used in more than two major European countries and in multiple crises.
- Discusses various business models used during crises in the case study collection
- Considers ELSI issues that cross-cut the disasters and geographical regions
- Establishes an initial set of criteria by which additional disasters and models will be added to the inventory
- Establishes an initial set of problems faced in attempts to work collaboratively across regions and agencies

The teams in the SecInCoRe consortium and contributors to this deliverable have conducted extensive prior research, much of which is documented in peer reviewed academic publications (e.g. Büscher 2007; Büscher et al. 2014; Pottebaum et al. 2014). The work for this deliverable has been carried out following the principles of rigorous and systematic academic research. However, the document had to be prepared swiftly (within the first 3 months of the project) to bring knowledge and research together and provide a springboard for the collaboration. These time constraints and the scale of literatures and data to review, and the complexities of the matters under consideration, as well as the diversity of perspectives we bring together here impose some limits on the completeness and accuracy of the information. The document has been internally reviewed by colleagues outside the workpackage and author team. Yet, some mistakes may have slipped through the net. We may have missed something or misrepresented some of the complex mechanisms and practices involved in disaster response. The editors take full responsibility and would appreciate any suggestions for corrections and additions. Please contact Katrina Petersen.

1.3 Relation to other documents

D2.1 has inputs from the Description of Work as well as from D3.1 being written in parallel. Its outputs, primarily T2.1 and T2.2, relate to other project documents as follows:

[1] Grant Agreement (no. 607832) and Annex 1. - Description of Work

[2] Consortium Agreement

[3] D2.2 (WP-2) – 'ELSI Guidelines for Collaborative Design and Database of Representative Emergency and Disaster Events in Europe' [in the form of T2.1; T2.2 input to T2.3]

[4] D2.3 (WP-2) – 'Report on Performance, Goals and Needs and First Draft of New Crisis Management Models and Ethical, Legal and Social Issues' [in the form of T2.2; T2.2 input to T2.3/T2.4]

[5] D2.4 (WP-2) – 'Domain Analysis: Baseline and Emergent Future Practices' [in the form of T2.1/T2.2]

[6] D2.7 (WP-2) – 'ELSI in Crisis Management through the Secure Dynamic Cloud' [in the form of T2.2 input to T2.4]

[7] D3.1 (WP-3) – 'Setup Inventory Framework and specification of Research Requirements' [in the form of T2.1/T2.2 input to T3.1, T3.2, T3.3; T2.2 input to T3.4]

[8] D3.2 (WP-3) – 'First Publication of Inventory Results' [in the form of T2.1/T2.2 input to T3.1, T3.2, T3.3; T2.2 input to T3.4/T3.5]

[9] D3.3 (WP-3) – 'Second Publication of Inventory Results, including Ethnography and Holistic Process Models and Statements on Future Evolutions' [in the form of T2.1/T2.2 input to T3.1, T3.2, T3.3; T2.2 input to T3.4]

[10] D3.4 (WP-3) - Final Publication of Inventory Results' [in the form of T2.1/T2.2 input to T3.1]

[11] D4.1 (WP-4) – 'Requirements Report' [in the form of T2.1/T2.2 input to T4.2]

[12] D4.2 (WP-4) – 'System Views and Concept Operations (CONOPS)' [in the form of T2.2 input to T4.3]

[13] D4.3 (WP-4) – 'Network Enabled Communication System Concept and Common' [in the form of T2.1 input to T4.1]

[14] D4.4 (WP-4) – 'Report on Interoperability Aspects' [in the form of T2.1 input to T4.1]

[15] D5.2 (WP-5) – 'Early Setup of Evaluation Model for Internal Use Cases' [in the form of T2.1/T2.2 input to T5.2]

[16] D5.3 (WP-5) – 'Validation Strategy and First Functional Evaluation Model of Communication System Concept' [in the form of T2.1/T2.2 input to T5.2]

1.4 Contribution of this document

D2.1 primarily contributes to the development of a Pan-European inventory, establishing some first overall criteria for developing the inventory, and an overall context and approach to the creation and use of the data inventory. This deliverable establishes requirements and constraints for the data within the inventory as well as barriers and opportunities for the use of the inventory in regards to the stakeholders and their emergency practices. To do so, this deliverable provides not just an initial set of disaster events from which to draw past data, but it also provides a basis for the analysis of crisis management models, stakeholders, information flows and information management and other content categories for the inventory drawn from information about past disasters and experience in practice. It also provides an initial analysis of stakeholders and crisis management models in order to qualify the criteria chosen for the inventory design. From these cases and analyses, it determines characteristics for selecting and excluding data for each category of the inventory, as well as to specify relevant factors and a study into ELSI in practice.

1.5 Target audience

The document at hand is intended first and foremost as a resource for the SecInCoRe team. This is an interdisciplinary group of practitioners (police officers, emergency medicine and fireservice first responders, policy professionals and emergency planners), computer scientists, industrial and academic software and hardware designers, social scientists, security policy think tanks. The overview and the discussions around criteria and key themes in relation to the design of the Pan-European Disaster Inventory and a secure dynamic cloud concept for information, communication and resource interoperability based on this inventory are meant to inform the SecInCoRe team's design efforts. However, the analysis and the extensive bibliography and index may also be useful for other researchers, designers and practitioners and we are happy to make the document openly available on our website, on the understanding that this is not a fully comprehensive peer reviewed academic study (although the document has gone through a rigorous internal review process), but a first overview. We welcome comments and expressions of interest to collaborate.

1.6 Glossary

Abbreviation	Expression	Explanation
AAIASB	Air Accident Investigation & Aviation Safety Board	
ARES	Amateur Radio Emergency Services	
ARIA	Lessons Learnt From Industrial Accidents http://www.aria.developpement-durable.gouv.fr/?lang=en	
ATC	Air Traffic Control (ATC)	
CAA	Civil Aviation Authority, UK	

	Cage Operation	When emergency responders create a perimeter for traffic around a region in order to keep suspects from fleeing.
CAST	http://www.cast-project.eu	Project that carries out research towards the development of a framework for customisation of SaaS applications.
CCTV	Closed Circuit Television	
CDC	Center for Disease Control, US	
CEP	Civil Engineering Planning	
	cloud computing	Computing as a service rather than a physical product that can be accessed mobily.
COBRA	the Cabinet Office Briefing Room A	
COMAH	The Control of Major Accident Hazards (COMAH) Regulations	
	Command and Control	The exercise of authority by a designated individual over a set of personnel and material resources in order to accomplish a specific goal (NATO).
	common operating picture	A central place/single representation of relevant inforamtion for decision making shared by more than one command
CPM	Civil Protection Mechanism	Supports and facilitates the mobilisation of emergency services to meet the immediate needs of countries hit by disaster or at risk from one. It improves the coordination of assistance interventions by defining the obligations of European Union (EU) countries and the Commission and by establishing certain bodies and procedures, such as the Monitoring and Information Centre (MIC).
CRED	WHO Collaborating Centre for Research on the Epidemiology of Disasters (CRED)	
	Data Protection Act	1998 UK law that defines what peronal data can and cannot be publically or privately shared.
	Data Valence	What is asked of the data once it is gathered

DERMI	CAST project Database on Emergency Response Major Incidents	
DI.COMA.C	Direction for Order and Control	Italy's national level of emergency operation center, a physical location set up near a disaster scene
	Disaster	Moments when a hazard exceeds a society's ability to manage the associated risks, causing undue harm to some segment of society, such as specific segments of the economy or the livelihood or health of specific communities.
DSS	Decision support system	A computer based system designed to aid in decision making activities
EACCC	European Aviation Crisis Coordination Cell	
ECDC	European Centre for Disease Prevention and Control	
EHR	Electronic Health Records	
EKAB	National Centre for Emergency Care	Greek publically funded pre-hospital center
EM-DAT	CRED's Emergency Events Database	
EMAC system	Emergney management assistance compact system	An agreement between the 50 U.S states and its territories that enables sharing of resources
EMAK	*Special Disaster Response Unit (EMAK), a special unit of the Hellenic Fire Corps, was sufficiently trained and specialized to deal with natural/man-made disasters and on highly critical Search and Rescue missions.*	
EMARS	European Major Accident Reporting System https://emars.jrc.ec.europa.eu	
EMIS	Emergency Management Information Systems	
EMS	Emergency Medical Services	
EMSA	European Agency of Maritime Safety	

ENISA	European Union Agency for Network and Information Security	
EPIS	Epidemic Intelligence Information System	
EPPO	Greek Earthquake Planning and Protection Organisation	
ERCC	Emergency Response Coordination Centre (formerly Monitoring and Information Centre (MIC)	The operational heart of the Civil Protection Mechanism. 'Based at the European Commission in Brussels, the ERCC is accessible 24/7 and can spring into action immediately when it receives a call for assistance. The ERCC works in close cooperation with national crisis centres throughout the 32 countries participating in the Mechanism (EU 28, the former Yugoslav Republic of Macedonia, Iceland, Liechtenstein and Norway).'
EVITA	European Crisis Visualization Interactive Tool for ATFCM	
EWRS	Early Warning and Response System	A "confidential computer system allowing Member States to send alerts about events with a potential impact on the EU, share information, and coordinate their response" (EU Commission Website).
FAA	Federal Aviation Administration	
FEMA	Federal Emergency Management Agency	
	First Responders	Emergency service workers designated to be first on the scene and oftne in charge of the immediate response
GDP	Gross Domestic Product	
GIS	Geographical Information System	
GSCP	UN's Global Social Compliance Program	"Business- driven programme for companies who want to harmonise existing efforts in order to deliver a shared, consistent and global approach for the continuous improvement of working conditions in global supply chains (http://www.un.org/partnerships/Docs/GSCP_Guide.pdf)

GPS	Global Positioning System	
	hazard	Biological, technological, natural, or socio-political agents that can trigger a disaster and create risk.
HAZMAT	Hazardous materials and items	
HCI	Human Computer Interaction	
ICAO	International Civil Aviation Organization (ICAO) is a UN specialized agency, created in 1944 upon the signing of the Convention on International Civil Aviation (Chicago Convention).	
ICS	Incident Command System	A style of command and control crisis management
ICT	Information and Communication Technology	
	Information systems	What information systems (e.g. operating systems, databases, networks, server-side or client-side software are being used to manage the data.
INERIS	France's L'Institut national de l'environnement industriel et des risques	
	Incident Commander	Person placed in charge of all emergency operations at a given location
	Information management process	How an organisation decides what information should be created, stored, shared and/or updated, who is involved in that decision- making process, and how the information creation/storage/ sharing/updating process is handled and coordinated.
	International Fund for Animal Welfare	NGO focuding on animal safety: http://www.ifaw.org
	International Red Cross and Red Crescent Movement	Volunteer-based organizations mandated, but not funded, by governments to support first responders in human welfare durign disasters. Not a first responder group.
ITOPF	International Tanker Owners Pollution Federation	

IVATF	International Volcanic Ash Taskforce	
Liaison Officer	A representative from one agency (e.g. fire) who is positioned at the headquarters of another agency (e.g. police) in order to share information.	
MACS	Multi-Agency Coordination System	Part of the U.S ICS that provides a basic architecture for interaction between agencies during disasters.
	Major incident	Arrangements by one or more of the emergency services and will generally include the involvement, either directly or indirectly, of large numbers of people. (London Emergency Services Liaision Panel (LESLP) Major Incident Procedures Manual)
MARPOL	International Convention for the Prevention of Pollution from Ships	
MIMMS	Major Incident Medical Management and Support	
Mirroring	Software solution that provides a copy of one system in a second location	
MOA	Memorandum of agreement	
MOU	Memerandum of understanding	
Mututal Aid	reciprocity or exchange of resrouces	
NASA	National Aeronautics and Space Administration	
National Pandemic Preparedness Plans	a WHO supported plan to encourage planning for health emergencies	
NATS	National Air Traffic Services	
NGO	Non-Governmental Organisations	
NOAA	National Oceanic and Atmospheric Administration	
NRL	The US Naval Research Laboratory	

OES	Office of Emergency Services	
PPE	Personal Protective Equipment	
	Preparedness	Looking in advance for unknowns that might lead to disasters in order to mitigate disaster's affects.
	Prevention	Attempting to stop a disaster from happening in the first place.
RNL	Royal National Lifeboat Institute	
ROSS	Resource Ordering and Status System	
SaaS	customer management software	
SAR	search and rescue	
SARS	Severe Acute Respiratory Syndrome	
SERCAM	Servicio de Emergencias de la Comunidad de Madrid	
Situational awareness	An understanding of the various elements of the environment, their importance and implications	
	Stakeholder	Stakeholders are everyone who is involved in overcoming a disaster event
STS	Science and Technology Studies	
SUMMA	Servicio de Urgencias Médicas de Madrid	U.S. web-based database for managing supplies and resources during wildfires.
SurvNet	an electronic surveillance system for infectious disease outbreaks in Germany in 2001	
SWAT	Special Weapons and Tactics	
system of systems	complex collection of task oriented systems that combine resources	
TETRA	Terrestrial Trunked Radio, a privately owned communications system by Airwave network	
Triage	Assignment of a degree of urgency to injury in order to determine patient treatment order	

unmanned aerial vehicles	Airplanes that conduct surveillance that are flown remotely	
USGS	United States Geologic Survey	
VAAC	Volcanic Ash Advisory Centre, UK Met Office	
VOST	Virtual operations support teams	Effort to make use of new communication technologies and social media tools within teams to aid removely in a disaster response.
WebEOC	Software to produce situational awareness, created by Intermedix	
WWF	World Wildlife Fund	
	Xenokratis	Greek Command and Control Model
ZEMA	Informationssystem zum Stand der Sicherheitstechnik (Information System about the Status of Safety Technology)	

1.7 List of figures

1.8 List of tables

1.9 Document Structure

The document is divided into 3 further sections. It starts with a selective review of case studies, qualitatively summarising key elements and expert analyses from disaster reports about past events. The aim is to chart what should be included in the inventory. This is followed by a chapter discussing key themes covered by this deliverable, with specific sections on stakeholders, information management processes, business models, and ELSI. A table opens this chapter summarizing the main issues within each theme as well as criteria for the inventory that result. Each section then details these issues and reasoning for the criteria, drawing on trends noted in the case studies as well as academic literature (disaster studies, STS, HCI, information science). The final chapter puts all these observations and analyses together to offer initial conceptualiations of what a SecInCoRe database could look like.

2 Case Studies: Criteria for a Pan-European Disaster Inventory

This section has three aims. It (1) develops an initial set of criteria for which kinds of disasters to include in the SecInCoRe Pan-European Disaster Inventory (SPEDI), (2) presents 17 different disaster case studies as a selective collection, and (3) offers definitions of the categories used to extract information about specific disaster events in the initial inventory.

2.1 Criteria for Including Specific Disaster Events in the Inventory

The terms emergency, crisis, disaster, catastrophe are 'sometimes used synonymously and sometimes with slight difference by scholars and practitioners' (Hiltz et al. 2009: 3). The list often indicates an escalation of severity and scale, with emergencies ranging from individual predicaments, such as a heart attack or a fall from a ladder, to a house fire or a motorway pile-up with multiple casualties. Along similar lines, the word crisis may be used to describe urgent situations with broader societal relevance, such as a financial crisis, political uprisings or riots, while 'disaster' or 'catastrophe' is often reserved for events that exceed the capabilities of a single community or even nation to address and which have long lasting consequences. Each definition is crafted and selected for specific social, political, or technological reasons and in relation to specific risks. There is no fix to this fluidity, a search for a once and for all authoritative definition is neither practical nor possible [see Appendix 1 for a range of working definitions of 'disaster']. The differences in interpretation need to be considered as part of the criteria for an inventory of disaster data as they will both affect how the inventory can be used and its validity to its users. The term 'disaster' has been chosen for this inventory, because it has meaning for a broad range of stakeholders and allows 'official' as well as 'public' interpretations. However, while it is useful to have a fairly fluid definition in many contexts, the use of the term 'disaster' should be clear in relation to SPEDI and we can find some common characteristics.

In the context of SPEDI a 'disaster' is, first of all, characterised as 'a situation, often unforeseen, in which there is a risk of great harm or loss and a need to act immediately or decisively if the loss or harm is to be averted or minimised' (Sorell 2003). Secondly, it is defined by a need for *multi-agency* collaboration. In many countries in the EU there are definitions of 'major accidents' which resemble the definition provided by EU Directive 2012/18 (EU Commission 2012), where 'major accident' means an occurrence such as a major emission, fire, or explosion resulting from uncontrolled developments in the course of the operation of any establishment covered by this Directive, and leading to serious danger to human health or the environment, immediate or delayed, inside or outside the establishment, and involving one or more dangerous substances. Response requires multi-agency collaboration and it might scale up beyond the national response capabilities.

Taking the UK as an example, multi-agency response is required in emergencies that range from 'major incidents' to 'catastrophic emergencies' (abridged, Cabinet Office 2013):

> *Major incidents* are routinely handled by the emergency services and other local responders without the need for central government

involvement. Such emergencies may include major road crashes, local floods or industrial accidents. The local multi-agency response is co-ordinated through a Strategic Co-ordinating Group (SCG). The chair of the group, whether a police lead or a Local Authority Chief Executive, is colloquially referred to as a 'Gold Commander'. (See Ramirez et al. 2012 for structures in other EU countries). A *Significant emergency (Level 1)* has a wider focus and requires central government involvement from a lead government department (LGD) alongside the emergency services, local authorities and other organisations. There is no requirement for fast, inter-departmental/agency, decision making which might necessitate the activation of the collective central government response, although there may be value in using the Cabinet Office Briefing Room (COBR) complex to facilitate the briefing of senior officials and ministers. Examples include most severe weather-related problems. In addition, most consular emergencies overseas fall into this category.

A *Serious emergency (Level 2)* has, or threatens, a wide and/or prolonged impact requiring sustained central government co-ordination and support from a number of departments and agencies. The central government response would be co-ordinated from COBR, under the leadership of the lead government department. Examples of an emergency at this level could be a terrorist attack, widespread urban flooding.

A *Catastrophic emergency (Level 3)* has an exceptionally high and widespread impact and requires immediate central government support, such as a major natural disaster, or a Chernobyl-scale industrial accident. Characteristics might include a top-down response in circumstances where the local response had been overwhelmed, or where emergency powers were required to direct the response or requisition assets and resources.

The range of agencies involved can be large. The table below lists a sample of 'Category I' and 'Category II' responders in the UK as an example, all frequent stakeholders in disaster response (Table 1).

Category I responders ('core responders')	**Category 2 responders ('co-operating responders')**
Emergency services	**Utilities**
Police Forces	Electricity Distributors and Transmitters
Fire Authorities	Gas Distributors
Ambulance Services	Water and Sewage Undertakers
Maritime and Coastguard Agencies	Telephone Service Providers (fixed & mobile)
Local authorities	Radio/Television Networks and Providers
All Principal Local Authorities (i.e. metropolitan, counties, districts)	**Transport**
Port and Health Authorities	Train Operating Companies

Animal Welfare Authorities	Rail Systems
	Airport Operators
Health bodies	Harbour Authorities
Primary Care Trusts & Acute Trusts	Highways Agencies
Foundation Trusts	**Health bodies**
Local Health Boards	Strategic Health Authorities
Health Protection Agencies	
	Government agencies
Government agencies	Health and Safety Executive
Environment Agencies	
Health Monitoring Agencies	

Table 1 Category I & II Responders

Modified from Source: (Civil Contingencies Act, UK Government 2004).

In addition, commercial organizations (such as supermarkets, hotels, and insurances), media, and volunteer organizations may become involved, as well as members of the public -- who are often the first responders at the scene of an incident providing first aid, transporting people to hospital or initiating search and rescue (Dynes 1970; Fischer 2008; Palen et al. 2007; Tierney 2003). In other words, disaster response is not limited to government officials nor to humanitarian aid organizations (

Figure 2).

For the purpose of this inventory, we define disasters as moments when a hazard exceeds a community's or a whole society's ability to manage the associated risks, causing undue harm to some segment of society, such as lives, economy, health, and livelihoods. They can be caused by what we refer to as socio-political hazards (e.g. terrorist), natural hazards (e.g. earthquake), biological (e.g. disease epidemic) or technological hazards (e.g. infrastructure failure). SPEDI is differentiated from other disaster inventories, such as EM-DAT, by our focus on qualitative causes, effects, detail of practices and experiences of disasters, as well as our focus on Europe. As Leoni et al. (2011) suggest: "[a] hazard becomes a disaster when it coincides with a vulnerable situation, when societies or communites are unable to cope with it with their own resources and capacities" (p. 14). In this way, no disaster is natural, social, or technological alone (Oliver-Smith 2002; Davis 1999; Steinberg 2006). Hazards, in themselves, are not disasters; thus, an earthquake (a natural hazard) only becomes a disaster as it affects such things like the instability of the housing near the epicenter, damage to the water infrastructure, the politics behind offering aid, or even how much of the city is mapped for responders to make plans. For example, the April 2010 earthquake near the US/Baja California border, while 7.2 on the richter scale, caused almost not harm because it was in a very unpopulated region. Yet, it was a 6.6 earthquake – order of magnitudes smaller – that caused the triple disaster now called the Great Eastern Japan Disaster 3.11 (Samuels 2013). It was not the hazard that defined the earthquake as a disaster, but its relationship to wider socio-technological systems. It is with this complexity in mind that the initial case study selection and criteria development for SPEDI is being made.

Figure 2 Example of Actors and Organisations Involved in Emergency Response

To balance the inventory, the cases within will represent the general spread of hazards, scales, and inter-agency collaboration seen in major incidents at present in Europe. These numbers, though, are going through drastic changes. In 2012, within Europe there was a threefold increase in the number of natural-hazard disasters recorded in 2011 (Guha-Sapir et al. 2013: 27&30). According to the Centre for Research on the Epidemiology of Disasters (CRED), in 2012 Europe experienced 65 natural-hazard induced disasters – which can be further broken down into climatological (n=45), geophysical (n=3), hydrological (n=16), and meteorological (n=1) disasters (Guha-Sapir et al. 2013: 27). The total number of major incidents has been increasing over the European annual average in general (Guha-Sapir et al. 2013).

Against the backdrop of these considerations, a first set of minimal criteria for inclusion are that each event constitutes:

- A major incident, requiring collaboration between different emergency response agencies.
- Happened in the last 15 years or is particularly significant such that both the response and effects have relevance for the crisis models and strategies used at present.
- 80-90% of examples should be from Europe, but we may include cases from outside Europe that either demonstrate new trends being seen in European disaster management (such as the 2007 wildfires in California, US) or potentials for future large-scale disasters (such as the international SARS epidemic).
- Geographically spread to reflect the different countries/regions of Europe.
- Geographically crossborder when possible.

- Reflect frequency of occurrence, taking into account hazard-type, risks, scale, and response (see Figure 1). For example, in 2012, there were only 2 acts of disaster-level terrorism on European soil (European Police Office (EUROPOL) 2013), but 65 natural hazard induced disasters (Guha-Sapir et al. 2013). Between 1998 and 2000, there were 576 natural-hazard induced disasters causing 98,803 fatalities, affecting 11 million people, and costing €149 billion in losses (European Environment Agency (EEA) 2010: 25). In that same time, the same report notes that there were only 352 technologically induced disasters, resulting in 169 fatalities (though the report notes these number are likely under-represented and incomplete due to lack of data).
- Reflect a mix of ad-hoc disasters (quickly resolved often without even evoking standards of practice) and slow motion disasters (such as climate change, air pollution, soil erosion that take years for effects to build and be acknowledged (Mosley 2015; Mosley 2014; Roqueplo 1986; Montgomery 2008).
- Reflect conclusions that are non-stereotyping. Disasters are often described using myths and metaphors that are unfounded in actual practice (Tierney, Bevc, and Kuligowski 2006). SPEDI should reflect a range of disasters such that unfounded assumptions commonly held about stakeholders, practices, causes or effects cannot overpower the empirical findings from SPEDI. These include tendencies to assume that disasters engender panic and a 'moral black hole', affected populations passively await aid, there will be looting by the underprivileged, or muslims are more likely to be terrorists.
- Represent the diversity of crisis management models used in Europe (with attention to the international context).
- Data can be found on the incidents causes, effects, response, and lessons learned. In this first overview difficulties were encountered in finding information regarding the use and need for specific data sets, the use of information systems and the application of business models.
- A balanced report is possible. The disaster case studies in this first selective collection draw on at least two different reports (maybe even from different sources) in order to establish the descriptions of each case study. Doing so makes sure that the disasters are not written from a single perspective, understanding of effects or success. Such range of sources will further establish an inventory that will reflect the successes and problems faced by all potential parties involved in using SPEDI and a common information space.

Drawing together the experimental development and application of these criteria for the inclusion of disaster events in this overview, of categories for the excerpting of information (see section 2.2 below), as well as the discussion of main themes and additional relevant factors in Chapter 3, the case studies demonstrate the value and potential of an inventory for acting as a foundation for a productive and expansive common information space.

The table below presents a quick 'snapshot' of the different disaster case studies included in this document and in accordance with different hazard-types (Table 2).

Snapshot of Disaster Case Studies	Number of Cases
Natural-Hazards	n=8
Earthquake	2
Epidemic/Disease	2
Severe Weather (cold/hot/storm/flood)	2
Volcano Eruption	1
Wildfire	1
Technological-Hazards	n=5
Plane/Train Crash	1
Oil/Chemical Spill	2
Infrastructure Failure (e.g. blackouts/building collapse)	1
Explosion	1
Social-Hazards	n=4
Terrorism	2
Shooting	1
Crowd Control/Security Negligence	1
Plane Crash/Pilot Suicide	1
Border Security/Movement of People	1
Total Number of Cases	**n=19**

Table 2 Number of Case Studies by Category

Chapter 3 summarises the results of a first analysis of these disaster events not only for the purpose of the domain analysis in WP2, but also for preparing the approach to SPEDI as set out in WP3, establishing requirements and constraints concerning information management process, information systems, and business models. These results are complemented by specific research methodologies which are mostly independent from singular incidents (see D3.1)

2.2 Definition of Categories to Excerpt Information from Disaster Reports

This section presents the case study information template and defines the categories used to excerpt information from the case studies.

Incident Number Description, Name, Date
Incident & Incident Number (XXXXXX)
A short description of the incident, based on a mix of statistics and socio-political details to explain the significance of the indicent chosen. No disaster is merely defined by numbers. Statistics help demonstrate the impact, qualitative descriptions explain why those numbers are meaningful. The description should discuss the causes of the incident.
Material Damage
Physical damage caused by the hazard. This includes, but is not limited to, damage to structures, infrastructures (roads, communication lines, electrical systems), personal property, farm crops, local environments (water, plants,

animals), as well as cascading damage across a wider area, for example through mobile environmental hazards. Where possible, the description should discuss causes and remedial actions.
Social and Human Impact
How society at a range of scales are affected by the disaster. This includes injuries, both physical and psychological, deaths, cultural exclusion, issues with recovery and resillience. These can describe local issues or larger international problems. Where possible, the description should discuss causes and remedial actions.
Economic Impact
How businesses and gross domestic products are affected by disasters, including, among other things, statistics on lost income from business closures, lost crop income, lost tourism, lost national funds due to cost of rebuilding. Where possible, the description should discuss causes and remedial actions.
Preparedness – Training, Emergency Plans, Crisis Management Models
Training, Emergency Plans, Crisis Management Models: What kinds of plans, acts, memorandums of understanding, specific training, standards of protocol, etc were put in to place prior to the disaster. What larger disaster response logic was used by the different groups. The aim is to identify some of the structures in place (or missing) that shaped the disaster response.
Interoperability – Information Sharing Communication, Coordination, Collaboration, Information Flows
Information Sharing Communication, Coordination, Collaboration, Information Flows: Pathways, practices, infrastructures – technological and human – attempted or stated has having been needed to enable cross-border or inter-agency work. Information systems and crisis management models used to encourage this are also described.
Responder Safety
Issues noted in the reports about the potential and actual endangerment of responders at the scene of the disaster.
Stakeholders
Everyone who is involved in overcoming a disaster event. While this first of all refers to first responders, including police authorities, and emergency managers, government agencies, and other 'Category I' type responders, this definition also leaves room for Category II type responders and other parties whose work either is incorporated by the government agencies, relied upon by the official response to complement its work, or who emerge in response to needs that are going unaddressed or unseen by the official response.
Public Engagement
How stakeholders engage with/communicate with the public.

Public Response	
Actions taken by the public in response to the disaster and the official response.	
Media	
How news media reported about the disaster, what issues were covered, for how long they made the news, and from what sources the media got their information. This can include mainstream, alternative, and social media. This also includes the role of the media in mass notifications directed from the first responders as well as their own investigations.	
Ethical, Legal and Social Issues	
This category covers issues of humanity, fairness, dignity, data protection, liability, cultural and social practices of collaboration and other ethical, legal or social issues arising in emergency response, with a particular focus on the role of information technologies. It explores such issues in relation to victims, bystanders, responders, and other stakeholders.	
Data-sets used	
gathered prior to disaster	What data, both type and format, was used during the disaster response that was referenced in the reports This can include data gathered prior to the disaster (e.g. topographical details or locations of fragile infrastructure),
gathered during disaster	data gathered during the disaster (e.g. fire perimeters or traffic flows),
gathered immediately after disaster	and data gathered immediately after the disaster (e.g. physchological impacts or longer-term environmental pollution levels).

Lessons Learnt	
explicit	Explicit lesson(s) learned are those that are stated directly in a document cited. These can also include conclusions, recommendations. Both categories can be based on what went wrong and what went exceptionally well. Where possible, the description should discuss the problem and remedial actions.
implicit	Implicit are those that can be assumed by the documented changes or future plans stated in the document, even if only the effects are described.

Timeline	Response

What happened from the start of a hazard taking effect to when recovery was declared	Data for each timeline should be drawn from multiple sources. In some cases that means sources that do not always agree on the order or timing of events. This has been done deliberately to construct more comprehensive and detailed timelines and in order to offer a range of perspectives on significant issues included within the timeline. Where conflicts occur, the academically more authoritative sources have been cited.

References
Full bibliographical information of references cited throughout the case study.

2.3 A 1st Collection of SecInCoRe Disaster Reports Based on Case Studies

The following 19 disaster case studies are presented in chronological order. While each has slightly different levels of completion (in part due to the range of accessible sources, in part due to the quick time frame of this deliverable), together they present a set of disasters that range in length, type, impacts, geographical location and spread. Each case study tried to draw on mulitple sources to cover a range of perspectives. Occasionally academic research on the individual cases was drawn upon when incident reports were not readily available or when the significance of an observation from a report needed to be highlighted. Each of the categories, especially the timelines, were used as checks on the others to ensure (as far as possible) that complete and correct details were listed within each category. For instance, when describing interoperability issues, a party may have been mentioned as vital to the flow of information. We then made sure that this party was also listed in the stakeholder category. The details described in the various categories form the foundation of the themes and further relevant factors developed in Chapter 3.

2.3.1 1999 - Earthquake Athens, Greece (KEMEA)

Incident (000001)

Figure 3 Athens Earthquake of September 1999

Source: http://www.newsbomb.gr/koinwnia/story/77429/dwdeka-chronia-meta-ta-59-richter-poy-sygklonisan-thn-athhna

At 14:56:50 local time on Tuesday, 7th September of 1999, a crustal earthquake of magnitude M_w= 5.8 to 6.0, occurred approximately 18 km northwest of Athens. Based on USGS and NOAA the epicentre was located near the damaged area at Mount Parnitha. The focal depth was approximately at 10km. The strongest aftershocks took place on the 7th and 8th of September (M_s= 4 - 4.7), and more than 1,000 aftershocks occurred in the first five days. Even though the earthquake caused serious structural damage there were no second disasters like fire or pollution. It was the most disastrous and costly natural hazard of the last 50 years in Greece.

Material Damage

While the magnitude of the earthquake was moderate, the intensity reached a peak of IX on Mercalli scale. The damage included:

- Approximately 100 buildings collapsed (some were reinforced concrete buildings)
- 4,682 buildings were beyond repair with severe structural damage (tagged as RED)
- 38,165 were found to be repairable with none or minimum structural damage

but uninhabitable (tagged as YELLOW) until repaired. • Of the buildings tagged as RED and YELLOW, more than 5,500 and 65,500, respectively, were residential properties.
Social and Human Impact
143 people died in the earthquake (127 died buried under wreckages from blunt trauma & asphyxia, the rest died from injuries, panic jumps and falls); more than 6.500 were injured; 2000 admitted to the hospital of which 500 were seriously wounded (Papadopoulos et al. 2004). The SAR operations lasted for six days with national and international teams joining forces. From the collapsed buildings all over Athens, 85 people were extracted alive and all of them in the first three days. Furthermore, more than 100,000 people were homeless during the first days of the earthquake either due to the collapse/damage of their dwellings or because the fear of staying indoors was too great, due to the strong meta seismic activity. Due to the criticality of the situation, the Greek government decided to distribute more than 20,000 tents, 8,000 blankets and 4,000 beds in order to help (Elenas 2003). Additionally, approximately 5,500 tents, 5,500 bed linen sets, 2,000 pillows, 12,500 mattresses, 15,850 blankets, 25 large tents and 47 rolls of plastic sheeting where distribute by the Balkan Red Cross (ReliefWeb 1999a). The Ministry of Environment, Urban Planning and Public Works assigned teams, each composed of two engineers, to inspect and asses all damaged properties. The final inspections left more than 50,000 people homeless (Pomonis 2002; United States Geological Survey (USGS) 2012). After the earthquake, psychiatrists from the University of Athens, divided in three groups was trying to support and help the victims. At the same time the three groups conducted a research in order to diagnose the psychological effects of disastrous events (Christodoulou et al. 2003). Based on the research on 102 subjects Christodoulou et al. (2003) wrote: “[...] 87 (85.3%) fulfilled the ICD-10 criteria for acute stress reaction (30 for a mild, 29 for a moderate and 28 for a severe reaction). The remaining 15 subjects (14.7%), although presenting some symptoms of autonomic hyperarousal, did not fulfil the criteria. In the total sample, the most prevalent symptoms were either 'non-specific symptoms of stress response' (i.e., exaggerated startle response, 77.5%; difficulty getting to sleep because of worrying, 75.5%; difficulty in concentrating, 58.2%) or 'autonomic arousal symptoms' (i.e., pounding heart, 69.0%; trembling, 68.0%; dry mouth, 62.2%), while 'dissociative symptoms' (i.e., loss of ability to perform movements, 10.3%; loss of speech, 6.2%; loss of vision or hearing, 0%) were the least prevalent” (p. 51).
Economic Impact
The overall cost of the earthquake is estimated at about 4 billion Euros (including insurance losses). It is considered to be the most costly natural hazard in the last half century in Greece (Pomonis 2002; Elenas 2003; Spence & So 2009).

The earthquake disrupted and discontinued the normal activities of thousands of businesses with 28,000 employees. Around 9,000 buildings were partially or completely destroyed, some 3,600 companies were temporarily closed, and 850 enterprises went out of business permanently. This situation also had a short term impact on the overall productivity of the country and a long term impact in the overall economy.

Preparedness – Training, Emergency Plans, Crisis Management Models

It is the first time in the country's history that an earthquake of this magnitude occurred only 18 km outside of the centre of Athens. Moreover, the earthquake stroke from an unmapped fault and therefore it was highly unexpected and the region was unprepared.

The Earthquake Planning and Protection Organisation (EPPO) revised the plan "Xenokratis-Earthquakes" in June 1999 which provides the mobilization of the agencies of Civil Protection in three levels: municipality, prefectural and national. (Kourou 2001).

The Special Disaster Response Unit (EMAK), a special unit of the Hellenic Fire Corps, was sufficiently trained and specialized to deal with natural/man-made disasters and on highly critical SAR missions.

The Strategic Plan "Xenokratis" drafted by General Secretariat for Civil Protection (GSCP) in 2003, is the official document describing the preparation and course of action for disastrous events, more specific:

- *"Specifies and identifies the kinds of natural disasters.*
- *Defines roles and is providing planning guidelines to Ministries, Regions, Municipalities and Communities.*
- *Clarifies that all projects are approved by the National Agency for Civil Protection*

Xenokratis also provides guidelines and information for:

- *Developing strategies and tactics*
- *Risk assessments*
- *Flag vulnerable areas*
- *Development of specific plans for each risk including forest fires*
- *Good organization and service equipment configuration and operational philosophy*
- *Early mobilization, motivation, direction and coordination of manpower and resources*
- *Creating opportunities for logistics troubleshooting both operational forces, and the affected citizens"* (Giourka 2014: 2-3).

In 2006, "*Xenokratis"* was revised under the Ministerial Decision 3384/2006, Law 776/28-06-06, to add the plan of "*Human Casualties Management*".

Interoperability – Information Sharing Communication, Coordination, Collaboration, Information Flows
The coordination and operations centre of the Hellenic Fire corps was damaged by the earthquake and thus it was necessary to set up a temporary site. Additional operational centres were also established for each scene. The telephone centres were either overloaded or damaged, resulting in a multitude of problems with communication capacities, coordination and relevant delays upon the arrival on the collapsed/damaged buildings. Even though EPPO was responsible for the coordination of the various agencies during disasters, they could not properly allocate the responders during the first day. There were also organizational problems related to the international teams. For example, there was difficulty accommoding the teams with dogs and coordinating in which scene they should assist (ReliefWeb 1999b; Theofili & Vetere Arellano 2001).
Responder Safety
The strong meta seismic activity and the unstable wreckages endangered the responder’s lives throughout the six days of search and rescue missions.
Stakeholders
Numerous agencies took part in the various missions, including more than 1500 firefighters, 25 EMAK units, more than 500 soldiers from the army, international SAR teams from eight different countries with more than 182 people, 15 trained dogs and special equipment, and unknown numbers of police officers, medical personnel, Non-Governmental Organizations (NGO), and volunteers. Hellenic Fire Corps; Special Disaster Response Unit; NGOs (Greek and International Red Cross and Red Crescent Movement, Doctors without Borders, Doctors of the world); Hellenic Police; National Centre for Emergency Care (EKAB); Hellenic Armed Forces; International Search and Rescue teams (including Turkey, Switzerland, Ukraine, France, Cyprus, Hungary, Russia, Isreal IDF); National, regional and municipal authorities; Institute of Geodynamics; General Secretariat of Civil Protection; Civil Engineers from the Technical Chamber of Greece; Prefecture of Attica; German Arbeiter-Samariter-Bund;
Public Engagement
The public was informed by official press releases (TV and Radio), from the moment the earthquake shook Athens until the rescue missions was formally over. The press releases were made by the representatives of the civil protection agencies (EPPO and GSCP), the representatives of Greek and International rescue teams and also from the representatives of the NGOs. Up to date news release for six days, with the progress of the rescue efforts as well as the efforts of the government and NGOs to distribute relief material to the homeless people

(ReliefWeb 1999b; Petropoulos 2005). The government informed the public about the communication difficulties and provided safety instructions through official press release (TV and Radio). Moreover, the public was asked by the government's representatives not to use the telephone lines and electricity if it was not necessary due to threat of the overload (ReliefWeb 1999b).	
Public Response	
Citizens volunteered for supporting roles during the six days of rescue efforts and on the shelters built for the people whose dwellings were either collapsed or heavily damaged.	
Media	
The Ministry of Environment and Public Works used press releases to inform the public for the overload or damaged electricity systems as well as the overload communication centres of the Hellenic Fire Corps and the EKAB. TV banners with two telephone lines were playing all day, for the people to ask for inspection of their dwellings.	
Ethical, Legal and Social Issues	
The Seismic Design Code changed in 1999-2000, as well as the Concrete Technology Code and the Reinforced Concrete Code in order to strengthen the constructions and minimize the damages in an upcoming earthquake. The utilization of the above Codes is mandatory for every new construction. The question of public access to information is left unexplored in this response. For example, by placing a banner on TV for those who need inspections in their homes, it is expected that they have access to a TV despite being displaced from their homes (where their TVs are), rather than addressing how the audience they needed to reach could be reached.	
Data-sets used	
gathered prior to disaster	
gathered during disaster	Damaged buildings in various states Psychological problems Logistics/supply data (distributed cots, water, etc) Geo-coded locations of epicentres and earthquake magnitudes, amplitudes, focal depths, (lat/long) Casuality statistics and cause

gathered immediately after disaster	Damaged buildings in various states Psychological problems Affected businesses Unemployed citizens Insurance claim costs Economic impacts

Lessons Learnt	
explicit	Unfortunately the call centres overloaded almost immediately after the earthquake due to the high number of calls. New information systems should be installed to avoid overload in a future disaster. The number of collapsed buildings (few with reinforced concrete) proved that previews inspections weren't sufficient and there are many old buildings. After the earthquake Seismic Design Code changed (1999-2000), as well as the Concrete Technology Code and the Reinforced Concrete Code in order to strengthen the constructions and minimize the damages in an upcoming earthquake.
implicit	

Timeline	*Response*
7 Sept 14:56:50	Earthquake strikes.
Coordination	Operational activities were coordinated through the Prefecture of Attica, including all activities of SAR teams, distribution of tents, beds, relief material, and official inspection and damage report/assessment.
Rescue Teams	Immediately after the earthquake more than 1,500 firefighters, 25 units from the Special Disaster Response Unit (EMAK) with sniffer dogs and 400 soldiers were deployed all over Athens to extricate people from wreckages.
Communications	The telecommunication systems and the call centres of the Hellenic Fire Corps, Police and National Centre for Emergency Care (EKAB) were overloaded causing the delayed arrival on some scenes (ReliefWeb 1999b; Theofili & Vetere Arellano

	2001).
On Route	Traffic problems occurred as the earthquake struck at rush hour, causing problems for the emergency agencies.
Police Efforts	The Hellenic Police deployed officers patrolled to regulate the traffic and escort the ambulances and the vehicles of the Hellenic Fire Corps. Furthermore, they patrolled the affected areas to prevent looting, help elderly people and inform the citizens not to go back into their houses.
Risk Assessment	The rescue teams assed the situation of each scene and proceed at the extraction of people slowly and with great caution as the wreckages were unstable and because the meta seismic activity could cause further collapsing.
Aftershock	A strong aftershock, 4.7 Richter, struck during the night causing small damages.
Rescue Efforts	SAR teams worked nonstop and overnight to locate and pull out survivors from the rubble.
8 Sept	
International SAR Aid	The morning of September 8th, the first teams from foreign countries came to assist the Greek SAR teams: • 20 persons from the Turkish SAR, • 7 persons and 3 dogs from Switzerland, • 40 SAR specialists arrived from France with 8 trained dogs. During the afternoon two more teams came to support the existing forces: • 14 experts and 11 dogs came from a German Arbeiter-Samariter-Bund (welfare organisation specialized in civil protection, rescue and social services), • Ukrainian SAR team consisting from 28 specialists, dogs and equipment. By the end of the day: • Rescue teams from Cyprus, Hungary and Russia arrived in Athens. • an airplane with 73 members of the Israeli IDF rescue team, left Israel to join forces with the rest of the national and international teams, here in Greece, on the rescue missions.
Rescue	62 people were extracted alive from the wreckages by national

Efforts	and international teams.
Aftershock	A second aftershock of 4.7 Richter hit Athens, endangering the lives of SAR teams as they continued their work.
9- 10 Sept	
Rescue Efforts	The rescue teams extracted 23 people from the wreckages and they continued to search for more.
Medical Care	People evacuated from collapsed buildings were treated on the scene from medical personnel and transferred immediately to the hospital. They were seriously injured as they were trapped under wreckages for 48-72 hours.
Police Efforts	Police officers continue to escort the ambulances from the scenes to the hospitals and vice versa. Moreover, they constantly patrol the affected areas to prevent looting.
11-13 Sept	
Rescue Efforts	The SAR teams continue to search for survivors through the wreckages but with no luck.
Formal announce-ment of casualties	On the 13th, the rescue teams announced that overall casualties of the earthquake were 143 people.

Timeline adapted from: ReliefWeb (1999b), ReliefWeb (1999a), ReliefWeb (1999c)

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2.3.2 2001 - Toulouse AZT Explosion, France (ULANC-MB)[1]

Incident (000002)

Figure 4 AZF Plant After the Explosion

Source: (Dechy et al. 2004).

At 10:17 on Friday, 21st September 2001, between 20-120 t of ammonium nitrate refuse exploded in a warehouse at the *Azote de France* fertiliser factory on the outskirts of Toulouse (Riddez et al. 2007; Mayerfeld Bell 2004). The blast registered 3.4 on the Richter scale and could be felt within an 80km radius. It created a crater of over 50m diameter and 7m depth. INERIS estimated the equivalent in TNT at a range of 20-40 t. This marks the explosion as one of the biggest in modern industrial history (Arens and Thull 2001). A cloud of dust and smoke formed and for a period of 30 minutes it was not known whether it was toxic (Riddez et al 2007; Zaitseva 2014).

Material Damage

Within the destruction zone, about 80ha of the plant were devastated, a shopping centre, several supermarkets and a bus depot were severely affected. Some 27,000 homes were damaged within a 3km radius, 11,000 of them seriously, with walls destroyed and roofs missing ARIA (French Ministry of

[1] This report is adapted from Zaitseva (2014)

Ecology Sustainable Development and Energy n.d.). A hospital with 1200 beds was badly damaged but remained operational. Many businesses and a residential block with 20,000 apartments were seriously damaged. Windows were broken within a radius of 5km, including the city centre. 40,000 damage claims were submitted to insurance companies. The airport at Toulouse-Blagnac and the main railway station were closed, 90 schools were evacuated. 10% of the population (40,000 people) had to be evacuated for several days (AZF n.d.).
Social and Human Impact
30 people, most of them workers at the plant, died in the explosion and its aftermath. Some were hit by debris in collapsing buildings, including a high school student at a school 500m from the facility. Data on the number of injured is uncertain, with estimates between 2,242 and 2,500 seriously wounded persons and 5,079-8,000 less seriously wounded (e.g. with cuts from shattered glass windows) and treated for stress (Dechy et al 2004; AZF n.d.).
Economic Impact
The economic cost of the disaster has been estimated at several billion Euros (between €1.5 and €2.3 billion, according to insurance companies) ARIA (French Ministry of Ecology Sustainable Development and Energy n.d.).
Preparedness – Training, Emergency Plans, Crisis Management Models
The plant had been given a 'high risk' Seveso designation, which means that strict safety procedures, including a duty to inform residents in the vicinity of the dangers of the substances held. These guidelines were not closely followed (Mayerfeld Bell 2004). The Accident Response Plan and local Disaster Alert, emergency medical aid plan (Plan Rouge) and the plan to utilise a network of medical facilities (White Plan) were activated (Riddez et al 2007; Zaitseva 2014).
Interoperability – Information Sharing Communication, Coordination, Collaboration, Information Flows
There were delays in the establishment and communication of a list of those seriously injured (Wohlleben 2003). Telephone networks broke down (Arens and Thull 2001). 1570 fireservice and military personnel worked in the response, and 950 police staff. Many arrived unplanned due to the communications technology breakdown (Dechy et al 2004). A local operational centre proved crucial to coordination between the emergency medical service (SAMU), general medical practitioners, firefighters and UIISC soldiers (Wohlleben 2003).

Responder Safety
Although pre-existing emergency plans about toxic gas release were activated, equipment such as breathing apparatus for the firefighters were found to be inadequate (Wohlleben 2003).
Stakeholders
Police, fire fighters, Medical Emergency Services (SAMU), Emergency and Intensive Care Services (SMUR), Intervention and Guidance Units for Civil Protection (UIISC (soldiers)), Ministries of the Interior, of Defence, of Industry, and of Ecology and Sustainable Development, Grand Paroisse, French Fertiliser Company, Atofina, a subsidiary owned by Total; the mayor of Toulouse, Prefect, District Prefect.
Public Engagement
It took 30 minutes to announce that the content of the smoke cloud were not toxic (Riddez et al 2007). Gas masks were distributed in the city centre and the city council announced that people living inside a 5km zone of the explosion should stay indoors and close their windows However, many windows had been shattered by the blast (Arens and Thull 2001; Zaitseva 2014) and people outside the 5km zone were told they could move freely. Via radio, citizens were instructed not to drink tap water or minimize its consumption. Many citizens attempted use their cars to leave the area or to collect family or friends and encountered police blockades (Zaitseva 2014).
Public Response
There had been widespread awareness of the 'high risk' nature of the plant and calls to address this in the *banlieus* sited nearby. The detonation and the subsequent conflicting public information resulted in a panic in the city centre some 3 kilometres from the blast (Arens and Thull 2001).
Media
There had been a longstanding media discourse on the risk of plants like AZT (Dechy et al 2004).
Ethical, Legal and Social Issues
The accident highlighted flaws in the social contract between society and organisations. Social and environmental disclosures offered by Total were mainly used as a powerful legitimacy device rather than an effort towards greater accountability (Cho 2009). Subcontracting at the plant was extensive and complicated. In the aftermath, the Environment Ministry made it compulsory to involve more widely the employees

and subcontractors in the risk management process (Dechy et al. 2004).	
Data-sets used	
gathered prior to disaster	information about chemicals stored at the plant
gathered during disaster	measurements of toxicity in the smoke cloud information about chemicals stored at the plant numbers and identity of people working at the plant, injured,
gathered immediately after disaster	information about chemicals stored at the plant

Lessons Learnt	
explicit	Although pre-existing emergency plans were activated, neither internal nor external emergency plans envisaged a scenario like this. Plans focused on the potential release of toxic gas. The incident highlighted the need to keep on assessing scenarios with a consideration of a possible failure of the safety barriers designed and imple- mented. Many different subcontracting companies were involved at AZT. After the incident new laws were designed, aiming at monitoring the use of subcontracting on Seveso sites (Dechy et al 2004). There was low security at the plant. There was a lack of sufficient training in preventing and responding to a chemical incident. The absence of a dedicated civil protection agency risks ‘making civil protection the interest of multiple agencies, but the priority of none’ (Wohlleben 2003: 10-11).
implicit	A separate network for responders is needed. Major traffic problems need addressing during disasters. Responders need early risk assessments before starting work. People evacuate in social groups, social ties may complicate evacuations.

Timeline	Response
00:00	**Explosion**
Alarm	The alarm system at the factory never activated.
Coordination	Police were inundated with reports of explosions in different parts of the city. A local operational centre was set up almost immediately after the explosion.
En route	Major traffic problems quickly arose around the site after the explosion, creating difficulties for the emergency services to reach the scene. Extensive damage hindered rescue services in their efforts to reach the factory.
00:13	
Arrival	Despite major traffic problems, the first rescue team was on-scene 13 minutes after the explosion.
SAR	Search and rescue operations began immediately after the first firefighters arrived on scene. The rescue units encountered a stream of dusty, injured persons fleeing the industrial area on foot.
Risk assessment	Rescue work began without a preliminary risk assessment for the rescuers. The firemen arriving on scene first were not protected with adequate equipment for a toxic cloud and with devices to detect toxic gases.
Situation Assessment	The rescuers were particularly shocked by the dumbness among the people at the factory who survived the explosion. None of them could speak. However, after a while these people recovered and actively helped those who needed it.
00:20	
Alarm	A major disaster alarm was triggered in Toulouse triggering a rescue effort.
SAR/Tech. Response	The operations were conducted on the premises of the factory and in the adjacent districts.
00:23	
Coordination	Accident Response Plan and Local Disaster Alert (Plan Rouge) were activated.

Evacuation	As many citizens attempted to leave the area in their cars, they suddenly encountered police blockades at the main roads to the south and at the central city ring road. Acting upon the order of the municipal authorities, local police closed off all motorways and the ring-road. However, movement on the roads was virtually paralyzed, because many residents rushed to their cars to pick up children and family members from schools and work places and leave the city.
Coordination	Emergency response was carried out in accordance with two pre-existing disaster plans: the Emergency Medical Aid Plan (known as PPI or "Red Plan") and the plan foreseeing the deployment of a network of emergency medical facilities ("White Plan").This ensured a quick mobilization of the necessary personnel and equipment to provide medical aid to the victims and minimize possible losses.
Triage/ Pre-hospital care	Having staffed ambulances with doctors who were on stand-by duty, a lot of medical experts could quickly reach the site, although initially there was a shortage of means of transportation. After a few hours, 60 doctors were present on-scene, most of them performing their duties at an assembly point set up a few kilometres away from the source of the explosion.
00:43	
Risk Assessment	After 30 minutes [since the arrival of the first rescue team] measurements showed that the cloud of dust and smoke caused by the explosion had a “low” toxic content.
Pre-hospital care	The assembly point started to receive the first injured at 11:00 and provided medical care to nearly 300 persons. The first aid was administered mainly to the seriously injured victims. About 85% of all seriously injured received such aid.
Resources	At the initial stage of the response, there was a shortage of material resources, especially medical supplies.
01:00+	
Medical transport	Seriously injured persons were taken to hospitals for special care, many of them using private cars.
Transport and distribution of injured	During the first day, 862 patients were taken to hospitals. The two largest hospitals in the region – the University linked Rangueil and Purpan Hospitals – received >1,500 injured persons. Rangueil Hospital received 435 injured persons; more than one-quarter of them were admitted for medical care. In addition, 50

	people, who were injured at the hospital when it was damaged, also received care. During the day of the explosion, Purpan Hospital received 1,048 injured persons; one-quarter of them were admitted.
Triage	Three-quarters of the injured who were received at Rangueil and Purpan Hospitals were able to leave the hospital the same day. Of those remaining at the hospital, 25 had suffered injuries, some of them serious. Four people were evacuated to other hospitals. Injured victims also presented at 24 other medical units, several of them private, or presented to their private general practitioners. In order to cope with the influx of injured persons, the staff at Purpan Hospital improvised, and conducted initial triage at the main ambulance entrance, where they allocated the injured to various injury sectors in the hospital.
Evacuation	Acting in accordance with the two emergency plans, the municipal authorities announced the formation of a 30-km safety zone around the city of Toulouse. They closed the local civil aviation airport, stopped all flights over the city, closed off all motorways and the city ring road, shut the railway station, stopped all railway transport, and evacuated the metro system. However, movement on the roads was virtually paralyzed because so many residents rushed to their cars in order to pick up their children and family members from schools and work places and leave the city.

Timeline adapted from: Riddez et al. (2007), Zaitseva (2014), Dechy et al. (2004) and Wohlleben (2003).

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2.3.3 2002 - Prestige Oil Spill, Spain (ULANC-SB)

Incident (000003)

Figure 5 Prestige Oil Spill off the Coast of Galicia, Spain 2002

Picture on the left*: The Prestige tanker sinking (Source: BBC News 2013)*

Picture on the righ*: Seabird covered in oil, Prestige disaster (Source: Greenpeace 2003)*

Due to stormy weather, on November 13, 2002 the oil tanker 'Prestige', carrying 77,000 tonnes of heavy fuel ran into difficulties off the West Coast of Galicia, Spain and began to spill fuel. The cause is contested, but is commonly thought to have been a 15m crack (The Guardian n.d.). The spill caused both a severe environmental crisis for the Spanish northwest coast and an economic crisis as that part of Spain relies heavily on fishing and tourism. In response, neither Spain nor Portugal would allow the tanker to port (The Guardian n.d.). As it was being towed to calmer waters, on November 19, six days after the tanker first reported trouble, the oil tanker's structure failed and it broke into two pieces (The Guardian n.d.), spilling 64,000 tonnes of oil into the ocean (Garcia 2003: 4). The event has been compared to the Exxon Valdez disaster in Alaska in 1989 (Garcia 2003: 6).

Material Damage

In total, the spill polluted 3,000km of coastline (Garcia 2003: 6), including 1,177 beaches (Hamilos 2013), as well as subtidal and continental self bottoms (Freire et al. 2006: 308). It damaged estuaries, environmentally protected areas, and killed/affected countless marine and wildlife (Castanedo et al. 2005; Garcia, 2003).

The coastline most affected was Galicia in the northwest of Spain, but Cantabria's coastline was also highly affected, as well as some of the Portuguese and French coastlines (Freire et al. 2006: 308).

It has been suggested that 66% of species diversity was lost and there was a

loss of sediment quality (Kirby and Law 2010: 798). A World Wildlife Fund (WWF) study estimates that 250,000 to 300,000 birds died putting some species at risk of extinction (Garcia 2003: 10). One year after the incident high levels of toxins were still reported in the areas close to where the tanker sank (Garcia 2003: 8) and would remain for years. Many boats and fishing gear were also ruined from the oil (Garcia 2003: 11).
Social and Human Impact
The affected coastlines were locations of business, tourism, environmental heritage, and homes (Castanedo et al. 2005; Garcia 2003). After the spill there was a 2-8 month ban on fishing/aquaculture in Galicia. In the Galician region alone, at least 33,000 locals employed by the fishing industry and 52,000 employed in tourism had their livelihoods affected or lost (Garza-Gil et al. 2006: 843). In a region where between 27% to 47% of those with jobs are employed in fishing, over 120,000 lost their jobs (Garcia 2003: 19). When fishing was reinstated, fishermen on the Costa da Morte continued to reported fewer catches (as low as 20% of normal catch) and “dwindling markets caused by loss of consumer confidence” (Garcia 2003: 11). Tourism also suffered, with considerably fewer people visiting and staying overnight in the region (Garza-Gil et al. 2006). The exposure to oil has been linked to damaged health of locals and those involved in long term cleanup (Aguilera et al. 2010).
Economic Impact
Many of the people who live in these regions rely heavily on fishing and tourism, both of which were severely affected (Castanedo et al. 2005: 272). The government gave fishing communities some compensation for their losses (Rainsford 2010). It is difficult to put a number to such things as lost biodiversity and recreational use of the areas (Garza-Gil et al. 2006: 844). There were both public and private costs associated with cleaning and restoriation (Garza-Gil et al. 2006: 843). The WWF and the Professional Economist Associations of Galicia estimates the economic damage over the next ten years can reach €5 billion (Garcia 2003: 19). The BBC noted that court documents estimated the total cost over the lifespan of the clean up at €4 billion (BBC News 2013).
Preparedness – Training, Emergency Plans, Crisis Management Models
There were various plans in place at the global, EU, regional, national, and local

levels when the *Prestige* sank.

Global Level: Many large NGOs, which work all around the world, had plans/guidelines regarding the clean-up and the protection of the environment and wildlife during oils spills (e.g. WWF) (see Garcia 2003).

EU Level: The EU Community Mechanism for Civil Protection was enacted at the request of the Spanish authorities. "[...F]ollowing the request of the Spanish authorities, the Commission immediately launched a formal request for assistance of specialized vessels for recovery of heavy fuel oil. This request, following Spanish instructions was first (14 November 2002) directed to the Netherlands, United Kingdom and France and secondly (15 November 2002) to all Member States" (EU Commission 2002).

The EU Civil Protection and Environmental Accidents Unit also remained in close contact with the Spanish authorities.

Regional Level: France was engaged in the event through the framework of a regional plan: 'Biscay Plan' (EU Commission 2002).

National Level: The Spanish authorities had a protocol in place for such accidents. In June 2001, for example, they conducted a "mock exercise in A Coruña off the Spanish Atlantic coast consisting of an imagined collision 45 miles north, in which a tankship spills oil" (Giménez 2007: 2). This protocol, however, was not followed during the *Prestige* disaster (Giménez 2007). The Spanish government also had a 'National Salvage Plan' in place which was supposed to act as a "blueprint for both sea rescue and response to pollution of marine water" (Castanedo et al. 2005: 274-273). The plan pointed to the government created organization called 'SASEMAR' as responsible for responding to such incidents, but due to the federal organization of Spain some responsibilities were given to and/or shared with the separate regional 'autonomies', such as environmental responsibilities (e.g. protecting and cleaning up after the spill) (Castanedo et al. 2005: 273). According to one author, when the spill occurred there were no forecasting systems in place that were designed to be used in oil spills (Castanedo et al. 2005: 274).

Local Level: Some Spanish autonomous regions affected by the spill did not have plans in place. In the autonomous region of Cantabria, for example, there was no pre-existing "regional contingency plan for accidental marine pollution"; rather, one was developed in situ (Castanedo et al. 2005: 273). In Cantabria, the University of Cantabria and the Regional Government, in cooperation with various national and international organisations, created an 'Emergency Spill Response System (ESRS)' as the spill and cleanup operations unfolded (Castanedo et al. 2005: 273). "The main objectives of the plan were to (1) establish an operational forecasting system for developing proper response strategies, making detailed risk assessment, and protecting natural resources; (2) perform damage assessment and monitoring of coastal ecosystems; and (3) propose and apply restoration measures in oiled coastal areas." (Castanedo et al. 2005: 273).

Interoperability – Information Sharing Communication, Coordination, Collaboration, Information Flows
The decision to keep the tanker at bay by both Spain and Portugal involved dispatching navy warships to keep the tank away (Bahree et al. 2002). In the end, a salvage company was used to tow the tanker away from the coastline. From the start of crisis, NGOs (especially WWF) gave advice to the government and helped to coordinate the cleanup (Anderson and Marhadour 2007; Garcia 2003). WWF created a crisis group to oversee communication and conservation policy strategies that involved various national organizations, holding meetings withgovernment officials, scientists, national and local NGOs, local fishermen's organizations, and the International Tanker Owners Pollution Federation (ITOPF). In other cases, NGOs like the International Fund for Animal Welfare sent in emergency relief teams for animal rehabilitation centres and to train regional authorities and volunteers to collect, rehabilitate and release wildlife (see Garcia 2003). The Spanish and Galician governments have been accused of not consulting non-governmental marine scientists (Anderson and Marhadour 2007: 99-100). Universities conducted separate monitoring and assessment activities. It took 2 mnoths, in January 2003, for the Spanish government to design and approve plans to manage funds for research, the Urgent Strategic Action and mid term Scientific Response (Albaigés et al. 2006: 205). The Univeristy of Cantabria, in collaboration with NOAA's HAZMAT devision, desgined the Emergency Spill Response System (ESRS) to help with the logistical problems of bringing together and organizing a large workforce (many of whom had no prior experience), technological tools, and the various resources that were needed to tackle the spill (Castanedo et al. 2005: 273). It coordinated weather and ocean forcasting systems, protecting sensitive areas, assessing damage, monitoring and restoring the environment in order to provide "real time" information in the form of maps and graphics of oil spill trajectory. The Crisis Center received the data once daily via fax or e-mail for for strategic (Castanedo et al. 2005: 274). Information for decision making was also provided by 25 on-the-scene observers from the Environmental Agency of Cantabria and fishing boats in the tidal inlets. (Castanedo et al. 2005: 274). Some key observations regarding the interoperability of this system are: **(1)** The data collected from the overflight observations were often done by inexperienced observers, which resulted in "incomplete and sometimes contradictory" reports that provided little information about the oil slick (Castanedo et al. 2005: 275). Overflight data was provided via fax or email twice a day (at 12:00 and at 17:00) by the Spanish and local government (Castanedo et al. 2005: 275). This data was not given in 'digital format' and, thus a time-consuming practice was used that involved filling out, by hand, a worksheet, difficult when 50 observations a day were often made over a 5 month period. **(2)** A range of organisations provided different forms of meteorological and

oceanographic data. The National Meteorological Institute provided 48-hour forecasts of wind velocity and direction. The Puertos del Estado (State Ports of Spain) provided data and 48-hour forecasts of sea conditions one a day via e-mail for ftp to the ESRS. The US Naval Research Laboratory (NRL) provided data on ocean currents once a day via ESRS. The Marine Research Institute also deployed 4 Argos drift buoys, with the University of Vigo, to follow the oil spill's trajectory (Castanedo et al. 2005: 275-276).

(3) The information provided by ESRS was used by decision-makers and local fisherman to plan and coordinate clean up over both deep and shallow waters, including fishing fleets, large oil recovery vessels, ports, and oil transport (Castanedo et al. 2005).

(4) A Cantabrian Open-Sea Response Team was developed with a "coordinator from the Environment Agency of Cantabria, a delegate of the Cantabrian Government, and a representative of the fishermen, including all eight fishing ports of the region" (Castanedo et al. 2005: 282).

(5) A Cantabrian Coastline Response Team was formed, consisting of over 500 technicians and volunteers working in beach cleanup (by hand, by bulldozer, by rake) and observation operations (Castanedo et al. 2005: 283).

Responder Safety
Many of the thousands of workers and volunteers who responded to the oil spill did so without appropriate bodily protection. No guidelines were provided by the government, so University scientists and NGO improvised basic guidelines. (Garcia 2003). Those who did not wear protective gear during cleanup have been reported to have had or continue to have health problems as a result of their exposure to the toxic oil, including higher risks of cancer (Aguilera et al. 2010; Rainsford 2010).
Stakeholders
The EU National/regional governments of the affected countries (e.g. Spain, Portugal, France) National/regional Environment Agencies Coastguards Universities (e.g. Cantabria University; Vigo University) National Meteorological Institute Puertos del Estado (State Ports of Spain) The Marine Research Institute Volunteer pilots for visual observations US Naval Research Laboratory (NRL)

U.S. National Oceanic and Atmosphere Administration (NOAA) Tanker Owners Pollution Federation Oil Recovery vessels A salvage company Military Local and international NGOs (e.g. Greenpeace; World Wildlife Fund; SEO/Birdlife/Spanish Society for Ornithology; International Fund for Animal Welfare; Friends of the Earth) Seaside communities Local fishermen Volunteers from across Spain and Europe
Public Engagement
Many NGOs and private persons engaged in distributing information about the oil spill and/or organizing volunteers for cleanup efforts (Anderson and Marhadour 2007).
Public Response
This disaster gained international visibility because of the large area affected, the potential long terms socioeconomic and ecological effects, and the slow governmental response (Albaigés et al. 2006: 205). There was anger and concern over how the Spanish government handled the event, leading to many large public demonstrations and the creation of various protest groups (e.g. 'Nunca Mais'/Never Again) and international NGOs (e.g. Greenpeace)(Anderson and Marhadour 2007; Freire et al. 2006; Garcia 2003). Thousands of people (including fisherman, local residents, NGO volunteers) actively volunteered to help with the cleanup (Albaigés et al. 2006: 205). Fishing boats were converted into cleaning vessels with make-shift skimming devices for surface oil removal. These volunteers also acted as observers where there were none otherwise (Castanedo et al. 2005: 282).
Media
The international, national, and local media reported on the *Prestige* oil spill, with more attention (and for a longer duration) given to it from local media outlets (Anderson and Marhadour 2007). At the beginning of the disaster, mainstream news reporting relied upon foreign research institutes as sources rather than Spanish institutes and the government (p. 99) because the Spanish government was too slow at issuing information, so "traditional Spanish media – most of which is controlled by the government – [...] largely failed to cover the event" (Scheeres 2002 as cited in Anderson and Marhadour 2007: 107). In contrast, the French and Portuguese scientific

communities published detailed information right from the outset of the crisis, details that came faster and often conflicted with the Spanish governments findings. There was distrust in the media regarding the 'official version' of events coming from the Spanish government (Anderson and Marhadour 2007: 99-100). This was exacerbated after the Spanish government prohibited the public TV from using the term 'oil spill' (Vilas Paz 2004 as cited in Anderson and Marhadour 2007: 108). There was considerable alternative media reporting on the issue, most notably personal accounts/stories, photographs, independent documentaries and reports, and web logs provided on the Internet provided by local universities, international NGOs (e.g. Friends of the Earth, World Wildlife Fund, and International Fund for Animal Welfare, Greenpeace) and emerging activist/protest groups (e.g. 'Nunca Mais', 'TsF Prestige', 'Burla Negra'). One of the more popular websites was started a days after the spill by University of Vigo and drew upon data from international marine science institutions. Sometimes these groups even coordinated their reports and online forums (Anderson and Marhadour 2007: 108). They used this coverage to organize volunteers and to to publisize petitions to challenge official accounts and pressure the government into action (p. 107).
Ethical, Legal and Social Issues
<u>International questions about national government response on a potentially global issue</u>: Some commentators argue that the Spanish government was slow to react to the ill-fated Prestige tanker, with internal politics to blame for the lack of immediate action (Giménez 2007). French officials have also criticised the Spanish government for its slow reaction (BBC News 2003). Many academic authors suggest that how the Spanish governments sent the *Prestige* away was the wrong decision and that it was made as a result of internal politics rather than based on scientific evidence (Garcia 2003; Giménez 2007). For example, while the government argues that this was a "technical decision" to turn the *Prestige* away, "no reports have even been issued to 'prove' this and "the marine scientific community largely regretted the decision was taken heedless of the knowledge on sea currents gathered over the years" (Giménez 2007: 2). <u>Questions about why non-government resources were ignored</u>: A report commissioned by French MP Philippe de Villiers argues that "[...] "good sense" should have told Spain to bring the stricken vessel into the port of La Coruna" (BBC News 2003). A WWF report suggests that at the "very outset of the crisis, the WWF issued an alert on the extraordinary ecological importance of the Galicia Bank, warning that every possible measure should be taken to prevent the tanker entering this area. Just a few days later, the Prestige when down precisely over the banks of this undersea mountain" (Garcia 2003: 8). <u>Untrustworthy Information</u>: Various authors have argued that the information that the Spanish authorities provided to the public after the oil spill was misleading and/or inaccurate and, thus, it was deemed to be untrustworthy (Anderson and Marhadour 2007; Garcia 2003; Giménez 2007). Some scholars suggest that the

government may have been trying to downplay the scenario (Garcia 2003) or sensor what was being said, a conception so strong that a petition was presented to the European Parliament demanding investigation (Anderson and Marhadour 2007) and that it should be blamed for the slow response (Giménez 2007: 3). The result was a plethora of protests and alternative media reporting on the issue (Anderson and Marhadour 2007).

Communication and Accessibility: Much of the alternative media was done via the Internet. However, in 2001 only 14.6 percent of the Galician population are thought to have had online access, so author argues that "[...] the Internet Web sites created in Galicia were made by activists *for* activists, and that the great majority of the Galician population was kept informed by the traditional mass media." (Anderson and Marhadour 2007: 110).

Poor Clean-up Operations/Coordination: While there was an apparent "a lack of resources, expert guidance, equipment and coordination" (Garcia 2003: 21), some authors argue that the Spanish government did not use all the means/resources available to prepare for the spill from the first moment of the event, even initially rejecting international aid (Giménez 2007: 3). There was also a general lack of coordination in the cleanup operations, with many people engaging in the cleanup without knowledge of the potential health risks and/or without proper protective gear (Aguilera et al. 2010). The WWF also argues that the cleanup operations did not follow their guidelines and put 'cosmetics' before the environment and, thus, caused further damage (Garcia 2003). This NGO issued a report on how to cleanup oil, including "guidelines for different habitats, along with many recommendations, derived from experience at previous spills, on how to prevent environmental damage", but that the Spanish government's guidelines did not include all of the WWF's recommendations and the omissions had the ability to cause further "damage to coastal fauna and flora, and jeopardize or seriously delay proper recovery" (Garcia 2003: 21). Furthermore, the people who carried out the cleanup did not follow the guidelines, leading to further environmental damage (Garcia 2003: 22).

Economic Priorities: A WWF report suggests that the government put socio-economic concerns before environmental concerns in some of its cleanup operations, leading to further environmental destruction (Garcia 2003: 21). It further argues that the Spanish government re-opened the fisheries too soon and that, despite reports of oil in the area, trawling beyond 12 miles was never suspended (Garcia 2003: 11). These decisions were deemed to not only have contributed to further negative environmental affects, but also to have potentially negative human health effects due to people consuming seafood and fish sourced too soon from the area. In general the WWF suggests that too little research was done on the long-term effects of the oil spill, such as the remaining toxicity and potential health effects (Garcia 2003).

Legal Battle: There has been a decade long court battle over who is to blame for the disaster. The Greek captain, the ship's engineer and the former head of the Spanish merchant navy were all put on trial for the spill. All have been acquitted. Another crewmember – the second officer – who was also charged, is still on the run (BBC News 2013). A civil suit was also put against the American Bureau of

Shipping, which had certified the *Prestige* as okay to sail; the case was "dismissed by a court in New York" (Hamilos 2013). The lack of charges brought in this case has been condemned by various NGOs, who suggest that it presents a 'green light' for further pollution.	
Data-sets used	
gathered prior to disaster	Maps of coastline and locations of estuaries and environmentally sensitive areas. Taxonomy lists of regional flora and fauna; endangered species in the area. Pre-existing hydrodynamic information of estuaries and sea currents data. Other important data included: "boom types, mooring and anchoring systems, boom availability, aerial photographs, and existing bathymetry of the estuaries." (Castanedo et al. 2005: 285).
gathered during disaster	Overflight photos and visual observations of the oil spill (e.g. location, size, appearance in regards to colour/thickness), predicted trajectory). Meteorological and oceanographic data (e.g. weather conditions; wave climate; tidal wind currents) – sometimes using wave buoys and tidal gauges and local meteorological stations. Wind data from the National Meteorological Institute using High-Resolution Limited Area Modelling. Sea condition data from Puertos del Estado (State Ports of Spain) using Mediteranean Wave Forecast numerical model (gave wave height, direction, and mean period). Oceanic current data was output of the Naval Research Laboratory's Navy Coastal Ocean Model. Oil Slick trajectory data from the Marine Research Institute and the University of Vigo via 4 Argos drift buoys (Castanedo et al. 2005: 277). Hydrodynamic data (depth and flow of water) from 14 estuaries in region (Castanedo et al. 2005: 273-274). Bird/Wildlife statistics
gathered immediately after disaster	Damage to wildlife Longer term health data of clean-up volunteers has also been gathered. Data regarding the "spatial and temporal distribution of hydrocarbons in the different marine biotic and abiotic compartments, along the Northern Spanish coast" (Albaigés et al. 2006: 206).

	“the impact on biota was studied at the level of biomarker responses, bacteriaoplankton, some intertidal organisms, as well as different shelf communities and their trophic structure.” (Albaigés et al. 2006: 206).

Lessons Learnt	
explicit	*Need notification systems to monitory maritime traffic and dangerous cargoes.* Drawing on the previous oil spill of the oil tanker Erika in 1999, the EU adopted measures entitled Erika I and Erika II to help improve maritime safety. In November 2002, they were just being rolled out (EU Commission 2002). *Greater speed needed when ratifying new regulations and conventions of such international significance.* This includes not taking 3 years to get the Erika measures into practice and quicker impliementation of updates to international protocol like MARPOL and related national legislation (Garcia 2003: 14). *Need local/regional response management plans; cannot rely on international plans or external orgnaizations* (Castanedo et al. 2005: 288). *Need scientific response plans* to organize and coordinate researchers. A plan was set up in January 2003 focusing on oil behavior at sea and in the environment, biological effects, seismic risks for maritime wrecks, socio-economic impacts. It also included the definition and implementation of contingency plans like the oceanographic observational data systems that can predict oil trajectories at sea (Albaigés et al. 2006: 205). *Needed a red-tide early warning system*, a system that has beeen established post-spill by Galicia’s Marine Environment Quality Monitoring Centre (Centre de Control da Calidade do Medio Marino) (Garcia 2003: 6).
implicit	*Need improvied national decision making structure for this scale of disaster* (Albaigés et al. 2006; Anderson and Marhadour 2007; Freire et al. 2006; Garcia 2003). *Better protective gear and instructions for use* are required for those doing the clean up in future similar situations (Rainsford 2010).

Timeline	Response
13 Nov	

Mid-day	Prestige oil tanker is battered by severe weather off the north-west coast of Spain. A mayday message is sent out to the Spanish coastguard (Bahree et al. 2002).
17:30	The Spanish coastguard airlift 24 crewmembers to safety, leaving behind the Captain and 2 other senior crewmembers (The Guardian n.d.).
18:30	Tugboats arrive to try and get the tanker under control (Bahree et al. 2002).
Nov. 14	A “coast-guard technician and an inspector from the harbour master’s office in La Coruña [...] helicopter out [to the tanker] for an assessment. They found the steel hull so severely damaged that the entire vessel was in jeopardy” (Bahree et al. 2002). The Director General of Spain’s merchant-marine service makes the decision to tow the ship away from the Spanish coastline (Albaigés et al., 2006: 205).. Warship Cataluña is dispatched to make sure this happens. The tanker is towed 25 miles in a north-east direction (Bahree et al., 2002).
19:00	France, Britain, and the Netherlands send “antipollution equipment, including nearly five miles of floating barriers” (Bahree et al. 2002).
Nov. 15	“An urgent written procedure was launched (approved on Friday 15 November), to enable the sending of a [EU] Community task force, if requested by the Spanish authorities.” (EU Commission 2002).
02:00	Salvage experts are helicopter dropped on the tanker’s deck.” (Bahree et al. 2002). Salvage experts recommend bringing vessel into calmer waters to pump oil into other vessel. The tug boats change direction; the tanker is now being taken south-west (Albaigés et al. 2006: 205).
Sunset	The Captain and remaining crew contact the coastguard; they are evacuated and when the Captain arrives at the airport, he is immediately arrested on several charges (Bahree et al. 2002).
Nov. 16	Under the Biscay Plan, France sent a specialized oil vessel; it arrives on the 16th (EU Commission 2002).
11:00	The salvage company is not able to convince the Spanish authorities of the plan to bring the tanker into a local (Bahree et al. 2002). They only wanted the oil tanker taken as far away as possible; did not trust that bringing it closer to land would advert the problem.

	Salvage company turn the vessel; they want to tow it so that the damaged hull faces away from the waves (Bahree et al. 2002). Salvage company decide to take the vessel toward Cape Verde Islands off Senegal where the Atlantic waters are calm (Bahree et al. 2002). Start going south-west.
Nov. 17 24:00	The tanker is still being taken south-west. Portuguese warship Joao Coutinho approaches and gives orders; they were not allowed to bring the vessel within 200 miles of the Portuguese coast. To comply with this, the vessel had to be brought more westward (Bahree et al. 2002).
Nov. 18	The tanker is still being taken south-west.
Nov. 19 07:50 09:30 16:15 **Dec. 5**	"The European Commission - Civil Protection and Environmental accidents Unit - remains in close contact with the Spanish authorities, and since the morning of 19 November, with the Portuguese authorities." (EU Commission 2002). The Netherlands sent a specialized oil vessel; it arrives on the 19th (EU Commission 2002). The Prestige oil tanker starts to break into two parts. The two parts are at 45-degree angles; The rear part of the tanker sinks in 3,600m of water (The Guardian n.d.). The Prestige sinks; it is 133 miles west of Spain and Portugal (Bahree et al. 2002). Much of the tanker's 77,000 tonnes of crude oil escape from the vessel and affect the coastlines of Spain, Portugal, and France. 17 days later the oil reaches the Cantabria coast, a region in the north of Spain (Castanedo et al. 2005).
Summer 2003	Recovery efforts for the remaining fuel in the sunken tanker start (Albaigés et al. 2006).
Nov 2013	Oil tanker crew acquitted

Timeline adapted from: Albaigés et al. (2006), Castanedo et al. (2005), EU Commission (2002a), and The Guardian (n.d.)

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2.3.4 2003 - Global SARS Outbreak - EU Lessons (ULANC-SB)

Incident (000004)

Figure 6 Global SARS Outbreak – EU Lessons

***Picture**: SARS-related scenes (Source: Fong 2013)*

In February 2003 Severe Acute Respiratory Syndrome (SARS) was discovered in Asia. Over a six month period the SARS outbreak spread – through human air travel – to "more than two dozen countries in North America, South America, Europe, and Asia" (CDC 2013). In terms of illness and death Europe was not severely affected by the SARS outbreak. The World Health Organisation (WHO) confirmed 33 cases in Europe. The country/case breakdown is: France (n=7), Germany (n=9), Italy (n=4), Ireland (n=1), Romania (n=1), Spain (n=1), Sweden (n=5) Switzerland (n= 1), and the United Kingdom (n=4) (WHO 2004). The countries most affected were: China, Hong Kong, Taiwan, Singapore, and Canada (WHO 2004).

Material Damage

n/a

Social and Human Impact

According to the WHO the 2003 outbreak of SARS infected 8,096 people around the world, with a total of 774 SARS-related deaths recorded (WHO 2004). Within Europe, of the 33 confirmed cases of SARS, there was only 1 reported SARS-

related death. However, in China, Hong Kong, Taiwan, and Singapore there were 7,669 SARS cases with 718 deaths. Outside of Asia, Canada was hit the hardest with 251 cases and 43 deaths (WHO 2004). Besides death, illness, and social panic, SARS also caused considerable disruption to both business and leisure travel plans in and out of SARS-affected areas. It also had a particularly large social impact on Chinese communities around the world. For example, European-Chinese communities expressed feeling 'suspect' and blamed (see Jiang 2009).
Economic Impact
Analysing the economic impact of SARS is challenging. Looking at countries which had at least 5 cases of SARS, Keogh-Brown and Smith (2008) suggest that SARS had the largest economic impact on the worst affected countries (e.g. the affected East Asian countries and Canada), with sectors such as investment, retail, restaurants, hotels, tourism, and air transport exhibiting the greatest impacts (p. 118). Their analysis suggests, for example, SARS-related GDP losses of US$ 3.7 billion for Hong Kong, US$ 3.2-6.4 billion for Canada, and US$ 4.9 billion for Singapore (p. 117). This analysis did not find any SARS-specific GDP losses for European countries. However, another study highlights how European-Chinese businesses and livelihoods suffered as a result of the outbreak. For example, many European-Chinese found their businesses struggling or unable to survive during this period as people avoided going to Chinatowns (see Jiang 2009).
Preparedness – Training, Emergency Plans, Crisis Management Models
At the time of the 2003 SARS outbreak the EU had "extensive defensive mechanisms for dealing with contagious animal diseases such as foot-and-mouth or the plague, [but] Brussels has no corresponding framework in cases of human epidemics" (Deutsche Welle 2003). Consequently, the European Member States followed their own protocols and, thus, took different approaches to the problem (BBC News 2003).
Interoperability – Information Sharing Communication, Coordination, Collaboration, Information Flows
. At the time of the SARS outbreak, the EU had already developed its Early Warning and Response System (EWRS). Set up in 1999, the EWRS is a "confidential computer system allowing Member States to send alerts about events with a potential impact on the EU, share information, and coordinate their response" (EU Commission Website). It was used extensively during the SARS outbreak and is thought to have: "provided a unique tool to circulate reliable information quickly to the Commission and to the members of the EWRS" (EU Commission 2005). The content of the messages circulated through this system during the SARS outbreak included: (a) measures undertaken by Member States to control the outbreak, which provided useful information to help co-ordinate the

response and (b) case and update reports. While the system worked well, the “nature and magnitude” of the event led to large and rapid flows of messages; there was an overload of the EWRS mailbox which had “a negative impact on processing and interpreting data on control activities”. According to the European Commission, “[t]he problem was solved by creating a specifically dedicated functional mailbox for selected messages (e.g. Case and update report, official communications, call for meetings and consultation teleconferences etc.)” (EU Commission 2005).
Responder Safety
A key concern during the SARS outbreak was transmission to health care workers. Due to poor understanding of the disease during the beginning stages of the outbreak, various health care workers around the world were infected; some of them subsequently died of the illness. Indeed, it is reported that 20% of those who became infected globally were health care workers (Branswell 2013). It was only after health care workers started to wear respirators that the outbreak was brought under control.
Stakeholders
Health care workers International health organisations (e.g. WHO) National and regional governments/public health authorities Virologists and epidemiologists Representatives of scientific and academic institutions Veterinary authorities Representatives of public/private organisations that monitor health indicators Representatives of pharmaceutical manufacturers/distributors Representatives of social service administrators Representative of military NGOs (e.g. Red Cross) Telecommunications/media relations experts The global travel/tourism business (e.g. airlines, hotels, restaurants, etc.) Citizens (list modified from: WHO 2005)
Public Engagement
Public Response
Various individuals took to wearing masks in public in an attempt to protect

<table>
<tr><td colspan="2">themselves from SARS. Other people – for example those who had recently travelled to SARS affected parts of East Asia – underwent self-imposed quarantine by avoiding family and friends when they arrived back in their country of residence (see Jiang 2009).</td></tr>
<tr><td colspan="2">Media</td></tr>
<tr><td colspan="2">The news media reported extensively on the SARS outbreak.</td></tr>
<tr><td colspan="2">Ethical, Legal and Social Issues</td></tr>
<tr><td colspan="2"><u>New powers to close borders</u>: Some EU states have legislated powers for closing of borders, compulsory screening, medical examination, treatment, vaccination (prohibited by laws in other states), capacity for community control (e.g. prohibition of gatherings, school closures) and quarantine measures (Martin et al. 2010). Many of these protocols have the ability to infringe on basic human rights, as well as challenge the EU principle of free movement.

<u>Sharing health data</u>: There are also potential ethical concerns when it comes to sharing health and perhaps travel data across different global, international, and national contexts.

<u>Targeting people of a particular ethnic group</u>: e.g. for quarantine and/or within the media – is also something that needs to be critically considered.

<u>Safety of responders</u>: Ethical issues in balancing safety of victims and safety of health responders.</td></tr>
<tr><td colspan="2">Data-sets used</td></tr>
<tr><td>gathered prior to disaster</td><td></td></tr>
<tr><td>gathered during disaster</td><td>health data sets from government/regional health authorities provided to EU

WHO health data from around the world.

Airline travel data regarding who was traveling to and from SARS ‘hotspots’.</td></tr>
<tr><td>gathered immediately after disaster</td><td>SARS samples were gathered and used in further medical tests in efforts to better understand the disease.</td></tr>
</table>

Lessons Learnt	
explicit	*Need an international pandemic preparedness checklist*. The 2003 global experience of SARS and other global outbreaks (e.g. H1N1) helped galvanize the EU to construct better coordination and preparedness plans for contagious disease outbreaks. In 2005 the WHO published a pandemic preparedness checklist.The European Commission has since updated their contagious disease plan to align with this list (Mounier-Jack and Coker 2006). Since 2003 each EU country also developed/updated their own National Pandemic Preparedness Plans (see WHO Regional Office for Europe Website). *Need a european-wide disease prevention center.* Since 2003 the EU has also developed a European Centre for Disease Prevention and Control (ECDC). The ECDC shares best practice and experience in preparedness and response planning; promotes the interoperability of national preparedness planning, addresses the intersectoral dimension of preparedness and response planning at the EU level and supports the implementation of core capacity requirements for the surveillance and response to the WHO's International Health Regulations Articles 5 and 13. According to the ECDC website, its areas of activity include: national focus points meetings; exchange of knowledge and information on threats and outbreaks through the Epidemic Intelligence Information System (EPIS); influenza pandemic preparedness; communicable disease threats at mass gatherings; bioterrorism and intentional threats; simulation exercises, training workshops; outbreak assistance teams; emerging and re-emerging diseases; outbreak support; development of guidelines, self-assessment instruments and tools to improve preparedness capabilities; and, support to countries in building capacities and crisis communication, facilitating sharing of experience, providing tools and resources (ECDC Website). *Need increase of information exchange across borders, particularly health information*. Data sharing regarding public health risks is done through the EU Network for epidemiological surveillance and control of communicable diseases, of which the Early Warning and Response System (EWRS) is a part. The European Centre for Disease and Control (ECDC) also coordinates the European Influenza Surveillance Network (EISN); information regarding influenza surveillance is disseminated through the 'Weekly Influenza Surveillance Overview (WISO). Furthermore, the Consumers, Health and Food Executive Agency (CHAFEA) also disseminates health-related information. The EU Health Security Committee also aims to improve cooperation and

	networking between laboratories (EU Commission Website). Many EU countries also participate in the WHO's Global Outbreak Alert and Response Network (GOARN).
implicit	*Need to continue to integrate national pandemic preparedness plans*. While there is greater global (e.g. WHO), international (e.g. EU), and country-level preparedness since 2003, some scholars have argued that EU National Pandemic Preparedness Plans remain significantly differentiated in regards to both their content and legal underpinning, and that some plans still do not explicitly note the need for collaboration with other member states during such crises (see: Martin et al. 2010; Mounier-Jack and Coker 2006).

Timeline	*Response*
November 16, 2002	First case of atypical pneumonia reported in Guangdong province in southern China.
February 14, 2003	Chinese Ministry of Health reports 300 cases, including five deaths in Guangdong province from SARS.
March 11	Hong Kong health officials report an outbreak of SARS.
March 12	The WHO issues a global alert for a 'severe form of pneumonia'.
March 15	The WHO confirms the global health threat of SARS and warns travellers to South East Asia about SARS.
March 19	SARS spreads to the US and Europe – the UK, Spain, Germany, and Slovenia report cases.
March 27	The WHO recommends screening of departing travellers from the worst affected areas.
March 29	The WHO official who first identified SARS - Carlo Urbani - dies of the disease.
April 2	The WHO recommends all non-essential travel to Hong Kong and Guangdong province of China be postponed.
April 5	China apologises for slow response to SARS outbreak; there are allegations that officials may have tried to cover up the extent of the spread of the disease.
April 9	The first SARS case in Africa is reported.

April 14	Canadian scientists sequence the genome of the SARS virus.
April 17	The first case of SARS in India is confirmed.
April 22	The US issues a health alert for travellers to Toronto, Canada.
April 23	The WHO recommends the postponement of all non-essential travel to Toronto, Canada. In Beijing all schools are shut for 2 weeks.
April 26	13 East and South-East Asian Countries call for international travellers to be screened for SARS.
April 27	Authorities in Beijing order all entertainment venues to be closed (e.g. theatres, cinemas, karaoke bars).
April 28	WHO says that Vietnam has contained the virus, as 20 days gone by with no new reported cases.
May 5	10,000 people in the Chinese city of Nanjing are quarantined.
May 6	The US has successfully contained the outbreak.
May 11	The Chinese city of Guangzhou bans spitting in public.
May 15	Chinese authorities threaten jail or execution for those who break quarantine.
May 20	The US lifts their travel alert to Toronto, Canada as 30 days have gone by with no new cases having been reported.
May 22	Taiwan infection rate reaches apex (65 new cases in one day).
May 23	US reinstates travel alert for Toronto, as 5 new possible cases reported.
May 31	Singapore is declared SARS free by the WHO.
June 4	US removes travel alert for Singapore and downgrades travel alert for Hong Kong.
June 5	WHO says global outbreak has reached peak.
June 13	WHO withdraws travel warnings for various Chinese provinces; maintains it for Beijing.
June 17	WHO withdraws travel warning for Taiwan.
June 23	WHO removes China and Hong Kong from SARS infected areas

	list.
July 2	WHO declares Toronto SARS-free as there have been 20 day within no new cases reported.
July 3	US removes travel alert for China.
July 5	WHO declares global SARS outbreak as contained.
July 10	US withdraws travel alert for both Hong Kong and Toronto.
July 15	US withdraws travel alert for Taiwan.
September 9	Singapore announces a patient has SARS; the case not confirmed by the WHO.
December 17	A medical researcher in Taiwan contracts SARS.
January 5, 2004	China confirms a case of SARS in Guangdong province; thousands of civet cats are to be slaughtered to curb the disease spread.
January 13	The US bans the import of civet cats.
January 16	WHO reports evidence that civet cats do carry the SARS virus.
January 17	2 new cases of SARS confirmed in China.
April 26	Potentially 4 new cases of SARS in China.
May 19	WHO says China contained latest outbreak.

Timeline adapted from: BBC News (2004) and CDC (2013).

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2.3.5 2004 - Madrid Train Bombings, Spain (ULANC-SB)

Incident (000005)

Figure 7 Responders Help Remove the Injured from Bombed Train in Madrid

(Source: ABC 2014)

On March 11, 2004, 10 different explosions occurred on 4 different commuter trains at four different locations in the city of Madrid: Santa Eugenia Station, Atocha Station, Téllez Street, and El Pozo Station. The trains were full of commuting workers, students, and children. It was an organised terrorist attack organized by an Al-Qaeda inspired cell, though no direct links to Al-Qaeda have been proven. This attack surpassed all those previously experienced on European soil (Brändström & Örtenwall 2007).

Material Damage
The bomb explosions destroyed 3 locomotives and 5 coaches in 3 different model 446 trains, and they destroyed another 2 coaches in a model 450 train; there was also extensive damage to railway installations and to the 3 affected stations, and damage was caused to 114 houses that lay in the vicinity of the explosions (Buesa et al. 2006: 18).
Social and Human Impact
In total 119 people were killed in the explosions and approximately 2,000 people were injured, some very severely (e.g. blindness, amputations) (Peral-Gutierrez de Ceballos et al. 2005). Some people also experienced severe shock, with others experiencing more lasting psychological issues, such as posttraumatic stress disorder (see Fraguas et al. 2006; Peral-Gutierrez de Ceballos et al. 2005). There were mass demonstrations after the attack, highlighting the impact the bombings also had on the wider Spanish population. One study highlights how the general population experienced sadness, disgust, anger and contempt after the bombings and, to a lesser extent, fear (Conejero & Etxebarria 2007: 283).
Economic Impact
While very hard to quantify, one working paper suggests that the minimum direct cost of the March 11, 2004 terrorist attacks was approximately 212 million Euros for the region of Madrid (Buesa et al. 2006: 24). This calculation takes into consideration: the costs of rescue and initial attention to the victims; hospital costs; costs of human lives lost/injuries in regards to compensation; loss of wages to people injured in the attacks; damages to rail infrastructure, rolling stock, and houses that were damaged; costs of infrastructure for the identification of victims and attention to relatives; cost of psychological services; opportunity costs which other citizens incurred to express solidarity with the victims of the attacks (Buesa et al. 2006: 8). This estimation does not take into account the indirect costs, such as loss in revenue from tourism (e.g. hotel occupation, entertainment, restaurants, etc.).
Preparedness – Training, Emergency Plans, Crisis Management Models
The police arrived at the scene and implemented a ‘Cage Operation’, a plan designed to create a containment perimeter (by stopping and searching vehicles and requiring idenficaton) to keep terrorists in a specific region (Lessons Learned Information Sharing n.d.). Madrid had several different EMSs, each with their own structure, including: (1) Madrid-112 (M-112) an emergency call centre; (2) Servicio de Urgencias Médicas de Madrid (SUMMA) run by the regional government and operates in both the province and city of Madrid; (3) Servicio de Emergencias de la Comunidad de Madrid (SERCAM) run by the regional government and operates in the province of Madrid, but not in the city; (4) Servicio de Asistencia Municipal

de Urgenica y Rescate-Protección Civil (SAMUR-PC) run by Madrid City Council and operates in the city; (5) Cruz Roja Espanola (CRE) a volunteer-based service that operates throughout the country; and (6) numerous civil protection organisations based in towns and villages (López Carresi 2007: 41).

The main emergency plan in Madrid was the: 'Plan Territorial de Emergencias de la Comunidad de Mardid' (PLATERCAM). This plan describes the different groups (medical/logistic) that should be set up in emergencies, as well as different emergency levels; different emergency levels give command/control to different authorities (e.g. local/regional). However, the plan left unclear how roles should be assigned. In addition, the plan's command and control structure was not followed (López Carresi 2007).

An 1998 agreement aimed to dedicate which EMS must respond to different emergencies, but it did not describe responsibilities and procedures in the case of a major event. A higher order plan 'Procedimiento Municipal de Emergencia Sanitaria' (PEMES) was unfamiliar to responders (López Carresi 2007).

There were different call-out procedures between the different organisations. In response to the differences and lack of plans for large scale disasters, many responders acted on their own initiative (López Carresi 2007). For example, the Spanish Red Cross, which usually waits to be formally asked to assist in a disaster, did not wait to start to help (The Guardian 2004).

There was no triage system or use of triage tags. There was also no plan to provide drinks/food for the responders (López Carresi 2007).

Hospitals had disaster plans. One of the largest public hospitals – the GMUGH -- received about a quarter of the causalities (Peral-Gutierrez de Ceballos et al. 2005). The aim of GMUGH's plan was to increase the hospital's capacity by cancelling scheduled operations and readying operation rooms; discharging as many patients as possible and/or moving patients to other wards; setting-up triage outside the hospital; and setting-up an information point for family, authorities, and media in an adjacent building (the Teaching Pavilion). However, no hospital emergency training drills had been done in collaboration with the EMSs (Turégano-Fuentes et al. 2008).

There was no pre-existing plan in place for the performance of forensic tasks in such a large scale disaster event; this was improvised by drawing upon the UK's Royal Society of Pathologist's recommendations/guidelines that were set-up in response to the Lockerbie attack. These UK guidelines helped to inform and manage the forensic actions taken in Madrid, including: where to locate the mortuary and how to process/identify the bodies (Prieto et al. 2007).

Interoperability – Information Sharing Communication, Coordination, Collaboration, Information Flows

Information Sharing/Communication

There were communication problems between units in the field: All of the different emergency services (medical and non-medical) at the explosion sites had their own communications centres and (and incompatible) radio frequencies so much communication was done in person or via telephone; there were no shared channels for responders in the field. The M-112 emergency call centre also did not maintain radio contact with all the different responding units; the coordination centre of each different EMS did this type of communication for their own units.

Even within individual organisations there were communication issues. For example, the SAMUR-PC radio system has 10 different communication channels, the same channel was used for all 4 explosion sites for the first 2 hours. The system became overloaded. When the mobile phone network was suspended, this meant some units had no means of communication (López Carresi 2007).

Unclear geospatial communication: Many responders and EMS did not understand that there were two explosion sites because Téllez Street was only 500m from Atocha Station. Police officers who saw the Téllez explosion diverted some ambulances to the site but the diverted ambulances thought that they had arrived at the Atocha explosion site and did not communicate properly their locations. For the first hour, reinforcements were only being sent to Atocha. At Téllez, 10 medics had to deal with more than 150 victims during this time (López Carresi 2007).

No communication between blast sites and the hospitals: hospitals did not know how many casualties to expect (López Carresi 2007; Turégano-Fuentes et al. 2008). Not all patient movements were registered due to radio logjams. One medic started registering onsite ambulances at the Atocha site using paper and pen. There were also a high number of uncontrolled evacuations from the site, with people evacuated using private cars (López Carresi 2007).

Ad-hoc online database system set up: The GMUGH hospital set-up a database system for arriving casualties and shared it online between hospitals/authorities (Turégano-Fuentes et al. 2008).

Forensic data shared between agencies: Police shared National Identity Document files to help forensic officers to quickly identify bodies. However, in the cases where fingerprints could not be used, greater access to dental/medical records may have made identification easier (Prieto et al. 2007).

Coordination/Collaboration

Unclear and different call-out procedures among the responding agencies left responders waiting to be deployed: For example, At 11:00 two buses were filled with medical personnel, but only one was instructed to leave the facility due to contradictory orders/confusing information.

Problems with command and control at the different explosion sites: Numerous senior EMS managers from different EMSs converged on the sites, but there was confusion about who was in charge, who should be managing instead of performing medical procedures, and not joint field center set up. Responders received different and sometimes contradictory orders from different EMS managers. Information often transmitted from person-to-person like ‘rumours’. (López Carresi 2007).

Pre-hospital management and triage in the field was not coordinated: Each team made personal decisions to conduct victim prioritization. At one site a senior manager finally used a loud-speaker to ask all victims who could walk to gather at a particular location. The lack of organisation meant that new responders arriving on the scene could not tell which victims had already been attended to. It was also impossible to relay basic patient information either orally or in written form during the rescue operation (López Carresi 2007). Some ambulance crews followed 'normal procedures' others followed 'emergency procedures: making it difficult to attend to all patients or have enough medical supplies (López Carresi 2007). Victim distribution not well coordinated: Instead of distributing the injured to different hospitals, the two geographically closest hospitals were burdened with over 50% of the casualties (Turégano-Fuentes et al. 2008) while the hospital with the largest capacity received only 5% of the casualties (López Carresi 2007).
Responder Safety
The emergency responders were not aware that three unexploded bombs remained the trains. Two of these bombs were discovered and destroyed by the police; one was overlooked by police dogs and transported to a police depot before being found and destroyed. The first responders attended to the victims on the train tracks. At first the railway traffic was not halted and trains passed at high speeds; in one case the responders had to quickly get off the tracks to avoid death. The train company Renfre said that this train passed at high speed to shield travellers from having to see the disaster; the train ran over a dead body in the process. There was no plan in place to provide the emergency responders with necessary food and refreshments (López Carresi 2007).
Stakeholders
National/regional/city governments Local and national police Civil Guard Civil Protection National, regional, city, town emergency services Emergency call centres Volunteer/NGO/charity emergency services (e.g the Red Cross) Civil protection organisations Hospitals and health workers Psychologists

Forensic staff Firefighters Renfre train company Traffic control personnel Transportation companies
Public Engagement
People were asked to help by staying home and off the roads.
Public Response
There were 480 Spanish Red Cross volunteers involved in the disaster response operation, including helping with the recovery of bodies, attending to the wounded, providing psychological support to victims' relatives, and assisting and supporting families in the identification of bodies at the mortuary. The Red Cross also helped to organize the collection of blood donations from people wanting to help (The Guardian 2004). Various bystanders and local residents also help relief workers. For example, people in nearby houses were asked to throw blankets down which were used as stretchers. Citizens also offered to use their personal vehicles to transport victims to hospitals in (López Carresi 2007).
Media
The news media reported the explosions soon after the first one went off. In some cases, emergency responders first heard about the event through the media and/or friends/colleagues (López Carresi 2007).
Ethical, Legal and Social Issues
Normal vs emergency proceedures: this became an issue when different teams practice different plans, the line between which was vague. Going to the right location: A miscommunication lead to an entire station receiving less aid in the urgent first moments. Sharing medical and forensic data: Much data was shared, but some was not delaying the identification of victims. This brings up valuable questions about privacy and ethics that do not often align between medicine and disasters.
Data-sets used

gathered prior to disaster	The National Identity Document file: which contains the fingerprints of Spanish citizens and resident immigrants, was used to help identify bodies; of the 191 fatal victims, 76% were identified in this way (Prieto et al. 2007).

gathered during disaster	Traffic and transportation data were likely used in both Operation Cage and in the re-routing of stranded travellers. the spontaneous data set of patients and ambulance locations finger prints and other identifying features of victims
gathered immediately after disaster	

Lessons Learnt	
explicit	*Need better mutual-aid communication systems and procedures*. The District of Columbia Hospital Association has funded a private radiofrequency system, called the hospital mutual aid radio system to provide direct link between hospitals (known as H-MARS) (Turégano-Fuentes et al. 2008: 439). The City of Madrid, in partnership with IBM and the IBM Business Partner Indra, has since created a new ‘Centro Integrado de Seguridad y Emergencias de Madrid’ (CISEM) (Integrated Centre for Security and Emergencies in Madrid) to integrate different applications used by different emergency entities, as well as external entities (e.g. M-112; video surveillance centre, M30 highway control center, the public) and to provide a shared mobile communication infrastructure using mobile wireless computers or PDAs to CISEM (IBM 2010).
implicit	Before boarding trains in Spain, all baggage must be scanned. Responders need training outside of their regional/local plans. Need training exercises for every plan, and joint training operations when interoperability is expected.

Timeline	*Response*
March 11, 2004	A total of 13 different bags, each filled with 10 kg (22lb) of explosives and a detonator device, are placed on 4 different commuter trains leaving Alcalá de Hernares station.
07:01-07:14	The 4 trains leave Alcalá de Hernares station at 07:01, 07:04, 07:10, and 07:14 respectively. They are heading toward the centre of Madrid.
07:36	As one of the trains arrives at *Santa Eugenia station* a bomb is detonated on the train; 16 people died immediately.

07:39	At *Atocha station* 3 explosions go off in another of the trains, which is now standing at a station platform; there are 29 instant deaths. As one train nears *Téllez Street* (500m away from Atocha station) 4 explosions go off on it; there are 59 immediate deaths. The last 2 explosions occur when the fourth train is just pulling away from *El Pozo station*; there are 67 immediate deaths.
07:40	By this time there have been 10 different explosions on the 4 different commuter trains, affecting the train stations: Santa Eugenia, Atocha, Téllez Street, and El Pozo. The remaining 3 bombs remain unexploded and are discovered and destroyed by the police later in the day.
07:45	First radio and TV broadcasts of the explosions.
08:00	Emergency workers start arriving on the scene at Atocha. Spanish Police start to implement 'Operacion Jaula' (Cage Operation). Hospitals are informed of the imminent arrival of victims and the first 'walking victims' arrive to GMUGH hospital, which is close to Atocha railway station. GMUGH hospital enacts its Disaster Plan. Between 08:00 and 09:00, 90 survivors are attended to; by noon more than 80% of all survivors brought to this hospital had been received. Between 08:00 and 17:00, 34 surgical interventions are performed on 32 victims.
08:30	Emergency workers start to arrive at all the explosion sites and start to set-up temporary field hospitals. Bystanders and local residents help relief workers.
08:40	The Spanish Red cross put in an urgent appeal for blood donations. The Interior Ministry warns motorists to stay off the roads to allow for swift transfer of the wounded to hospitals. People are asked to stay in their homes.
08:45	Renfre shut down all rail traffic in and out of Madrid (including commuter, regional, and intercity trains). International rail traffic is also interrupted.
08:56	The police have sealed off the streets and areas around the attacks and rerouted or stopped incoming and departing traffic.

	They establish controlled routes and security control points throughout the city.
09:27	All incoming trains are stopped due to fears of further explosions.
11:00 to 17:00	City traffic is reduced by half. Madrid transportation officials coordinate the movement of stranded passengers. Renfe organizes alternative commuter transportation and reroutes traffic. 3,000 stranded passengers are moved by road during the day.
Later in Day	Police discover a van containing 7 detonators and a tape with Arabic language.

Timeline adapted from: Administración de Justicia (2004); BBC News (2004); Lessons Learned Information Sharing (n.d.); Peral-Gutierrez de Ceballos et al. (2005); Turégano-Fuentes et al. (2008).

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2.3.6 2005 - London Bombings, UK (BAPCO-PH)

Incident (000006)

Figure 8 London Bombings July 2005

Sources:

Picture on left: http://all-len-all.com/on-this-day-july-7-2005-terrorists-attack-london-transit-system-at-rush-hour/

Picture on right: http://www.theguardian.com/uk/july7

Following on from the naming pattern of '9-11' (the World Trade Centre terrorist incident in 2001) the London terrorist incidents of July 2005 have become known as '7-7'. However, unlike 9-11, in this case there were two discrete bomb attacks in London that month. The first and most serious was on 7 July, but a second series of attempted attacks took place on 21 July. Directly linked to the two attacks was the highly controversial fatal shooting by police of Jean Charles de Menezes, mistakenly identified as a suspected terrorist wanted by the police and security services for the earlier bombing incidents.

In the first attack on 7 July, four terrorists ignited four devices; three on the London Underground system at Aldgate, Edgeware Road, between Kings Cross and Russell Square and one on a public bus in Tavistock Square. In these attacks, 52 people were killed and a further 770 were injured.

On 21 July, in an almost identical incident, attempts were made to detonate devices at Shepherds Bush, Warren Street and the Oval underground train stations and on a public bus in Shoreditch. None of these devices exploded successfully (for reasons which have never been fully disclosed) and a fifth terrorist disposed of a further device in a west London park from where it was later recovered by police) without attempting to initiate it.

Material Damage

Some sources suggest that the cost of the incident itself was In the region of $2.5 billion (£1.5 billion) (Lomborg 2008).

Social and Human Impact
In the first incident, 52 people plus the four bombers died and over 770 were injured. No injuries were sustained on 21st July incident. This attack came, apparently coincidentally at the time the UK was hosting the G8 Summit in Scotland: together with (and following in the style of the Madrid bombings) the difficulties presented for the emergency services in dealing with multiple sites, the short-term impact of the incident was very significant and drew world-wide attention to the incident. Immediately after the incident of the 7th, there were questions as to whether the Security Services knew about the terrorist activity and could have prevented it. Despite official findings (Intelligence and Security Committee 2009) the question is still being asked in some quarters (Calvari 2014).
Economic Impact
The attacks came at a time when the UK economy was already in decline and had slumped to levels not seen since the eve of the Iraq War in 2003. In both economic terms and with the onset of the summer tourist peak flow, the timing of the attacks could not have been worse. Figures suggested a decrease in footfall in the West End of 20% to 30% in the period immediately following the attacks and the number of peole saying they would change their travel plans as a result of the incident on the 7th rose from 21% to 27% after the second attack on the 21st. Respondents to a survey by the London Chamber of Commerce and Industry (2005) reported that their members were still greatly concerned about public transport safety in London, leading to increased costs as staff switched modes of transport to car or taxi. Some companies saw an increase in cost as they switched to using courier services to transfer important documents intead of potentially putting staff at risk travelling into the City and within central London. The Royal Mail suspended their vehicles from moving between central London sites in and out of London on the 7th July, leading to a degree of service interruption which affected deliveries beyond London itself (London Chamber of Commerce and Industry 2005). The longer-term impact was not as serious as might at first have been thought. The Royal Mail resumed deliveries on the 8th July and one public relations firm reported to the Chamber of Conmmerce that, although they had cancelled meetings scheduled for the 7th and 8th, most staff were back at their desks on the Monday following. This reaction was mirrored by one of the major rail network operators (Virgin Trains), which also reported a predictable down-turn in passengers on the 7th and the following day (London Chamber of Commerce and Industry 2005). By the Monday they described service as ‘very much back to normal’. It is possibly significant, given that the 7th was a Thursday, and that many workers chose to finish their week early as a result of the disruption to transport systems on the 8th, returning to work after the weekend. Some areas of commerce actually saw their income boosted as a result of the inidents: Evans

Cycles (a large national chain) reported a doubling sales in the two weeks following the 7th July attack. One year after the incident, the London theatres reported a 7% year-on-year increase in attendance (London Chamber of Commerce and Industry 2005).

Preparedness – Training, Emergency Plans, Crisis Management Models

The London Emergency Services Liaison Panel was established in 1973. Operating practices laid down in that group's Major Incident Procedures Manual were implemented. Readers should also remember that whilst the events of July 2005 were the largest, London already had considerable experience in responding to terrorist incidents dating back to the early 1970's, not least as a result of the Provisional Irish Republican Army (PIRA) activity on mainland Britain.

Another well-established group, the Cabinet Office Briefing Room A (COBRA) was instigated, bringing together key elements of government, public utilities, emergency services, the military and security service.

The police Gold commander was quoted as follows: "It was role, not rank: and you're not dealing with 'someone from the Fire Brigade'. I was dealing with 'Ron' – someone I know. A mate of mine. We've gone on training weekends, we've done training exercises together. We've drunk, probably to excess on occasion, together...we all know and trust each other" (The Guardian 2005).

The Anti-Terrorism Branch of the Metropolitan Police hosts quarterly multi-agency exercises to practice for emergencies of this nature. Exercise 'Atlantic Blue' which had taken place in April 2005 included multiple Underground attacks in its scenario (Trident Communications 2005).

Some purely coincidental occurences were to assist the emergency services on the 7th July: the bus bomb exploded outside the British Medical Association, whose medically qualified staff immediately began providing care; the air ambulance service headquarters and one of the locations for helicopter casualty evacuation was at Royal London Hospital, where large numbers of current and former helicopter-trained doctors and paramedics happened to be meeting for a study day (London Assembly 2006); injured passengers from the Russell Square station bomb were evacuated into Bernard Street, consisting largely of housing for the doctors and nurses of Great Ormond Street Childrens Hospital, who also provided immediate medical assistance.

The incidents highlighted that a significant number of businesses (of all sizes) had insufficient resilience in place to cope: many IT systems (and their back-up facilities) were located in-house; many had no contingency plans; businesses which depended on the cellular telephone network were badly disrupted as a result of the network outage which occurred (London Chamber of Commerce and Industry 2005).

Interoperability – Information Sharing Communication, Coordination, Collaboration, Information Flows
The decision to establish a Casualty Bureau and activate COBRA was taken at 09:30hrs; a Gold Co-ordinating Group (multi-agency) was established very quickly. Limitations on the initial collection and subsequent sharing of data between the police and humanitarian support agencies hampered the connection of survivors to support services like the Assistance Centre. The concern at the time was that the Data Protection Act might prevent the sharing of personal data without the explicit consent of those concerned. As a result, there were delays in information reaching survivors about the support services available. An overzealous or incorrect interpretation of the duties imposed on public organisations by the Data Protection Act has been previously identified as a cause for concern. That inquiry found no reason why, where the sharing of data was appropriate and for a good purpose, it should not be done (UK Government 2006a). In its report on the incident, the London Regional Resilience Forum noted that while the response had by no means been perfect, the overall multi-agency emergency response to the 7 July bombings had been very successful. By quick, professional and effective action at the scene of each of the bombs, the situation had been contained and the potential additional loss of life and suffering considerably reduced. Four years of planning and exercises had clearly paid great dividends. Cooperation and co-ordination between responders had been effective and there was a willingness to work through issues jointly to achieve a successful response. The events of 7 July did not exceed the capacity of the responding agencies to contain and deal with the situation. The response did, however, provide an opportunity to identify areas that required further work to increase London's ability to successfully deal with future emergencies on a similar, or greater scale. Particular successes were noted as follows: (a) Familiarity with roles and partners was evident. This was greatly helped by a long series of exercises (including Atlantic Blue) (b) The initial response by London Underground staff was exemplary - the result both of solid training and individual dedication and courage. (c) London Buses reacted quickly and effectively, by initially withdrawing services from central London and then maintaining staff morale in order to reinstate the network, other than in the incident areas, in time for the evening peak. (d) The emergency services' response was rapid and effective. (e) London emergency plans were successfully deployed including the London Emergency Services Liaison Panel (LESLP) Major Incident Plan, Operation Benbow (joint operation by London's police forces), and the London Command and Control Protocol, Local Authority Gold Protocol, First Alert Protocol, Public Information Plan, Mass Fatality Plan and Disaster Fund Plan. (f) Hospitals were rapidly made ready and reserve capacity identified. 1200 hospital beds were made ready in three hours.

(g) Mutual aid arrangements worked well. London Fire Brigade and London Ambulance Service's mutual aid arrangements were successfully triggered. London Ambulance Service was also well supported by voluntary sector ambulances. (h) London Underground's evacuation procedures worked well. This was only the second evacuation of the entire network in living memory (the previous was 23 December 1991 when a number of incendiary devices had been hidden under train seats both on mainline and Tube trains.
Responder Safety
No responders were physically injured as a result of these incidents.
Stakeholders
Emergency services Central and local government London Transport Security and intelligence services Business community Public utilities Mobile and other communications network operators Public health & hospital services
Public Engagement
On 7th July, the police Casualty Bureau network received more calls in the first 24 hours than in any previous incident: at its peak, 43,000 attempted calls per hour and over the entire incident, it received details of almost 8000 persons believed missing (UK Government 2006a).
Public Response
Media
National and Regional Media Emergency Forum network and Media Centre were established during the morning. This structure had been in place since 2001 and was a reaction to the 9/11 incident. Initial updates to avoud travelling were sent out quicly and correctly, although subsequent information was not used as effectively. The media were still using some out of date information later on the 7th. Initial updates given by the Metropolitan Police Commissioner, although this caused confusion later on when junior officers took over and their reports and

comments were not seen as carrying the same weight. Agreed at the debrief that media should be part of major incident exercises but that there is a difficult relationship between the use of the media to warn and inform the public for safety purposes and the media role to report and interprete what it sees.		
Ethical, Legal and Social Issues		
Racial Stereotyping: In the immediate aftermath of the bombings and despite strong condemnation of the incidents by Muslim leaders across Europe, there were some racially motivated and anti-Muslim attacks. Mythologizing places and extremism: As a result of events both before and after July 2005, it was argued that Luton, the town where the 7/7 bombers joined the train to travel into London had become synonymous with Islamic extremism and racial tension (Travis 2006). Personal Privacy: The police took over 12,500 statements from witnesses; acquired 26,000 exhibits; seized 142 computers and obtained more than 6000 hours of CCTV footage for evidential purposes and / or forensic examination (EUMC 2005).		
Data-sets used		
gathered prior to disaster	Hard copy and computer-based mapping systems; London Underground network systems (TrackerNet) Contingency plans for most emergency or transport organisations	
gathered during disaster	Initial situation assessments (largely verbal) from first-responders at the various scenes Casualty and missing person descriptions from HOLMES (Home Office Large / Major Enquiry System) CCTV footage taken at the time Images taken by the public and passed to the police or media Classified intelligence data Discrete emergency service command & control systems Eye witness reports Live media reporting Aerial photographs and video footage	
gathered immediately after disaster	CCTV footage Witness descriptions and evidential statements Classified intelligence data	

Lessons Learnt	
explicit	A report published in September 2006 specifically addresses the lessons learned: *Flexibility was a strength*. Overall, the response to the bombings demonstrated the strength and flexibility of the UK's emergency response arrangements. *Need increased communication and psychological support for victims*. Need to better share information and provide practical and emotional support to bereaved and survivors. *Reception and Assistance Centres need to be quickly established*. *Emergency service telecommunications needs improvement*. The telecommunications equipment used by the emergency services worked well although older systems did not perform as efficiently. The imminent roll-out of the TETRA *Airwave* network would improve things significantly. *Just because a technology exists, does not mean it is accessible or helps*. The Access Overload Control protocol (ACCOLC) was discovered not to be fully accessible by those who needed to use it and indeed its use could also be counter-productive (UK Government 2006b).
implicit	*Need more senior staff*. Agencies to ensure that they have sufficient senior staff trained to give strategic direction over a long period of time, not just during the short-term emergency. *Over-reliance on the mobile telephone network.* Athough it did not collapse entirely, it became massively overloaded and was a major hinderance to communication at all levels. Alternative methods of communication needed to be sourced.

Timeline	*Response*
7 July 07:15 BST	Four young British Muslim men, all carrying large rucksacks, enter Luton train station, in Bedfordshire. Mohammad Sidique Khan, 30, Shehzad Tanweer, 22, Hasib Hussain, 18 - who have all driven together from Leeds that morning - and 19-year-old Germaine Lindsay look like they are heading off on a camping trip, but each rucksack contains an estimated 2-5kg of high explosive.
07:25	The four men mingle with the suited commuters on a train to London King's Cross Thameslink.
08:30	CCTV images at King's Cross station appear to show the four men hugging and in a happy mood. They then split up, each one

	apparently going towards a different section of the London Underground.
08:50	Shehzad Tanweer sets off his bomb between Liverpool Street and Aldgate stations on the eastbound Circle Line. Tanweer's bomb kills seven people and injures 171. Mohammad Sidique Khan, on board a westbound Circle Line train, fiddles with his rucksack before it explodes at Edgware Road, killing six other people and injuring 163. Germaine Lindsay is on a packed Piccadilly Line train as it travels between King's Cross and Russell Square. The blast from his rucksack kills 26 other people and leaves more than 340 injured.
08:52	London Underground (LU) reports power surges on the underground network - it is the effect of the simultaneous explosions but LU control does not know this yet.
08:55	Hasib Hussain is seen on Euston Road, outside King's Cross station. He tries to contact his friends on a mobile phone. He gets no reply.
09:00	Hussain goes back into King's Cross mainline station, where he buys a 9-volt battery from WH Smith before heading across Euston Road to McDonald's.
09:15	Emergency services confirm they have been called to Liverpool Street station after reports of an explosion. A power failure may be the cause, Transport for London says. London Underground has received reports of a train derailment at Edgware Road, a person under a train at Liverpool Street and walking wounded leaving stations. It begins shutting down the entire network and evacuating an estimated 200,000 passengers from more than 500 trains.
09:19	A man fitting Hasib Hussain's description is seen looking nervous and pushing past people on a number 91 bus from King's Cross to Euston station, where he switches to the number 30 bus travelling east from Marble Arch.
09:29	The Metropolitan Police confirm they are dealing with a major incident in London, but say it is too early to know what has happened.
09:30	Cabinet Office Briefing Room A (COBRA), the government's national crisis management facility, is activated to co-ordinate the response to the unfolding events.
09:40	British Transport Police say power surges have happened on the underground at King's Cross, Edgware Road, Russell Square, Aldgate and Old Street.
09:47	The number 30 bus is crowded because of the Tube closures, but Hasib Hussain finds a seat on the upper deck towards the back. Hussain's device goes off in Tavistock Square - killing 13 other people and injuring more than 110 - nearly an hour after those of his friends. Hussain may have decided not to board a Northern Line Tube

	train from King's Cross because of delays, or was possibly unable to detonate his device with the original battery.
09:55	BBC News website readers begin e-mailing their accounts and pictures of what is happening in London.
09:57	Andrew McCormack e-mails: "My gf [girl friend] works up by holborn and has just called to tell me a bus has exploded outside her office in tavistock square, bodies strewn all over the road." Jolyon Segal's e-mail says: "I have just managed to travel into work via taxi, having seen people injured and looking dazed on the tube. It's mayhem and no-one knows what is going on - rumours already abound of terrorist attack and deaths."
10:21	Scotland Yard says there have been "multiple explosions" in London and two minutes later BTP confirm there has been an explosion on a bus in Tavistock Square.
10:40	All London hospitals are on major-incident alert.
10:53	Home Secretary Charles Clarke says "dreadful incidents" have caused "terrible injuries".
11:18	London's Metropolitan Police Commissioner, Sir Ian Blair, says he knows of "about six explosions" but it is "still a confusing situation".
11:25	The first reports confirming deaths in the blasts emerge. A police spokesman says there are at least two fatalities.
12:05	Prime Minister Tony Blair, breaking off from the G8 summit in Gleneagles, says there has been "a series of terrorist attacks in London... there are people that have died and people seriously injured".
12:10	A website linked to al-Qaeda carries a statement saying it has carried out a "blessed raid" in London "in retaliation for the massacres Britain is committing in Iraq and Afghanistan".
12:55	Mr Clarke tells MPs four explosions have been confirmed, three on trains and a fourth on a bus, but it is not known who is responsible.
13:13	The Mayor of London, Ken Livingstone, says Londoners responded "calmly and courageously" to the "cowardly terrorist attack"
14:58	Sir Iqbal Sacranie, secretary general of the Muslim Council of Britain, joins other religious leaders in condemning the attacks.
15:25	Fears of a substantial death toll are confirmed when police reveal that at least 33 people have been killed. Some of the seriously injured have lost limbs.
16:35	The union jack flying over Buckingham Palace is lowered to half mast at the Queen's request.
17:32	Mr Blair says the "slaughter of innocent people" through terrorism will not intimidate Britain. "When they seek to change our country, our way of life by these methods, we will not be changed. When they try to divide our people or weaken our resolve, we will not be divided and our resolve will hold firm."

18:13	The number of confirmed dead rises to 37.
19:40	The attacks bear all the hallmarks of al-Qaeda, says Foreign Secretary Jack Straw. He adds that neither the British police nor the intelligence services had any warning of the attacks.
22:19	The emergency casualty bureau receives a call from the family of Hasib Hussain, reporting him missing.
23:40	A police exhibits officer tells investigators that cash and membership cards in the names of "Sidique Khan" and "Mr S Tanweer" have been found at the scene of the Aldgate blast. Police are on the trail of the bombers.
9/7/2005	Police teams find more evidence of the bombers' identities.
12/7/2005	Premises in West Yorkshire searched. These include the Leeds flat where bombs were made.
14/7/2005	Police publicly name Tanweer and Hussain.
16/7/2005	Khan and Lindsay named as other bombers.
21/7/05 12:26	Small explosions occur at Shepherd's Bush tube station (Hammersmith and City Line), Warren Street tube station and Oval tube station.
13:30	A backpack is reported as exploding in east London on the Number 26 bus travelling from Waterloo to Hackney Wick.
14:30	University College Hospital is cordoned off by police, it is feared that the bomber from the Warren Street tube station, opposite, ran into the building.
14:45	Whitehall, which was previously sealed off after the explosions, is reopened.
15:25	A major security alert again closes Whitehall
15:30	A man carrying a backpack is arrested by armed police outside the Ministry of Defence in Whitehall, approximately 20 metres from Downing Street
16:00	Sir Ian Blair now describes the situation as “firmly under control”
27/7/2005	Pictures emerge of bombs left behind by the bombers in a car at Luton.
1/9/2005	Al-Jazeera TV releases video of Khan justifying such attacks.
19/9/2005	Al-Qaeda's deputy leader says it "launched" the attacks.
11/5/2006	True extent of al-Qaeda involvement remains unclear,

	government says. MPs' report says lack of resources prevented security services intercepting bombers.
6/7/2006	Video released showing Tanweer saying the attacks were "only the beginning"

Timeline adapted from: UK Government 2006b.

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2.3.7 2001 - Helios Airplane Crash and Wildfire, Greece (KEMEA)

Incident (000007)

Figure 9 The Wreckage of the Helios 522 Plane Crash

Source: http://pixel.nymag.com/imgs/daily/intelligencer/2014/03/26/26-helios-flight-22-crash.w560.h375.2x.jpg

On Sunday 14 August 2005, Flight 522 of Helios airways departed from Larnaca (Cyprus) with a stopover in Athens (Greece) and final destination in Prague (Czech Republic) after an incomplete inspection leading to the loss of air pressure during the flight leaving the passengers and flight crew unconscious. This resulted in a plane crash in a forest area near Grammatiko at Attica and thus leading to a major fire. The ground engineer set the pressurization system to “Manual”, to perform the inspection without having to close the airplane’s engines, and afterwards failed to set it back to “Auto”. In addition, the aft outflow has been left partially opened by the crew and the safety detection systems failed to identify the problem.

As the aircraft took off and gained altitude, cabin pressure dropped. The flight crew disregarded the warning signals and after a few minutes all on board lost consciousness. A member of the flight crew who had a pilot’s license tried unsuccessfully to take control of the aircraft.

The plane continued to fly on autopilot and entered the Athens Flight Information Region. After numerous failed attempts by Air Traffic Control (ATC) to communicate with the flight crew two F-16 were sent to find the plane. When Flight 522 was located, the F-16 pilots reported there were no signs of terrorism, the co-pilot was slumped over, and the cabin emergency oxygen system has been deployed.

Eventually the plan ran out of fuel and the engines stopped operating. The plane crashed in the mountains near Grammatiko, breaking into pieces and scattering the pieces, its passengers, and luggage. The violent crash and remnants of fuel and oil caused a major fire. The moderate prevailing winds (approximately 5 Beauforts) from NE to SW were sufficient to fan and spread the flames. The fire was very difficult to control due to the steep landscape and the strong winds. The fire threatened destroyed only croplands and fire areas. Although the fire was close to the residential area, it didn't threaten any houses due to the swift action of the firefighters. The Fire brigade reported that the fire was under control after 7 seven hours of continuous burning.

Material Damage

The material damage caused by the crash, other than the plane and its contents, was minimal. The environmental damage, on the other hand, was great. Eighty thousands (80.000) square meters of forest consisting of pine trees and were burned. In addition, two hundred twenty six thousands (226.000) square meters of croplands were burned.

Social and Human Impact

The Helios flight 522 claimed the lives of 121 people, 115 passengers and 6 crew members. According to Department of Cardiology of the Hellenic Air Force Medical Center, the passengers were alive but unconscious and therefore died from the crash and the fire that was caused (Report of the Air Accident Investigation & Aviation Safety Board (AAIASB)).

One issue was that the Greeks and Cypriot citizens started to worry and dispute the actual security measures of the civil aviation. It was observed that passengers were making phone calls to airline companies to get information about security measures. Moreover, many first responders that assisted on the field needed psychological support after-the-fact.

Since the fire threatened the residential area, it also triggered a review of safety procedures in case of fire to the local communities. Such procedures include the safe evacuation of buildings and other areas. Also, there were several lessons on schools on how to safely use extinguishers in case of a fire. However, these measures were temporary and after a few years, their existence was ceased

Economic Impact

The economic impact of the crash mainly caused economic consequences in the Helios Airways. At March 2005 the Helios airways was rebranded to Ajet and at October of 2006 Ajet announced that it was to cease its operations. According to the burned croplands there isn't any aggregated report about the economic impact of the fire that was caused.

Preparedness – Training, Emergency Plans, Crisis Management Models

The Hellenic air force accompanied the plane so as to avoid the crash into residential areas and due to the knowledge and the experience of all the Fire Brigadethe fire was under control only six hours after the crash. There was not any specific plan for this type of situation. There was not any special training or any special force team that helped on site.
Interoperability – Information Sharing Communication, Coordination, Collaboration, Information Flows
The telecommunications (analogical radio, TETRA) as well as the operation of mobile phones were insufficient to meet the needs of an operation of such a scale. The main reason was the terrain and the mountains that were blocking the telecommunication signals. However, there were critical delays in the cooperation of the involved forces and authorities. The Boeing Forensics lab had helped and the Nord-Micro laboratory to read data from a memory chip containing information.
Responder Safety
The inaccessible area of the crash as well as the lack electronic surveillance of the scene put the First Responder's lives at risk. There wasn't any detection system for the leakage of hazardous or radioacti\ve materials so as to protect the operating personnel.
Stakeholders
Police Forces**:** 97 vehicles, 496 crew members, 2 ambulances, 1 helicopter Hellenic Land Forces: 9 officers, 174 draftees, 16 vehicles, 2 buses, 5 ambulances with 1 doctor Hellenic Navy Forces: 1 officer, 17 sea men, 2 vehicles, 2 buses, 3 ambulances with 1 doctor, 2 helicopters Hellenic Air Force: 2 officers, 18 air men, 2 buses, 2 ambulances and 1 doctor, 2 vehicles, 2 C-130 aircrafts to transport 50 corpses to Cyprus Ambulance Service Forces: 48 vehicles, 162 crew members, 1 helicopter Boeing Forensics lab Nord-Micro laboratory
Public Engagement
The public was informed about the accident through the public media, including the victim's families who found out about the crash through the media. The relatives of the passengers were in continuous contact with the Greek authorities and the Helios airline company for the latest news.

Public Response	
Media	
The media covered the incident with news bulletins in which the Greek authorities were announcing the progress at the area of the incident.	
Ethical, Legal and Social Issues	
Buying vs Serving Time: The litigation about flight helios 522 incident sentenced the CEO, the flight operations manager, a former chief pilot, and the chief engineer of Helios airways to 10 years of imprisonment. They were given the option to buy their sentence for the price of 75000 euros. No planned psychological support for first responders: Some of the involved personnel were in need of psychological support after the end of the operation, but there is no planned psychological support of first responders in Greece. In addition, there was not government supported psychological aid for families, either. Some was performed months after crash in specific response to the trauma faced by the responders. Family members of the victims appeared to be an afterthought: No plans seemed to be in place (or activated) for communicating with family members of the victims, who had to learn about the situation through the media.	
Data-sets used	
gathered prior to disaster	Historic data of the inspections and the operation of the Aircraft
gathered during disaster	Breakdown of communication with the pliot GPS and other data tracking flight movement
gathered immediately after disaster	Black Boxes Forensics on the Remnants of the Airplane No available data on burned croplands.

Lessons Learnt	
explicit	*Need more warning lights*. In March 2011, the Federal Aviation Administration released a directive requiring all Boeing 737-100 to 737-500 to be fitted with additional two cockpit warning lights

implicit	*Need pre-planned psychological support for first responders and victim's families*. There should be psychological support to the victim families as well as to the First Responders that helped on site. There should be First Aid and Safety procedures courses at schools.

Timeline	*Response*
Sunday 14 August 2005 09:07	Take-off
09:14	Pilots report air-conditioning problem
09:20	Last contact with crew
09:37	Aircraft enters the Athens Flight Information Region.
10:00 – 10:48	Flight crew failed to make a contact with the Athens Air Traffic Controllers.
11:05	Two F-16s depart to accompany the airplane
11:54	2 MAYDAY messages are recorded
12:02	Aircraft crashes
12:03	The Coordinational & Operational Center (C.O.C.) of the Hellenic Fire Corps (H.F.C.) received the first call via analogical radio.
12:44	The first two fire vehicles have arrived at the point with a 5 member crew.
13:00	Seven more fire vehicles have arrived.
13:25	The first water air drop using sea water.
18:40	The H.F.C. reported that the fire is under control.
18:50	3 Caterpillar vehicles and a group of 105 firemen of the Special Fire & Rescue Unit arrived to the point in order to search for survivors and transfer them to the ambulance service.

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2.3.8 2005 - Buncefield Oil Depot Explosion and Fire, UK (ULANC-SB)

Incident (000008)

Figure 10 Buncefield Oil Depot After Explosion and Fire

Source: Buncefield Major Incident Investigation Board (BMIIB 2008: 1)

On Sunday the 11th of December, 2005 there was a massive explosion followed by a series of explosions and a fire at the Buncefield Oil Storage Depot in Hemel Hempstead, Hertfordshire, UK. The explosion was caused by the overfilling of a large petrol storage tank (due to a safety alarm failure), which led to the escape of over 300 tonnes of petrol, 10% of which formed a 'vapour cloud'. It was the vapour cloud which combusted and led to the explosion and subsequent fire. The resulting fire lasted 5 days and ultimately destroyed a large proportion of the depot (engulfing over 20 large fuel storage tanks). During the 5 day fire, thousands of gallons of petrol were burned, resulting in large clouds of black smoke being sent into the atmosphere, reaching across the South of England and beyond. The event measured 2.4 on the Richter Scale (BMIIB 2008).

Material Damage

The event not only destroyed the oil depot, but it also destroyed various commercial and residential buildings near to the site, as well as affected buildings in up to a 5 mile (8 km) radius around the site (e.g. with broken windows, damaged walls, ceilings, etc.). The explosion and fire resulted in some roads near the site being closed for months, as they were subsequently deemed unsafe. The environmental pollution caused by the event is thought to have mainly been nearby soil and water, which was contaminated by the fuel and from the foam and water used to put out the fire. Drinking water is said not to have

been affected (BMIIB 2008).
Social and Human Impact
While over 40 people were injured by the explosion and subsequent fire, there were no fatalities. That being said, approximately 2000 people needed to be evacuated from their homes, and parts of the M1, M10, and M25 motorways were closed resulting in considerable disruptions. Some schools in Hertfordshire, Buckinghamshire, and Bedfordshire were also closed for two days following the explosion. Furthermore, due to the damage to residential homes, some people experienced considerable damage to their property (including personal possessions) and had to seek temporary accommodation; in some cases people could not return home for considerable periods of time. It has also been noted that various individuals needed psychological help after the event. No serious health effects – short-term or long – have been reported as a result of the smoke (BMIIB 2008: 10).
Economic Impact
According to the Buncefield Major Incident Investigation Board's Final Report (BMIIB 2008): "The estimate of total quantifiable costs arising from the Buncefield incident comes close to £1 billion." (p. 24). The sectors included in the costs are: site operators (compensation claims) (£625m), aviation (£245m), competent authority and Government response (£15m), emergency response (£7), and environmental impact (£2) for a total of approximately £894 million (p. 25). The largest costs relate to insurance compensation claims, with individuals (£30m), local authorities (£4m), and businesses (inside/outside the site perimeter, £103m and £488 respectively) forming the considerable bulk of these claims. The main components of the emergency response costs included: Hertfordshire Fire and Rescue Service (£2.1m) and Hertfordshire Country Council (£2.3m) (p. 26). The Report also highlights the unquantifiable costs of: the closure of the M1, M10, and M25 motorways, the loss of goods in local warehouses, "temporary loss of engineering and certification services affecting the services and manufacturing sectors", "temporary outsourced payroll service disruptions", "temporary loss of London congestion charging administration", "temporary loss of outsourced medical records", and, "temporary loss of other public service records" (p. 28). In total it is thought to be the most expensive UK disaster to date (see: www.buncefieldinvestigation.com).
Preparedness – Training, Emergency Plans, Crisis Management Models
The Buncefield Major Incident Investigation Board's (BMIIB 2008) Final Report argues that the event was caused by the failure of an on-site alarm to stop tanks from overfilling. While an on-site emergency plan was in place (i.e. developed by the Oil Depot), the Report argues that it had not taken into consideration the potentiality for such a major incident. It goes on to argue that: "The impressive emergency response to Buncefield effectively relied on initiative and good working relations of the responders in dealing with an incident that had been

unforeseen and therefore not planned for.” (BMIIB 2008: 51, emphasis added). This reliance on ‘initiative and good working relations’ between responders was further collaborated by the Hertfordshire Resilience Forum's (HRF) (2007) Report on Buncefield. This Report highlights the importance of Hertfordshire’s long-running Local Resilience Forum (LRF) which regularly brings together senior officers from across the different emergency services. Because these different bodies (e.g. the police, the fire services, etc.) already understood and trusted one another, had an established history of planning, training and exercising together, as well as learning from one another’s responses to previous major incidents, they were well-placed to work effectively together (HRF 2007: 1). The Control of Major Accident Hazards (COMAH) Regulations provided a framework for pre-existing on- and off-site emergency plans. However, the on- and off-site plans were not well-linked, with “Buncefield off-site plan(s), warning and information arrangements [...] limited to the Public Information Zone” (HRF 2007: 3). Thus, the affected area was geographically divided along ‘on-site’ and ‘off-site’ politics and imaginaries.
Interoperability – Information Sharing Communication, Coordination, Collaboration, Information Flows
Coordination/Collaboration Within hours of the first explosion a Strategic Co-ordinating Group (‘The Gold Command Group’) was established, coordinated by the Hertfordshire Police and involved the Hertfordshire Fire and Rescue Service, Hertfordshire County Council, Dacorum Borough Council, the Environment Agency and the Health Protection Agency, and the Health and Safety Executive (BMIIB, 2008: 16). While the Gold Command Group looked at strategies, there were Silver and Bronze Groups which looked at tactics and applying tactics respectively. Help also arrived from the Bedford Police, the Met Police, firefighters from across the UK, and the Military. Many of the organisations involved operated on a ‘consensus’ format of decision-making, while others operated in a ‘command and control’ format of decision-making. According to the HRF (2007), organisations need to be flexible and learn when which form of decision-making is needed. *Communication and Information Sharing/Flows* ▪ People were encouraged to use understandable language and not slip into jargon and tech-speak, but this was not always adhered to (HRF 2007). ▪ Across agencies, different interpretations of the same strategies were noted (HRF 2007). ▪ Different services use different levels of technology, in some cases whiteboards and photographs were used in lieu of digital technologies. ▪ Responders used different communications systems (e.g. different radio frequencies) meaning they had to rely upon mobile phones, which are

vulnerable to disruption (HRF 2007: 11). ▪ In some instances, responders used different hardcopy and GIS maps, with HRF recommending a "networked mapping system" (HRF 2007: 6). ▪ The different organisation successfully and productively used teleconferencing technology to communicate (HRF 2007: 15).
Responder Safety
A key concern raised was the longevity of the problem (5 days), making it necessary to ensure that the responders got an adequate amount of time off to recuperate between on-duty shifts (HRF 2007).
Stakeholders
The operator EMS Water Environment Agency Major Incident Investigation Board Hertfordshire Fire and Rescue Service Hertfordshire Country Council Civil Engineers Hertfordshire Police Dacorum Borough Council Health Protection Agency Health and Safety Executive Bedford Police Met Police, firefighters from across the UK Military
Public Engagement
Communication with the public was done through knocking on doors and impromptu community meetings which the Chief Superintendent attended. During the event there were concerns over the correct actions regarding giving public health information and about Personal Protection Equipment (HRF 2007: 6). The HRF Report argues that sometimes a quick "best guess" would be better than no action at all or long-drawn out decision-making in these cases (HRF 2007: 6).

Communication problems with the public also occurred when respondents used 'jargon and technical language'; this made the communication regarding public health hard to understand and requiring further interpretation (HRF 2007: 10) After the event, a fully public Government website was set up (see: www.buncefieldinvestigation.gov.uk) which published all of the official documents from the investigation into the event.
Public Response
There were tensions and problems in the communication between the emergency responders and the business community, who wanted to gain access to their businesses to inspect the level of damage and keep their property safe (HRF 2007: 7).
Media
The use of 'talking heads' (designated persons to speak to the media) were used (HRF 2007: 15). Social media. Over 2000 images were sent to the BBC.
Ethical, Legal and Social Issues
<u>Assigning responsibility to a technological disaster</u>: According to the Government website www.buncefieldinvestigation.gov.uk: "Criminal proceedings have been commenced against Total UK Ltd, Hertfordshire Oil Storage Ltd; British Pipeline Agency Ltd; TAV Engineering Ltd; and Motherwell Control Systems 2003 Ltd following a thorough and complex criminal investigation conducted by the Health and Safety Executive and the Environment Agency."
Data-sets used

gathered prior to disaster	Hardcopy and GIS maps.
gathered during disaster	Eyewitnesses CCTV images Initial first-hand emergency responder assessments
gathered immediately after disaster	

Lessons Learnt	
explicit	*Need to incorporate disasters like these into preparedness plans and have greater awareness of health and safety issues*

	regarding plants like these. The disaster led to the formation of a Major Incident Investigation set up by the Health and Safety Commission (now the Health and Safety Executive) under section 14(2)(a) of the Health and Safety at Work Act 1974 (BMIIB 2008: 2). The Final Report of the Buncefield Major Incident Investigation Board makes 32 recommendations regarding 'emergency preparedness for, response to and recovery from incidents' (pp. 50-57). A key finding and recommendation of the report is to plan for all 'reasonably foreseeable' potentialities and consult with health advisors and emergency responders. *Need to share experience*. There has also been considerable post-event 'learning dissemination'. The Hertfordshire Resilience Forum (2007) wrote their report to share their learning with the 'wider emergency planning community'; one of a series of initiatives to share experiences and learning (p. 1).
implicit	

Timeline	*Response*
11.12.05 (Day 1) 05.30	The safety system in place to prevent tank overfill, failed to operate.
05:37	The tank started to overflow with petrol. A vapour cloud formed, which dispersed and flowed West off site towards the Marylands Industrial Estate.
05:59	Tank drivers report mist/vapour. The pipeline supervisor opened Fina Line inlet value to the neighbouring tank, which he wrongly assumed was causing the problem (Health and Safety Executive (HSE), Website).
06:01	The pipeline supervisor pressed the fire alarm button, which sounded the alarm and started the firewater pump. But "A 'vapour cloud explosion' occurred almost immediately, probably ignited by a spark caused by the firewater pump starting." (COMAH 2011: 11). Numerous explosions followed.
06:08	The Emergency Services (Fire and Rescue Service and Police) arrive on the scene. The police put up an exclusion zone around the area, which

	remain in position for several days (BMIIB, 2006)..
8:00	The Gold Command Group was formed at Headquarter in Welwyn Garden City (8-10 miles away and equipped with facilities to establish GC). The Silver Group was placed at Watford and looked at tactics.
15:00 – 16:00	The Bronze Group was set up at Hemel Hempstead and looked at applying tactics.
12.12.05 (Day 2) Noon	The fire reached its peak – "there were 26 Hertfordshire pumps on site, 20 support vehicles and 180 firefighters. More than 250,000 of foam concentrate were used, together with 25 million litres of water and 30 km of high-volume hose" (BMIIB 2006: 6). Volunteer services attend to the emergency personnel.
18:00	32 hours after main blaze started, the main blaze is extinguished.
13.12.05 (Day 3) Morning	Some smaller tanks still burning.
14.12.05 (Day 4)	New fire started in a previously undamaged tank; fire service let it burn out safety.
15.12.05 (Day 5)	All fires out.

Timeline adapted from: BMIIB (2006), COMAH (2011), and Health and Safety Executive (HSE) Website.

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2.3.9 2006 - European Blackout (ULANC-VT) (000009)
Incident (000009)
On 4 November 2006 at 22:10 hrs, approximately 15 million people in Germany, France, Italy, Spain, Belgium, Portugal, Morocco, Greece and Croatia experienced a power outage (BBC News 2006). The outage originated in Germany where E.ON Netz (henceforth referred to as E.ON), a German electricity company, temporarily shut down one of its high-power transmission lines to allow a large cruise ship to pass safely underneath. When the high-transmission line was shut down, another nearby line tripped due to overloading, which led to a cascading power outage throughout the region. Although power was fully restored within two hours, many services were delayed and the security of the electricity supply network was at risk. The event was one of the worst blackouts in recent European history and forced the Union for the Coordination of the Transmission of Electricity (Federal Network Agency 2007; UCTE 2007) to make several policy, technical and organizational changes.
Material Damage
Due to the quick actions of Transmissions Systems Operators (TSOs) and the existing design of the electrical grid in Europe, this blackout caused no material damage to the electrical grid (Federal Network Agency 2007; UCTE 2007) andno material damage to other infrastructure was reported.
Social and Human Impact
In Germany, the blackout delayed nearly 100 trains. In Paris, firemen responded to 40 calls from people trapped in lifts (Castle 2006). Elsewhere across the affected countries, residents and businesses were without power for up to two hours, and subway/metro stations were evacuated.
Economic Impact
Costs to businesses, including restaurants and bars, were estimated to be over 100 million Euros (Castle 2006).
Preparedness – Training, Emergency Plans, Crisis Management Models
Because requests to disconnect this line occur regularly E.ON is required to conduct a thorough N-1 criterion analysis before approving any disconnection requests (UCTE 2007). Additionally, all TSOs are “obliged to conduct a weakpoint analysis every year in order to avoid serious supply disruptions … (Section 13 subsection 7 of the Energy Managcement Act)” (Federal Network Agency 2007). These measures typically prevent power outages in Europe. In the event of a blackout, TSOs are required to resynchronize their electricity grid as quickly as possible. Training simulations for such scenarios run regularly (UCTE 2007). However, at the time of the 2006 blackout, pan-European TSO coordination during the resynchronisation process was poorly coordinated and

loosely defined in EU policies (ERGEG 2007; Federal Network Agency 2007; UCTE 2007).
Interoperability – Information Sharing Communication, Coordination, Collaboration, Information Flows
Insufficient information sharing was identified as one of the two main causes of the blackout (UCTE 2007; ERGEG 2007). E.ON should have communicated with the other TSOs prior to deciding that it would shut down the line two hours earlier than planned.
Responder Safety
In Paris, firemen responded to 40 calls from people trapped in lifts (Castle 2006), but there were no reported complications with this operation.
Stakeholders
The UCTE, Transmission System Operators (e.g E.ON Netz, RWE Transportnetz Strom, TenneT), Distribution System Operators, European Union, European Regulators' Group for Electricity and Gas (ERGEG), citizens throughout the EU, passengers on the cruise ship, and tourists visiting the affected cities and regions.
Public Engagement
There was no public engagement related to E.ON's initial decision to power down the electricity line, nor its decision to power down the line two hours early. Following the blackout, the UCTE, European Union, E.ON, band the governments of several countries held media conferences, released news briefs and produced follow-up reports about the blackout.
Public Response
Media
The blackout received coverage across Europe (BBC News 2006; Castle 2006) and around the globe (The New York Times 2006). Interviews were conducted with politicians, representatives of the UCTE, ERGEG and TSOs.
Ethical, Legal and Social Issues
The legal framework in place prior to the 2006 blackout was widely considered to be adequate (ERGEG 2007). However, the blackout showed that there is a Europe-wide "need for an improved legal and regulatory framework to minimise the risk of future interruptions" (Federal Network Agency 2007).

Data-sets used	
gathered prior to disaster	TSOs keep real-time data on power supply, power consumption and power line activity.
gathered during disaster	TSOs monitored the real-time power supply, power consumption and power line activity during the blackout.
gathered immediately after disaster	TSOs reviewed the data before, during and after the blackout.

Lessons Learnt	
explicit	According to ERGEG (2007), “more precisely and uniformly defined rules for coordinated real time security assessment and control (including but not limited to the steady state contingency analysis) are needed from TSOs to facilitate secure network operation in synchronous areas.” ERGEG (2007) also claimed it would be necessary to create a new legal framework in which “the European Grid” is defined, with TSOs having to develop a “European Grid Code”. This code would need to be approved by the regulatory authorities and the latter would need to ensure it is implemented by the TSOs. Additional training was recommended for TSO dispatchers so that they could predict EU-wide network usage more effectively (ERGEG 2007). The training would also help reduce the issues caused “individual TSOs interpret the requirements made in the UCTE Operation Handbook differently.” (Federal Network Agency 2007).
implicit	Switzerland avoided blackouts because its network engineers quickly reacted to the reduced power supply from Germany (BBC News 2006). Thus, an implicit lesson learnt is that close monitoring of incoming and outgoing power supply information can prevent blackouts from striking some parts of Europe.

Timeline	*Response*
18 Sept. 2006	The Meyerwerft shipyard sends a request to E.ON to disconnect the double circuit 380 kV line Conneforde-Diele so that the Norwegian Pearl ship could pass through the River Elms to the North Sea on 5 November at 01:00.

	E.ON informs TenneT and RWE Transportnetz Strom about the request so that they can carry out an N-1 analysis on their networks. The results of the N-1 analysis show that the grid would be secure, so the TSOs agree to reduce the transmission line's load between 00:00 and 06:00hrs on 5 November 2006.
3 Nov. 2006	Meyerwerft calls E.ON by telephone and requests that the line disconnection is brought forward by three hours to 22:00 hrs on 4 November. E.ON analyzes the forecasted line load and the wind power feed-in without performing an N-1 analysis and without informing RWE Transportnetz Strom or TenneT. E.ON approves the advance timing request and does not include any information about the change in the Day Ahead Congestion Forecast (DACF) report for 4 November 2006.
4 Nov. 2006	
18:00 – 19:00 hrs	E.ON informs RWE Transportnetz Strom and TenneT of the new time for switching off the Diele-Coneforde line.
19:33 hrs	TenneT prepares the Diele line for the new switch off time.
21:29 hrs	E.ON evaluates the load flow on the Conneforde-Diele line—without numerical computation—and determines there should not be any violation of limit values.
21:38 hrs	E.ON switches off the first circuit of the Connefore-Diele line.
21:39 hrs	E.ON receives several warning messages about the high power flow on nearby lines. Dispatchers choose to take no immediate action.
21:42 hrs	The network control station at E.ON phones its counterparts at RWE Transportnetz Strom to see if everything is OK. RWE says say—the security criteria was still being met on its own grid. Dispatchers at E.ON issue the passage approval for the ship.
21:46 - 21:52 hrs	E.ON and Vattenfall Europe Transmission exchange phone calls expressing concern about the lines.
22:05 -	A sudden and inexplicable load increase is measured on the nearby Landesbergen-Wehrendorf line. This triggers a request for

22:07 hrs	urgent intervention to restore safe grid operation.
22:08	Staff at E.ON make an empirical assessment of the situation, without making any load flow calculations and without checking to see if the N-1 criterion would be met. They decide to "couple the busbars in the substation of Landesbergen" to reduce the load.
22:10:11 hrs	E.ON couples the busbars at Landesbergen.
22:10:13 hrs	The Landesbergen-Wehrendorf line is automatically disconnected, leading to load deviations across Europe and the immediate shutdown of several lines (e.g. at 22:10:15 hrs - the Bielefeld/East-Gütersloh line is disconnected. at 22:10:19 hrs - the Bechterdissen-Elsen line is disconnected) (see: Bundesnetzagentur p. 9 for complete list).
22:11 hrs	Some TSOs make contact with each other, discover the European grid system is split into three sub-systems, and start to plan a resynchronisation of the systems.
22:34 hrs	TSOs attempt to resynchronise the sub-systems, but fail to do so due to the high frequency differentials (see: UCTE 2007: 42-46 for more specific details).
22:47 hrs	The North-Eastern and Western subsystems are resynchronised. The lines that had tripped in Germany are switched back on. Power begins to return for some customers.
23:57	The grid is fully reconnected. Power is restored to the 15 million people who had been affected.
5 Nov. 2006 01:00 hrs	German TSOs report that all readjustments have been completed and every requirement in Section 13, subsection 2 of the Energy Management act has been met.

Timeline adapted from: ERGEG 2007; Federal Network Agency 2007; UCTE 2007

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2.3.10 2007 - San Diego Wildfires, USA (ULANC-KP)

Incident (000010)

Figure 11 Satellite Image from Day 3 of the Fires, 24 Oct 2007

Source: NASA: http://www.nasa.gov/vision/earth/lookingatearth/socal_wildfires_oct07.html

In late October 2007, Southern California faced one of the largest wildfire events in its history. Within two days, thirteen separate wildfires were burning between Tijuana and Los Angeles, seven of them in San Diego County alone. It took almost twenty days to contain the wildfires. Fanned by winds that regularly clocked at 70 and 80 mph (WFLLC 2007), these fires were the most intense and longest lasting in San Diego County recorded history (County of San Diego Office of ES 2007). As the edges of the fires wandered unchecked, San Diego residents experienced the nation's largest ever evacuation due to wildfire(County of San Diego Office of ES 2007).

Between 20-25 October, in addition to the 23 large fires in 7 counties, another 251 vegetation fires were extinguished by fire service personnel before damage occurred (WFLLC 2007). All together, these wildfires burned a total of 368,340 acres/149 Hectares (County of San Diego Office of ES 2007).

Over 6000 firefighters and 100 aircraft from across the nation were deployed to control these fires. Personnel came from more than 60 disciplines during the fires and represented Federal, State, and local departments and agencies. The fires required the response of 5 incident management teams (County of San Diego Office of ES 2007).

Smoke from the fires caused serious health effects (Ginsberg et al. 2008).

Material Damage
Over 2000 homes were destroyed (over 3000 structures in total) and over 500,000 acres (over 202,000 hectares) of land were burnt including 13% of San Diego County (County of San Diego Office of ES 2007; CDFFP/USFS/GOES 2008; San Diego RDF 2008).
Social and Human Impact
There was a distrust of police and fire services that emerged from this event as a result of how minorities were treated both at evacuation zones and at evacuation centers. At evacuation zones, it's been claimed that many people were not allowed back in based on skin colour. At the main county evacuation center, the border patrol arrived to help, but a couple took it upon themselves to monitor supplies, targeting minorities to kick them out and search their documents (ACLU 2007). During the fires, non-evacuated residents were recommended to stay inside or wear specialized filtered masks if outside (most did not heed these warnings). Most public sector jobs/buildings were closed for a week. There were 10 deaths, most of them immigrants crossing the border illegally. Of the 23 civilian injuries, many were migrant workers in farm fields who did not feel as though they could leave their jobs (San Diego RDF 2008). Some of the major freeways were shut down for periods of time, and county residents were strongly encouraged to stay off the roads (County of San Diego Office of ES 2007). The number of cases of respiratory illness almost doubled during the weeks after the fires (Ginsberg et al. 2008).
Economic Impact
The cost of the fires and recovery is estimated to be around US$ 2 billion (San Diego RDF 2008).
Preparedness – Training, Emergency Plans, Crisis Management Models
New plans were implemented earlier that year designed specifically to deal with large and multiple fires (County of San Diego Office of ES 2007). However, many of the new standards of protocol that need to be written as a result of the plans had just be drafted and thus not tested (City of San Diego 2007). Moreover, there were many different there were different plans at every scale (city, regional, state, federal, tribal). As the fries crossed boundaries, some wound had teams from different scales, e.g. county team fighting one end of a fire, state team another end (County of San Diego Office of ES 2007). In additional, local communities were mandated to develop their own Community

Wildfire Protection Plans, unique to the priority and values of each community which need to be accounted for by any fire agency involved in protecting that community. To help with some of the coordination of the plans, the San Diego County Sheriff's Department established a single emergency planning unit. *Individual plans in place during the Fires:* *Derived from sources:* (CDFFP/USFS/GOES 2008, County of San Diego Office of ES 2007, WFLLC 2007) • National Fire Plan (NFP) • FIRESCOPE • Multi Agency Coordinating Group (MAC) and System (MACS) • Community Wildfire Protection Plans • County Operational Plan • Regional Communications System Storm Plan (to help identify opportunities to manipulate communication system activities and discard noncritical communications) • Tactical Interoperable Communications Plan (TICP) designed to encourage interoperable communications capabilities among Federal, State, and local fire and law enforcement agencies with Unified Command components • Defense Support to Civil Authority (DSCA). DSCA allows civilians to request immediate response and assistance from the military • County, city, and community evacuation plans • Continuity of Operations Plans for all county departments and agencies • Amateur Radio Emergency Services (ARES), a plan to incorporate ham radio operators when emergency communications are limited or fail • Hospital Evacuation Plans • Hospital Incident Command System (HICS) • A draft volunteer management plan was written but has not been finalized • Unified Command and Control Prior to the fire, joint exercises had been conducted throughout the county between volunteer organizations, public services, and first responders.
Interoperability – Information Sharing Communication, Coordination, Collaboration, Information Flows
Information Sharing Since then, the value of GIS has been solidified as a technique for data sharing, as well as the value of WebEOC, an online bulletin board (County of San Diego

Office of ES 2007; City of San Diego 2007).

Different data sources have different types of restrictions. For example: in 2007 was Landsat 5, USDA NAIP, high resolution urban area aerial data were public resources while there was restricted access was quickbird data and ResourceSAT AWIFS (ISRO via IC). Some data from Commercial Satellites required fees for services, impeding who had access (Hardwick 2008).

Without regular conference calls, information/data on the surface seemed like it conflicted (WFLLC 2007).

There were five independent real-time mapping platforms with no coordination between them, and the tools being used were “often embedded more in agency policy than in the geospatial technology” (WFLLC 2007: 19).

Collaboration/Coordination

The value of academic partnerships has been established both for skills and networks, but also the technological capabilities (CITIT 2007). Coordinating data formats has become a top priority (WFLLC 2007).

Each jurisdiction conducted damage assessment independently, using different criteria for the assessments. The resulting data sets could not be integrated due to varying attributes and spatial geometry differences (County of San Diego Office of ES 2007)

Several memorandums of understanding (MOUs) and memorandums of agreement (MOAs) were developed to further coordination and cooperation among regional partners. These included agreements between the San Diego County OES and California Department of Forestry and Fire Protection to provide fire liaisons to the OAEOC, and the San Diego County Geographical Information Service and the NASA to share imagery technologies.

Within the county, there were three different resource ordering systems: Emergency Management Assistance Compact (EMAC) system were received from other states more quickly than through the federal Resource Ordering and Status System (ROSS) request process (WFLLC 2007).

Military liaisons provided a conduit to a variety of critical resources, such as aerial reconnaissance (County of San Diego Office of ES 2007).

The newly created field liaison positions provided crucial information back and forth between the OAEOC and the Incident Command Posts (County of San Diego Office of ES 2007).

First fire reported by RACES, not a government group (County of San Diego Office of ES 2007). Without the MOU between the amateur radio groups and the county, there would have been a greater delay in response.

Information Flows

Information flow was hindered by different data types and server capacities (County of San Diego Office of ES 2007; California Institute for Telecommunications and Information Technology 2007; The San Diego RDF 2008).

By Tuesday, October 23, 2007, the SDSU Department of Geography; the Center for Information Technology and Infrastructure Visualization Center; and the local public broadcasting station, KPBS, had established websites on their servers that provided geospatial information on the fires. These sites helped alleviate some of the traffic on the overloaded county website. In doing so, they also introduced new resources to the county and state (County of San Diego Office of ES 2007).

The OAEOC improved its infrastructure through technological enhancements, including the purchase and implementation of WebEOC, a real-time, web-based emergency management system, and Reverse 911 and AlertSanDiego, two automated telephone delivery systems used throughout the county for emergency and evacuation notifications. Also, the OAEOC underwent a staffing reorganisation to provide for a more seamless emergency response (County of San Diego Office of ES 2007).

County Emergency services equipment upgrades were made that included new video teleconferencing capability and electronic status boards built to enhance communications and information management (County of San Diego Office of ES 2007).

Responder Safety

89 firefighter injuries (County of San Diego Office of ES 2007).

Collecting details about responding resources and feeding them back to requestees in some cases put the firefighters in undue danger due to the distraction from their main job (WFLLC 2007).

Stakeholders

Firefighters

Police

Red Cross

County and city emergency workers

Park services

San Diego State University geography department,

KPBS, public news media station

California Institute for Telecommunications and Information Technology,

Department of Emegency Health Local Communities Military, Amateur radio operators Google San Diego Gas and Electric (public utilities) United States Forest Service, California Department of Forestry and Fire Protection Volunteers, Voluntary Organizations Active in Disasters (VOADs) 211 San Diego Border Patrol Animal Services ESRI (GIS provider)
Public Engagement
Public was notified of evacuations and warning via a new system, reverse 9-1-1 that was an emergency line that called registered phones, the reverse of an emergency line that can be called from home (County of San Diego Office of ES 2007). A public alert program was put into place, Reverse 911 and AlertSanDiego, that sent automated calls to an estimated 515,000 evacuated residents (County of San Diego Office of ES 2007). However, calls only in English were sent out, despite the multilingual nature of the region (ACLU 2007). Unclear and sometimes contradictory information about protective measures for resperitory health were provided by the state, creating a public perception that masks were not necessary or that simple paper masks were sufficient (Kailes 2008).
Public Response
The public volunteered, were able to provide information, requested greater information as a result of the number of people evacuated. Many reports about the public helping their neighbors. Some of the public engagement was backlash – by such groups as the border angels who were frustrated with the limitations of the county response with the immigrant issues at the border. The county added a full-time public information specialist to the OES staff.
Media

The media were frustrated with the communication by the government offices and many started their own data gathering initiatives. One of the more successful media initiatives was a map and website started by a local public news station that received more hits than the county's own sites (Glaser 2007).	
Ethical, Legal and Social Issues	
There were issues accessing the data due to costs, sharing it due to liability and accountability. There were different concepts of risk and what was the most vital threats. There were issues with reverse 9-1-1 (how evacuation orders were delivered) not reaching people who were not at home, including all the migrant workers in the farm fields, who made up most of the deaths. Much of the government data was not initially released to the public but after a couple of public groups starting gathering their own data, the government made parts of their work public. However to get it, an internet connection was needed and the county servers could not handle the requests. There were issues with data ending at the border but the fire and effects flowed over the border. While the fire was well documented, the air quality information was less so and more obscure to find (Petersen 2014).	
Data-sets used:	
gathered prior to disaster	Derived from: (Cannon et al. 2007; CDFFP 2008; County of San Diego Office of ES 2007; Office of the State Fire Marshal 2007; City of San Diego, 2007) Prior burn extents Topography Jurisdictional boundaries Responsibility zones Pre-mapping of special needs facilities Common use map brand overlays "QuickBird" satellite imagery of pre-fire conditions Water sources Water authorities and pathways Power grid (or relationship with sdge to provide info) Fire hazard severity zones General phone information for city region Land use/Parcel Information Historical/archeological sites
gathered	Incident data comes from a number of sources: GPS data,

during disaster	remotely sensed imagery, reverse 9-1-1, word of mouth, scratch paper (County of San Diego Office of ES 2007; City of San Diego, 2007; State of California, 2007; Ginsberg et al., 2008). *Fire Management* Structures Damaged Weather data Response resource inventory Officers/employees/volunteers in the field, available Hours worked for first responders and type of response (air, ground, etc) Ikhana's imagery IR imaging from naval aircraft Data from Global Positioning System (GPS) technology (both handheld and computer) Information from video teleconferencing Burn severity zones within fire perimeters Threatened species, animal and flora, and land Critical radio infrastructure Critical infrastructure *People Management* Number of volunteers for county-run shelter Number of evacuees in shelters Animal rescues Water and electricity supply Road closures Evacuation resource inventory Evacuation orders (regions and individual phone numbers called) Evacuation routes Safe areas Air pollution water quality food safety hazardous materials Medical care facilities

	People of special need Volunteers/donations (while coordinated externally, required logistic support, and thus knowledge, from the county) Respiratory health visits 911 calls
gathered immediately after disaster	Debris Flow Studies (Cannon et al. 2007) Soil Erosion Increased Runoff Flooding Fuels and Fire Risk

Lessons Learnt	
explicit	There was redundancy in the system from the multiple agencies involved (County of San Diego Office of ES 2007). Need a common communication plan to coordinate radio frequency and technology for communication used by each group (WFLLC 2007). State and local government public health officials, in partnership with health-focused NGOs should compile health information specific to the types of disasters common in California (Kailes 2008) Need to be better prepared to serve people with special needs as they are evacuated (Kailes 2008) Need better local evacuation plans, including more guidance from the state to develop them (Kailes 2008) Need better cross-training with NGOs (State and local government public health officials, in partnership with health-focused NGOs should compile health information specific to the types of disasters common in California (Kailes 2008). Need to be better prepared to serve people with special needs as they are evacuated (Kailes 2008). Need better local evacuation plans, including more guidance from the state to develop them (Kailes 2008). Need better cross-training with NGOs (Kailes 2008). Emergency plans need to be reviewed at a greater frequency (Kailes 2008). “Areas for improvement include continued integration of the

	Medical Operations Center (MOC) functional role; increased information sharing among several county agencies; additional training on WebEOC and other technological resources; volunteer and donations management coordination; the formation of a formal repopulation plan; and further development of critical MOUs/MOAs. Recommendations include reviewing initial fire notifications with OAEOC personnel; reviewing the length of operational periods; continuing to develop information sharing and personnel management systems used during disasters; formalizing sheltering MOUs/MOAs that include the pre-positioning of shelter supplies; and clarifying reimbursement and documentation responsibilities within county departments" (County of San Diego Office of ES 2007). Implement a regional master fuel management plan (County of San Diego Office of ES 2007). Emergency plans need to be reviewed at a greater frequency (Kailes 2008). Implement a regional master fuel management plan (County of San Diego Office of ES 2007).
implicit	Better public disclosure of border fire management process.

Timeline	*Response*
21 Oct	First fires start to burn
09:23	The San Diego County Sheriff's Department receives request for aviation support for Harris Fire. 30 minute later the San Diego County Office of Emergency Services (OES) gets call from RACES about a 30 acre fire off of Highway 94 at Harris Ranch.
10:30	The Sheriff's Department Operations Center (DOC) activated. Reverse 911 activated; calls made to ~70 residences.
11:16	The Operational Area Emergency Operations Center (OAEOC) is activated at Level 1, personnel called in via AlertSanDiego. ~300 firefighters are on scene with air and ground support. An information hotline established for media personnel only.
12:41	Mandatory evacuations for Tecate. Reverse 911 messages are sent to 700 homes. Animal Services is dispatched to the Steele Canyon shelter. San Diego County Humane Society establishes a large animal shelter near Jamul Fire Station.
13:06	Witch Creek Fire starts. Structures are immediately threatened. Highway 78 closed.
13:38	Sheriff's Department reports mandatory evacuations for Dulzura. 322 reverse-911 calls are made. Residents are urged to call or visit 211s website.
13:49	The OAEOC activates Level 2.
14:22	Harris Fire is 2,500 acres. Witch Creek fire is 3,000 acres. The Sheriff's Department issues an advisory evacuation message via reverse-911 to ~8,900 homes.
14:46	Local emergency declared and San Diego County requests State Proclamation and Presidential Declaration.
16:02	The OAEOC is activated at Level 3
16:10-16:30	Mandatory evacuation issues for ~700 homes in the Otay Lakes / Barrett Junction and ~300 homes in the Witch Creek
19:36	Harris Fire 14,000 acres. 5% contained. Potrero, Tecate, and Dulzura, and parts of Deerhorn Valley evacuated. The Witch Creek Fire is 5,000 acres and 0% contained. Mandatory evacuations for Witch Creek, Old Julian Highway, and the northeast side of San Diego Country Estates
22:10	Mandatory evacuation order for Ramona. ~10,000 reverse 911 calls made. Poway and Escondido High Schools are designated as shelters.
22:41	San Diego County Courts closed on October 22.

22:45	The City of Escondido EOC is activated.
23:00	Red Cross closes the Poway High School shelter due to health concerns. Evacuees are relocated to Mira Mesa High School.
22 Oct	Red Flag warning issued through 24 Oct (high winds, high temperatures, low humidity).
01:36	Escondido Fire Department requests reverse 911 calls for ~2,000 residents in southeastern Escondido.
02:01	Coronado Hills Fire begins. City of San Marcos proclaims local emergency (county not notified until 0600).
02:56	Mandatory evacuations for part of San Marcos. ~4,300 reverse 911 calls made.
03:00-03:14	EOCs activated of the City of Poway EOC, the City of San Marcos and, the Cal State San Marcos.
03:32	Mandatory evacuation for Coyote Holler, ~970 reverse 911 calls.
03:45	The City of San Diego EOC is activated.
04:16	The Rice Canyon Fire begins in northern San Diego County near Rainbow.
04:22	Mandatory evacuation order for part of Poway, ~1,900 reverse 911 calls made.
04:36	The City of Poway proclaims a local emergency.
04:42	The City of Carlsbad EOC is activated at Level 1.
05:24	Precautionary evacuation issued for Carlsbad ~22,770 reverse 911 calls made
06:00-35	Mandatory evacuation for Del Dios, unincorporated Escondido, Rainbow and Valley Center ~45,000 reverse 911 calls.
06:35	After a brief lull, winds throughout the county exceed 50 mph.
07:36	Advisory evacuation for more of Poway ~4,000 reverse 911 calls.
08:30	City of Chula Vista EOC is activated. Pomerado Hospital and nearby nursing homes evacuating with 10 ambulances and 23 Poway Unified School District busses assisting.
10:08	Mandatory evacuation orders for Rancho Santa Fe and Leucadia, ~17,600 reverse 911 calls made.
10:45	The Solana Beach Fire Department begins door-to-door voluntary evacuation notifications for portions of Solana Beach.

10:55	Mandatory evacuation order for more of Poway, ~8,700 reverse 911 calls made
11:15	All San Diego County schools closed for October 23
11:18-12:24	Mandatory evacuation for Poway, Elfin Forrest, Escondido, Fallbrook, Olivenhain, and Encinitas ~19,000 reverse 911 calls.
13:00	The City of Chula Vista proclaims local emergency.
13:56	The City of Carlsbad issues a voluntary evacuation for south Carlsbad.
14:04	The City of San Diego evacuates Scripps Ranch, ~45,000 residents are affected.
14:28	The National Guard stages at Del Mar Fairgrounds, and 100 troops are expected in the next 12 hours with 1,100 troops in 24 hours.
14:38	The City of Carlsbad proclaims a local emergency.
14:45	County requests United States Ship Mercy Hospital to shelter patients evacuated from two area hospitals. Medical facility evacuees are expected to exceed 3,000. Public Health and the Medical Reserve Corps are expected to provide staff to assist.
15:52	The Coronado Hills Fire in San Marcos is 100% contained.
16:12-16:42	The Cities of Imperial Beach and Encinitas activate EOCs.
18:25	Advisory evacuation of Del Mar, Solana Beach, and Rancho Santa, ~34,700 reverse 911 calls made.
18:57	Del Mar Fairgrounds reports that 2,000 evacuated horses are currently in stalls and have adequate food and care.
20:09	The City of Encinitas requests the mandatory evacuation of portions of Olivenhain, ~1,640 reverse 911 calls made.
23 Oct	
02:43	Lakeside Fire Department requests the mandatory evacuation of Wildcat Canyon and Muth Valley, ~3,800 reverse 911 calls made.
03:09	The Sheriff's Department issues mandatory evacuation for North Jamul and Indian Springs. ~1,550 reverse 911 calls are made, and residents are instructed to evacuate to Qualcomm Stadium.
03:13	The Poomacha Fire begins as a structure fire on the La Jolla Indian Reservation and eventually joins the Witch Creek Fire.
04:45	Mandatory evacuation order for La Jolla Indian Reservation and Pauma Valley, ~4,100 reverse 911 calls made.

06:30-45	Mandatory evacuation order of the Palomar Mountain and Hidden Meadows, ~11,000 reverse 911 calls made.
07:07	National Guard troops deployed to Rancho Santa Fe, Fallbrook, Valley Center, Ramona to assist with roadblocks and security.
07:24	The American Red Cross National Management Team arrives and brings supplies and staff to support 20 shelters, which are being managed by county personnel or volunteer organizations.
10:18	Mandatory evacuation order of De Luz and portions of Rainbow, ~1,000 reverse 911 calls made.
10:34	Mandatory evacuations for eastern Chula Vista areas.
11:13	The San Diego County Water Authority (SDCWA) reports the Ramona Water District Poway pump station is inoperable. Emergency generators ordered, coming from Los Angeles.
12:38	Mandatory evacuation of Ramona/Lakeside (Highway 67 corridor), ~1,800 reverse 911 calls made.
13:27-14:13	Mandatory evacuation order near Julian and De Luz, ~6,800 reverse 911 calls made.
14:45	Mandatory evacuation of Jamul, ~800 reverse 911 calls made.
16:12	All San Diego Schools are closed through Friday, 26 October. Advisory evacuation of Julian, ~3,100 reverse 911 calls made.
16:18	Cities of Chula Vista and Solana Beach lift all evacuation orders
18:00	The City of Encinitas lifts Olivenhain evacuation orders.
18:33	All City of Del Mar evacuation notices are lifted.
17:30	Mandatory evacuation of Eagle Peak and Cuyamaca, ~142 reverse 911 calls made.
20:15	Mandatory evacuation for Fallbrook, ~14,000 reverse 911 calls.
23:05	The SDCWA requests 1,200 gallons of diesel fuel. The Ramona Water District orders fuel to run the replacement generators.

24 Oct	
01:00	Interstate 5 is closed near Camp Pendelton (only road between San Diego and LA).
02:10	Mandatory evacuation for the De Luz, ~900 reverse 911 calls.
03:34	Horno Fire reaches 6,000 acres and growing. Train service between San Clemente and Oceanside is halted
10:00	The City of Poway lifts evacuation orders.
10:23	Work continues to bring both Ramona Water District pumps online. SDCWA has queried the Ramona Water District regarding mutual aid needed to restore service.
11:55	The City of San Diego announces the re-opening of northeastern Rancho Bernardo.
13:46	City of Del Mar EOC deactivates
14:01	Ramona Water District asked CAL FIRE to refrain from using water system until entire system is filled and pressurized. CAL FIRE continues to fill aerial tankers with water from water trucks.
14:07	The City of San Diego announces that Rancho Penasquitos, 4S Ranch, and Santa Luzare are open for repopulation.
14:44	Ramona Water District sends reverse 911 message to the entire Ramona community. The message stated that water restrictions were limited to emergency use only.
15:15	The City of San Marcos EOC deactivates.
15:56	A Regional Assistance Center opens in Rancho Bernardo.
16:54	The public is notified of the request to not use water in Ramona in order to rebuild water system pressure to support fire suppression operations. A boil-water notice was issued for the Ramona area on October 23 at 1900 and remains in effect until further notice.
17:00	The City of Poway EOC deactivates.
25 Oct	
09:11	The City of Escondido lifts evacuation orders.
09:57	The City of Escondido EOC deactivates.
09:58	The Harris Fire incident commander advises
11:30	Portions of Rancho Santa Fe are authorized to repopulate.
12:00	Potrero re-openned. Tecate Border Crossing re-opened.
12:19	The State Office of Drinking Water requests OAEOC assistance to provide drinking water to Ramona (as bottled or hauled water).

13:43	Portions of Valley Center are authorized to repopulate
13:54	Mandatory evacuation for Lawson Valley and Carveacre, ~950 reverse 911 calls made.
14:39	Qualcomm Stadium evacuees move to the Del Mar Fairgrounds.
14:48	The San Pasqual Reservation is authorized to repopulate.
15:02	Portions of Valley Center evacuation orders are lifted.
15:56	Water issues continue to be the problem with repopulating the community of Ramona. Low water-pressure problems continue and could adversely hamper fire suppression efforts.
15:52	The City of Santee EOC deactivates.
19:15	The Ramona evacuation order is lifted at 1915, with provision that no water be used.
19:31	Evacuation orders for portions of Fallbrook are lifted.
19:51	recovery website created by county: www.sdcountyrecovery.com.
20:56	The reverse 911 system is used to notify the community of Ramona of unsafe and limited water situation.
26 Oct	
08:00-08:10	Valley Center and Western Jamul authorized to repopulate.
16:10	21 shelters are open. Remaining shelter population is 2,900
18:00-19:00	Rancho Heights, Pauma Valley, the Highway 76 corridor, Julian, Wynola, Pine Hills, Cuyamaca, and areas around Rice Canyon Fire authorized for repopulation.
27 Oct	
00:56	Del Dios is authorized to repopulate.
09:11	Dulzura is authorized to repopulate.
13:22	Bonsall and Rainbow are authorized to repopulate.
14:43	14 shelters are open. The shelter population is ~2,044 evacuees.
15:54	All evacuation orders issued for the Harris Fires are lifted. Repopulation of all evacuated areas is authorized.
17:41	Ramona residents warned not to have contact with municipal water, even when boiled. Reverse 911 message sent to residents
28 Oct	Majority of operations being to focus on recovery operations.
29 Oct	Ramona residents told that their water supply was safe to drink.
9 Nov	County OAEOC deactivated.

Timeline adapted from: County of San Diego Office of ES (2007).

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2.3.11 2007 - Flooding at Walham Substation, UK (ULANC-SB)

Incident (000011)

Figure 12 Walham Substation During Emergency Operations

Source: (National Grid, website)

May to July 2007 saw unprecedented heavy rain and widespread flooding throughout the United Kingdom. The county of Gloucestershire in South West England was particularly affected. On July 22 it became clear that the Castle Meads and Walham substations were at risk of needing to be shut down due to the flooding. The Walham substation was deemed of 'critical national importance', as it supplied electricity to approximately half a million homes in both England and Wales, as well as to various important Government Communications Headquarters and to a nuclear establishment. Consequently, a multi-agency operation was initiated on July 22, 2007 to prevent the rising flood water from overtaking Walham substation. The emergency response was to erect flood defences around Walham substation's switching room using sandbags and the Environment Agency's flood barriers and pumping equipment. The main concern was erecting the flood defences before high tide, which would have raised the water to unsafe levels requiring the substation to be shut down (McMaster and Baber 2008).

Material Damage

The widespread flooding of June and July caused extensive material damage to many essential infrastructures (e.g. roads, rails, electrical substations, water treatment plants, sewage treatment plants, telecommunications networks) as well as to businesses, residential properties, whole towns, and crop fields (McMaster and Baber 2008; The Pitt Review 2007).

Social and Human Impact

The floods of 2007 saw "several people" lose their lives (Rooke 2007). The widespread flooding also trapped hundreds of people in their homes and disrupted travel. On July 20, approximately 10,000 people were stranded overnight on motorway M5 and other roads, as were 500 people stranded in Gloucester when the rail network failed (The Pitt Review 2007: 18).

Approximately 55,000 homes and businesses were flooded (Environment Agency 2007) and 50,000 homes were temporarily left without power, with a further 500,000 homes put at risk of losing their power due to the threat the flooding posed to the Castle Meads and Walham substations (McMaster and Baber 2008). Approximately 350,000 people were left without fresh water supplies for two weeks as a water treatment plant had to be shut down due to the flooding (McMaster and Baber 2008). In addition, approximately 400,000 pupil school days were lost due to school closures (Chatterton et al. 2010: iv).

gathered prior to disaster	The EA helped to provide flood warnings and flood risk predictions and maps.
gathered during disaster	The Royal National Lifeboat Institute (RNLI) gathered and disseminated tide data and did floodwater risk assessments; they measured the water depth and provided support on flood defences. The National Grid monitored the depths of the flood water in critical areas and provided safety data regarding the site and electrocution risk.
gathered immediately after disaster	

Lessons Learnt	
explicit	
implicit	

Timeline	*Response*
Sunday July 22, 2007 Early Morning	Strategic Coordination Group at Gold Command notified that, due to rising river levels massive flooding in Gloucestershire was likely. Gloucestershire Constable Headquarters notified the military that they will likely be requested to assist. Walham substation identified as under-threat of flooding; Gold Command took the decision to deploy barriers and pumps to try to protect the substation.
12:00	Formal military assistance requested by Gloucestershire Constabulary.
16:00	Environment Agency (EA) contacted by Gold Command and briefed about the Walham situation; asked if their flood defences could be used to protect the substation.

	Site assessment was performed to determine if EA flood barrier could be used. Decided yes it could, but would be difficult in the time available. Regional Operations Delivery Manager briefed by phone; barrier components deployed along with other equipment. 2 EA Operations Delivery teams mobilised and briefed at their depots.
17:30	Fire and Rescue appliances and personnel sent from Avon to assist; equipment included High Volume Pumps (HVPs) to train flood water from the substation.
18:00	Brigade Readiness Team member at Gold Command briefed by Deputy JRLO, preceded to Walham to act as Military Liaison Officer.
18:30	Liaison Officer arrived at Walham; met with Fire and Rescue Incident Commander to find suitable helicopter landing sites. The 2 EA Operations Delivery teams arrived on site. Briefed by the National Grid Electrical Site Controller on site safety.
19:30	Avon Fire and Rescue resources arrive at Walham. One such office appointed Incident Commander; briefed by previous Commander. Team from RAF Innsworth arrived on site; reported directly to Fire and Rescue Incident Commander.
20:30	EA flood defence equipment began to arrive; EA teams start to build barrier.
21:30	RAF Cosford personnel arrive; Liaison Officer briefed RAF teams and put them to work sandbagging and moving flood defence components into place. RAF Lynham personnel arrived later and helped to build flood defences.
Monday, July 23, 2007 02:40	One of EA Team Members reported that they thought the barrier was sealed.
02:50	Fire and Rescue Incident Commander reports that water level inside barrier is starting to drop.Flood water had come to 2 inches below the height at which the substation would have had to been shut down. All non-essential personnel had been withdrawn from the site before high tide. The water level at high tide did not reach the level of the flood

	defences; they had held.

Timeline adapted from: McMaster & Baber (2008).

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2.3.12 2009 - L'Aquila Earthquale, Italy (T-6)
Incident (000012)

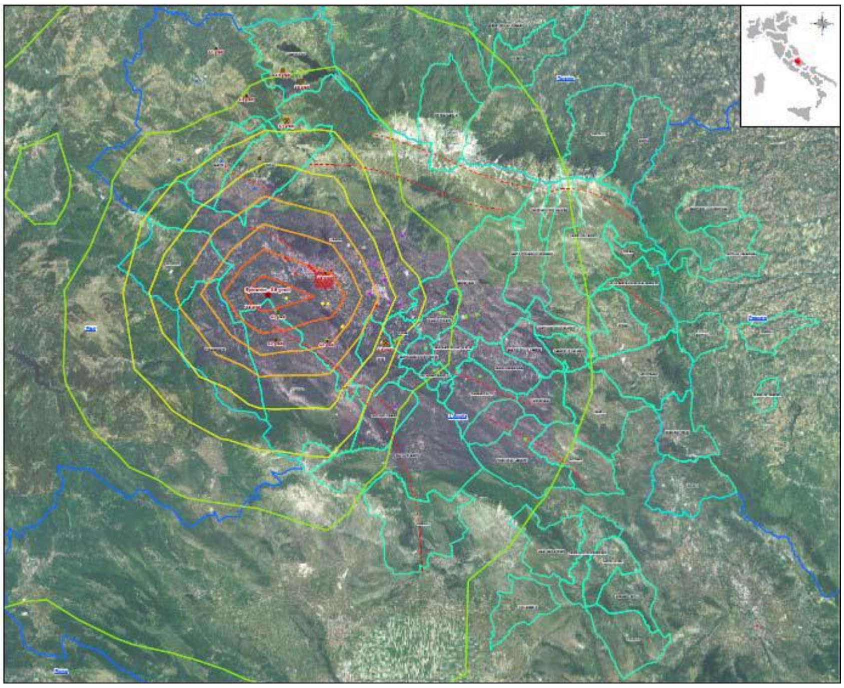

Figure 13 L'Aquila Earthquake

The crater area in the Abruzzo Region and intensity of the earthquake according to Richter scale (Source: www.iptsat.com)

In the night of 6 April 2009, a 27 seconds earthquake occurred in Abruzzo region, in the central part of Italy. It caused the death of 308 people (Scalzo 2010), the injury of 1600 people and the destruction of the historical centre of L'Aquila, the main city of the region, with some completely destroyed neighborhoods (e.g. the center of Onna which also had the highest percentage of died people). The Abruzzo earthquake severely affected population in terms of death toll compared with the (not very high) magnitude of the shake (5.8 Richter scale) due to the collapse of a huge number of buildings.The relevance of the event concerns also the fact that the earthquake has strongly hit an important urban area with a rich cultural heritage and even having a neuralgic role for all the surrounding territory due to the concentration of significant administrative functions and economic activities.

Material Damage

Damages have been counted to be more than $2500 million of which only 260 were insured (Munich Re 2009). The area more severely affected by the earthquake, consisting of 49 municipalities for a total amount of 133.831 inhabitants, has been officially defined as the "crater" (Figure 14).

Many public structures (the Court of law, the Cadastre, the Prison, the Regional Council, the University) have suffered severe structural damages and have partly collapsed. More alarming is the fact that during the emergency phase two structures failed their strategic role. First, the main hospital of the city (San Salvatore hospital) – although inauguarated in 2000 and, as consequence, supposed to be “earthquake-resistant” was declared ‘unfit for use’ a few hours after the earthquake, and consequently evacuated. Second, the Prefecture (Palazzo del Governo), a symbol for L’Aquila city - was completely destroyed (Figure 13), although it was restructured in the nineties. While the strategic importance of a hospital in an emergency phase is rather obvious, the importance of the Prefecture has to be shortly explained: according to Law 225/92, the Prefect, at the occurrence of a natural disaster, becomes the chief of the overall management of the emergency services and has the responsibility for coordinating the emergency activities and the involved institutions (Province, Civil Protection, Municipalities) making use of the prefecture structure (Dopheide et al. 2010).
Social and Human Impact
308 dead people, 1600 injuries and 65000 people homeless. Behind the terrible losses of lives, the population has been forced to leave the places they lived with a strong identity nature to move to places without services and meeting areas. (The situation is quite the same still now, after 5 years from the occurrence of the earthquake).
Economic Impact
The economic activities of L’Aquila city, before the earthquake, were mainly related to commercial activities (in both wholesale and retail forms), accommodation facilities, building sector, real estate, ITC and research and manufacturing (e.g. food, textile, engineering, pharmaceutical-chemical industries,furniturefactories) (CRESA 2009). Other Municipalities of the crater were, on the contrary, mainly based on agricultural activity, hunt and forestry. Moreover, it has to be highlighted that about half of the commercial activities, bars, hotels and restaurants of L’Aquila municipality were destroyed. The interdiction of part of the historical center - the so-called “red zone” - has completely paralyzed the incomes coming from these activities.

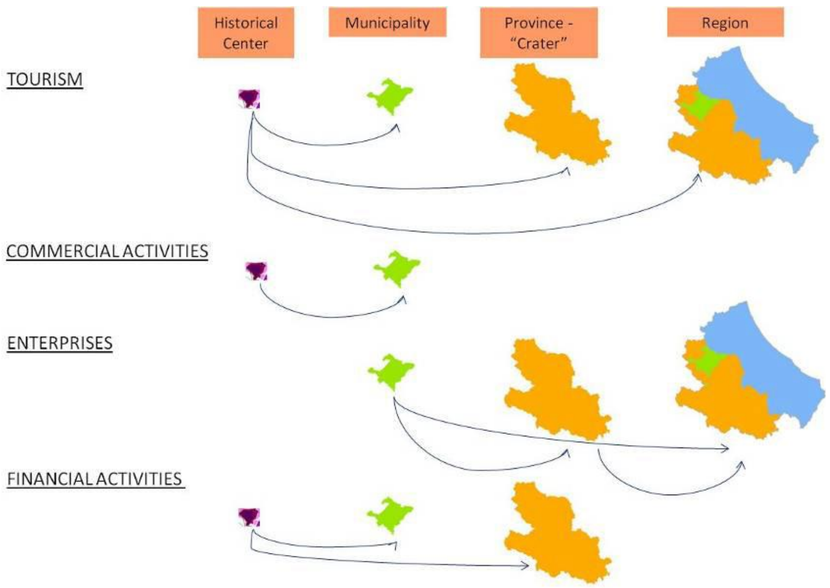

Figure 14 The Transference of Vulnerability

Vulnerability of some economic sectors moving from one scale to another showing the relevance of the occurrence of the event for the entire region (Source: *ENSURE Project 2011)*

Preparedness – Training, Emergency Plans, Crisis Management Models

In terms of prevention, many of the collapsed building (Imarisio and Fiorenza 2009), including the Prefecture, had been classified as having a medium-high level of vulnerability to earthquake within a devoted report of 1999 on the vulnerability of public, strategic and special buildings carried under the coordination of the under-secretary of Civil Protection in charge in those years (Rapporto 2009). The results of that report, useful for undertaking seismic-oriented refurbishment activities, has been completely ignored until the occurrence of the event.

In terms of preparedness, the members of the Great Risks Commission met on 31th of March to discuss about the sequence of seismic shakes occurrence and the probability of a forthcoming relevant earthquake. No need for a warning to the population emerged during the meeting and some members agree on the fact that, even if it could not be completely excluded, the occurrence of a strong earthquake, as those destroying L'Aquila city in 1703, could be discarded (L'Espresso 2009).

In terms of Crisis Management Models, the Italian Civil Protection has developed - over the years - an own Intervention model in case of an emergency. According to this model, a Direction for Order and Control (DI.COMA.C) is nominated and the territory is divided into Operational Centers according to homegeneous features of its different parts.

Interoperability – Information Sharing Communication, Coordination, Collaboration, Information Flows

In the immediate aftermath of the event the functionality of ICT infrastructures was checked. The electricity service was damaged but the overall functionality has been guaranteed. Disruption occurred to the mobiles phone network; in order to overcome such a disadvantage, a lot of mobile systems were installed (PCM 2009). In some cases, the use of mobile phone helped first responders to locate injured people under the rubble.

All the activities were managed by the Civil Protection Department (CPD) in the person of the Special Commissioner, under the supervision of the Presidence of the Council of Ministry and by involving the Prefecture, Region and other local bodies, police forces, volunteer civil protection organizations, competencies centers, the National Health Service and privates. The main decisions came into force by including them into decrees and ordinances of the CPD.

Responder Safety

All the responders have been adequately equipped for providing first aid and trying to extract people under the rubbles. The main threat during the aid action has been represented by the collapse of part of buildings or of other buildings adjacent to those already collapsed or severely damaged.

Stakeholders

Public Administrations

Municipality

Police

Civil Protection

Armed Forces

Italian Red Cross

Volunteers

Fire Brigades

Electricity

Gas and water providers

Mobile phone operators.

Engineers/architects

Chamber of Commerce

Public Engagement

Public Authorities have been involved in the event even before its occurrence. In the area concerned, the seismic activity had been recorded for the previous five months. One day after the persistence of tremors and the last shake of magnitude 4.0 on the 30th of March, the Chief of the Department of Civil Protection convoked the Great Risk Commission (Commissione Nazionale per la Prevenzione e Previsione dei Grandi Rischi), devoted to the analysis of major phenomena causing disasters (L'Espresso 2009). Nevertheless, in the absence of a deterministic correlation between the data, the Commission, responsible also for awareness activities, decided to avoid any alerting measure to the local population. On the following day, the Major of L'Aquila sent a telegram to the Department of Civil Protection, to the Region's governor, to the Prefecture and to the regional councilor of the Civil Protection, asking for the declaration of the 'emergency state' due to the persistence of sismic activity and to the following cracks found both in private and public buildings. In detail, he asked for a proper and urgent expenditure for structural interventions as a consequence of the continuous shaking since January (Caporale 2009). Referring to an evacuation order, it is plausible that considerations about the socio-economic consequences following a false alarm have had the upper hand here (Dopheide et al. 2010).

Public Response

Media

The 6th April Abruzzo earthquake has represented an emblematic case for what concerns the communication of risk. Such an aspect has been strongly influenced by the reassurance provided by public authority in charge to evaluate the risk. Mass media contributed to spread a false sense of safety paradoxically grounded on the "stability" of the sequence of shakes (Braun 2010).

The days after the event have been well documented event through images captured by the population and uploaded even on non-official channels (e.g. youtube).

Ethical, Legal and Social Issues

Legal surveys on the occurred damages provoked by the disaster have focused on two aspects:

1) The responsibility of public Authorities about the communication of risk;
2) The widespread application of bad construction practices and the lack of compliance with building codes.

An important social issue referring to the post-disaster phase concern the public choice to build new houses in new settlements - even far from the original place - where parts of the population has been transferred to, instead of preferentially refurbishing the building stock of the historical center. Such a decision has still now a lot of social consequences in terms of sense of community that was very strong in L'Aquila city before the event.

Data-sets used	
gathered prior to disaster	Before the event, the available data concerns the sequence of foreshocks occurred from 16 January 2009 till the day of the event with a peak on 30 March (M=4.0), as recorded by the National Institute of Geophysical and Volcanology (INGV) seismic network.

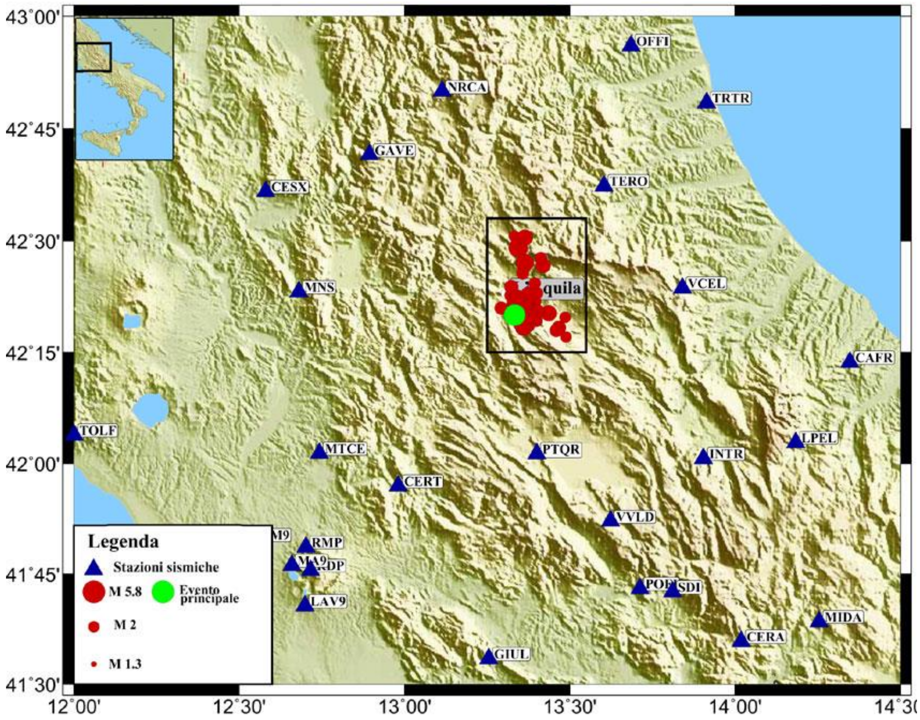

Figure 15 Epicenters and Magnitude of Earthquake, Foreshocks, and Aftershocks

(Source: http://www.amracenter.com/laquila/)

gathered during disaster	Data referring to seismic activity.
gathered immediately after disaster	Geophysical survey to establish "safety areas" to move the population. Images captured by air and helicopter flights in order to recognize the areas more severely hit by the earthquake.

Lessons Learnt	
explicit	The spread of a sense of “false safety” can be devastating. The population has been not adequately informed about the risk before the event although the sequence of forescocks of the last months and the occurrence of modifications of other so-called “precursor” parameters. The awareness level of the population can be determinant to survive to a natural and non predictable event as an earthquake.
implicit	Despite the fact that earthquakes can not be forecasted, a correct information can be crucial. Other useful tools that can contribute to the reduction of likely damage are early warning systems that have been already implemented in areas characterized by a high level of seismic risk (e.g. Japan).

Timeline	*Response*
6 April 2009 3:32	The quake, rated 5.8 out of 10 on the Richter scale, *hit* in the night at 3.32 am. Other three relevant shakes occurredthe day after, respectively with a 4.7,5.3 and 4.2 Magnitudo. (PCM 2009).
3:57	The National Institute for Geophysics and Volcanology (INGV) provides information about the occurred event to the Government and, specifically, to the Civil Protection Department
Immediate aftermath of the event	Soon contacted operational room of Civil Protection Department (CPD) in order to acquire information
4:15	Crisis Unit of Civil Protection (CP) is activated
4:30	A first team of expert technicians devoted to carry out macroseismic surveys and to outline a first state of structural and infrastructural damage is sent by CPD
4:40	Meeting of the Operational Committee of CP
4:40	Other two operational teams are sent by CPD for surveys
7:30	Launched a reconnaissance mission by helicopter
8:30	National Emergency State declared by the President of the Council of Ministries. The Chief of Civil Department became Responsible for all the Emergency activities (Special Commissioner)
9:00	Activation of Direction of Order and Control (DI.COMA.C) in the

	School of Italian Finance Police in Coppito (L'Aquila)
9:00 – 13:00	Other experts in Emergency Management, Logistic, Health, Cultural Heritage joined the teams of technicians already present on the territory
9:00- 16:00	Activation of different regional travelling coloumns of Fire Brigades
16:30	New meeting of Great Risks Commission in L'Aquila (Scalzo 2010)
8 April 2009	27.772 people arranged in camps (17.772) and in hotels (10.000), 10 shelters areas realized, 2962 tents assembled, 10 camp kitchen organized, 13 hospital unit guaranteed

Timeline adapted from: Scalzo (2010) and PCM (2009).

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2.3.13 2010 - Eyjafjallajökull Volcano Eruption, Iceland (ULANC-KP)

Incident (000013)

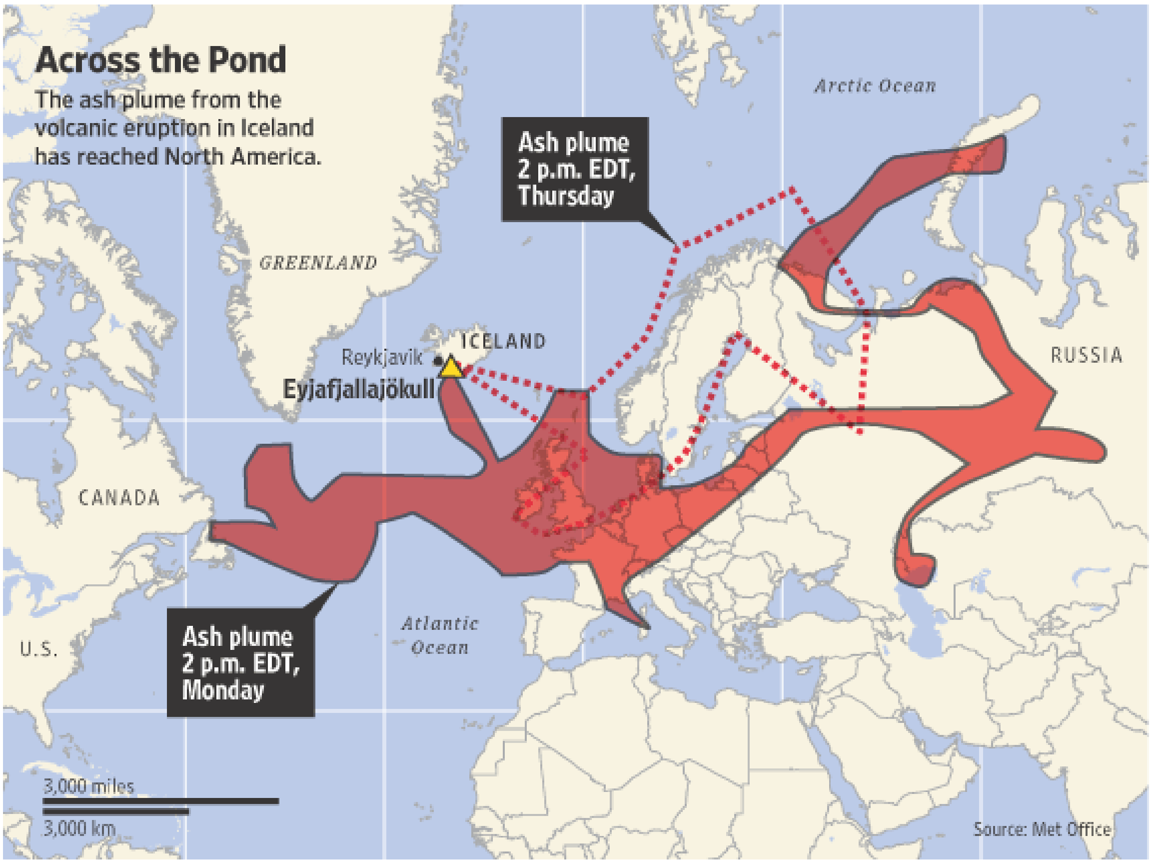

Figure 16 Eyafjallajökull Volcano Eruption 14-18 April 2010

Distribution of ash plume (Source: IATA 2010).

For six days, 14-18 April 2010, the Eyjafjallajökull volcano in Iceland erupted. While the eruption was relatively small it spread ash in the airspace of 20 different countries, mostly in the EU, causing most to close their airspace from 15-20 April. The eruption continued for months and was declared over in October 2010 (Iceland Review Online 2010b). Over 100,000 daily flights both in and out of Europe were cancelled (Bye 2011).

The volcano produced over 250 million cubic metres ejected tephra, the ash plume that rose approximately 9 km high (4 on the Volcanic Explosivity Index) (Cottrell 2010).

Material Damage

The ash accumulation on the glaciers caused mudslides and new vents opened, as well as layers of ash (less that 5mm) throughout Europe, but no physical structures were damaged (Than 2010). There was some damage to airplane engines that flew prior to the airspace being closed (Hoyle 2010).

There was some damage to cropland, water quality, and animals in Iceland.
Social and Human Impact
Travelers around the world were stranded as a result of the eruption. The majority were in Europe and Africa. It also affected the ability of heads of state to get to events such as the funeral for Polish political elite who had recently died in a plane crash (IATA 2010). 6–9 months after the Eyjafjallajökull eruption, residents living in the exposed area, particularly those closest to the volcano, had markedly increased prevalence of respiratory and cardiovascular symptoms and mental health issues (Carlsen et al. 2012).
Economic Impact
The ash-filled air cost airlines more than EUR 1.3 billion in revenue losses in just 6 days. During the worst of the ash, on 18 and 19 April, around 19,000 flights per day were cancelled. This grounded nearly 30% of worldwide scheduled passenger capacity. Overall, over 100,000 flights were cancelled. Around 10 million passengers were affected by the Eyjafjallajökull ash cloud (IATA 2010). Finland, Ireland, UK, and Iceland saw 90% of the air traffic loss (Eurocontrol 2010c). The ash also affected local farming (Iceland Review Online 2010a). Iceland tourism dropped 30% for two months, a major part of the countries economy (Brooklyn Brothers 2014)
Preparedness – Training, Emergency Plans, Crisis Management Models
It was the first eruption in over 200 years, so other than evacuating the local villages, there were not many plans in place other than local evacuation plans (BBC News 2010). Moreover, the decisions were made using old ICAO qualitative guidelines to avoid visible volcanic ash, guidelines that had to quantitative threshold for ash concentration levels (IACA n.d.). Each country had their own closing and re-opening evaluation and procedures.
Interoperability – Information Sharing Communication, Coordination, Collaboration, Information Flows
Coordination and Communication between governments and airlines was not good (IATA 2014). Coordinated press releases started taking place 3 days into the cancellations (Eurocontrol 2010b). There was also no consensus on scientific limits for ash hazards between countries (IACA n.d.). The Volcanic Ash Advisory Centre (VAAC), who are responsible for monitoring volcanic activity in the north Atlantic ocean Civil Aviation Authority (CAA) and National Air Traffic Services (NATS) where the ash would be every six hours. These are the two agencies that are responsible for the airspace in that region. We also had full support from the Icelandic Meteorological Office as well as the

European and global VAAC community. (Met Office 2011).
Responder Safety
n/a
Stakeholders
Airlines Airports Farmers National Air Flight Agencies throughout the EU Civil Aviation Authority (CAA) Volcanic Ash Advisory Centre (VAAC) National Air Traffic Services (NATS) Civil Aviation Organization (ICAO) Meteorological Offices Airplane manufacturers/quality control testers Travel Insurance Agencies International Volcanic Ash Taskforce (IVATF)
Public Engagement
In an attempt to manage the negative sentiments about travelling to Iceland at the time, an interdisciplinary group of marketers and academics started a social media initiative to change the perception, using facebook, twitter, tumblr, and vimeo (Brooklyn Brothers 2014).
Public Response
Media
Overall, the media coverage was almost entirely about the disrupted air travel.
Ethical, Legal and Social Issues
Coordination across national borders: It became clear that greater coordination was needed when managing airspace across national borders. Public-private emergency management: It also became clear that these decisions were made primarily by scientific and private agencies (meteorology offices and airports), suggesting a different preparedness and response model than typical emergencies. Responsibility for victims: Because it was a weather event, there was only partial compensation (mostly through travel insurance) for stranded passengers. It is unclear who has responsibility to deal with the affected populations in these kinds of situations.

Data-sets used	
gathered prior to disaster	Information about one airplane travelling through a Volcanic Plume in the Philippines that caused engine troubles. Historical eruption information Seismic activity around the volcano
gathered during disaster	Plume projections: Pollution model NAME (Numerical Atmospheric-dispersion Modeling Environment), used to forecast how the ash cloud would move (this was also used during the Buncefield oil depot fire). Ash density in air Weather information Engine Damage Air visibility Airline Passenger data
gathered immediately after disaster	Transport data (increase in train, bus, boat passengers). Insurance reimbursements

Lessons Learnt	
explicit	*Scientific models need to be based on a wider range of tests and updated more frequently*. Civil Aviation Authority (CAA) updated their requirements for ash safety in plane engines as well as decreased the restrictions on flights in ash plumes (Marks 2010). NAME model was reconfigured to provide forecasts to the new tolerance of ash deemed safe by regulators. *Greater coordination managing international airspace*. How airspace affects international relations also needs greater 'harmonization' (IATA 2014). New tools, such as European Crisis Visualization Interactive Tool for ATFCM (EVITA) have since been developed as a response. The global air traffic management Contingency Plan template was introduced which will be merged into regional plans by the Planning and Implementation Regional Groups (IACA n.d.). European Aviation Crisis Coordination Cell (EACCC) has since been created as a result of this event (IATA 2014). *States should not be in sole-control of decisions to close their airspace at will*. These decisions need to be based on recommendations from scientific and planning agencies (IATA 2014). *Visible ash is as accurate a technique as other methods of monitoring*. [There also needs to be greater centralization for warnings – so decision makers have a common place to search

	(IATA 2014). Greater preparedness is needed that links European countries as well as public-private management models. In 2011 there was an EU wide volcanic ash disaster drill (The Volcanic Contamination Exercise) that was used to test collaboration, air traffic management response as well as to test new models for atmospheric ash flow and flight capabilities. It concluded that about 70% of the cancelled flights could have taken off. The same exercise found that European response was disorganized and discordant (IATA 2014).
implicit	*Just because it happens less frequently does not mean it isn't as important*. Volcanic ash should be treated similarly to any other significant meteorological hazard. The International Volcanic Ash Task Force (IVATF) was also created soon after to help establish appropriate projects for the MET office (IATA 2014).

Timeline	*Response*
20 March 2010	Eruptions began in the volcanic arc. Scientific Monitoring
14 April 2010	Eyjafjallajökull erupts for first time (many small eruptions to follow during the week) (Iceland Review Online 2010b). Norway and the UK (Scotland) are the first countries to take measures. By midnight, Sweden and Finland have also begun to regulate parts of their airspace. Operation decisions were delegated to the airlines (IATA 2014).
15-16 April 2010	Airspace closures spread to the rest of UK, Netherlands, Belgium, Denmark, Ireland, and southern Sweden (Eurocontrol 2010b). European Aviation Crisis Coordination Cell (EACCC) has since been created as a result of this event (IATA 2014).
17 April	Estonia and Poland close their airspace. France and Germany close part of their airspace (Eurocontrol 2010b). Throughout Britain resident reporting ash on cars.
18 April	Airspaces begin to reopen (Eurocontrol 2010b).
20 April	ICAO issues guidance that no aircraft should fly through volcanic ash.
22 April	Almost all flights take off and airspaces are reopenned (Eurocontrol 2010b).

23 April	Weather forecasts show switch in wind direction.
24 April	Restrictions on flights at Reykjavik and Keflavik, Iceland, due to the ash.
26 April	Airlines instructed by regulators to conduct a risk assessment before flying and engine inspections before and after each flight.
2 May	Eruption and plume activity increases, spreads over Western Europe
17 May	New safety thresholds set by the CAA, based on information from engine manufacturers and airlines.
June 2010	Last documented volcanic spew (Iceland Review Online 2010b).
Oct 2010	Eruptions declared over (Iceland Review Online 2010b).

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2.3.14 2010 - Love Parade Stampede, Germany (UPB)
Incident (000014)
 *Figure 17 Love Parade Festival in Duisburg* *(Source: © Arne Müseler / arne-mueseler.de / CC-BY-SA-3.0 / (https://creativecommons.org/licenses/by-sa/3.0/de/deed.de)* On 24 July 2010, at the electronic dance music festival Love Parade in Duisburg, ‘crowd turbulence’ caused the death of 21 festival attendees. The event was cause by poor tunnel entrance and exit control into the festival area, leading to a fatal level of overcrowding (Helbing and Mukerji 2012: 1).
Material Damage
None identified (partly due to ongoing culpability trial)
Social and Human Impact
21 people died and about 500 people were injured (Der Westen n.d.). Due to the occurrences several efforts for enhancing the planning and conduction of major events have been conducted. Some of these are • Project “Sicherheit bei Großveranstaltungen im Freien (Safety of outdoor major events) (MIKLDW 2013) • Provision of documents and guidelines for the planning of major events at Change of regulations: Major events are only approved in case of every security authorities involved agreeing to the security concept (Jager 2010) • Recommendations regarding the following aspects: ○ standards for private security services (certification) ○ requirements towards the qualification of security staff ○ statutory obligation of indemnity insurance of the event (Handelsblatt 2010).

Economic Impact
Insurance against personal and material damage about 7.5 Mio. € at AXA. Leyendecker, Hans and Richter, Nicolas. (2010). (Handelsblatt 2010).
Preparedness – Training, Emergency Plans, Crisis Management Models
Installation of management group from the fire service in Duisburg (about 50 persons) and emergency services to plan ambulance and rescue service (Marx et al. 2013: 1010).
Interoperability – Information Sharing Communication, Coordination, Collaboration, Information Flows
Little available (partly due to ongoing culpability trial)
Responder Safety
No injuries for emergency services
Stakeholders
Lovapent GmbH (organiser) Landespolizei Nordrhein-Westfalen Polizei Duisburg Polizeihundertschaft Münster Polizeihundertschaft Köln Fire service Duisburg Deutsches Rotes Kreuz Duisburg (emergency service) Arbeiter-Samariter-Bund Duisburg (emergency service) Johanniter-Unfall-Hilfe Duisburg (emergency service) Malteser Hilfsdienst Duisburg (emergency service) R.A.D. Sicherheits GmbH (Private security service) Kötter (Private security service) CCS Security (Private security service) SMS Security (Private security service) Challenge Security (Private security service) (Marx et al 2013; Juttner 2011; Leyendecker and Richter 2010).
Public Engagement
Public was communicated with via loudspeakers.

Public Response	
Social media has been used to provide comments from different people. For example a Love Parade regarded message board at "*Spiegel Online*" has been installed which included a total of 6360 user comments (Schwarz 2012:434]). During the disaster people supported other persons in leaving the critical area.	
Media	
The event was reported in terms of all available media formats (TV, newspaper etc.). Especially the questions for the cause and the regarding responsibilities were focused on.	
Ethical, Legal and Social Issues	
Trial that last years before details of situation can be made public. Lack of safety precautions for festival goers – partly due to outsourcing.	
Data-sets used	
gathered prior to disaster	Architectural drawings City Infrastructure maps Parade path/map/timing Physical layout of the festival Festival event timing
gathered during disaster	Crowd numbers and movement details Movement of emergency vehicles and personnel Traffic/road conditions Open hospital beds Police cordons
gathered immediately after disaster	Data about the actions of the security members Location of CCTVs/video footage from those cameras
Other	

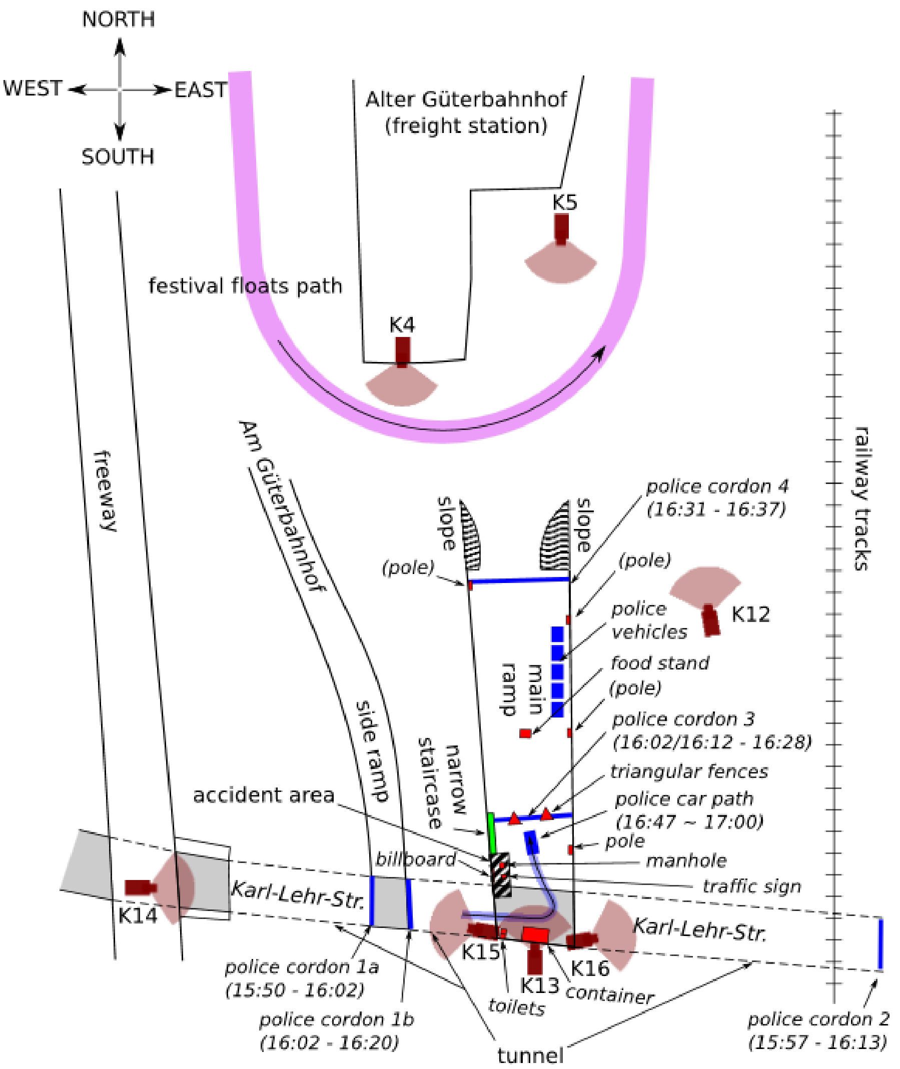

Figure 18 (Source: Helbing and Mukerji 2012: 5)

Lessons Learnt	
explicit	Standards for private security services have to be introduced and requirements towards the qualification of security staff have to be formulated. A simulation has been conducted drawing on data from this disaster (unknown staircase in the simulation). The results have been used to define a new safety concept for future planning, specifically effective traffic management (the tunnel closure should have been different (RP Online 2010) . Future similar situations need an effectively defined process to evaluate safety warnings from different sources (Jager 2010).
implicit	

Timeline	*Response*
July 24, 2010	Opening of the festival area via access control points along the east and west ends of a tunnel.
12:02	Reduction of the inflow of people into the main festival area by closing 10 of 16 turnstiles at the east and west entrances.
13:00	Start of the Love Parade
14:00	Increasing concentration of visitors at the end of entrance area due to obstacles in terms of music trucks
14:15-14:30	Increasing visitor flow on the entrance ramp and from the west
14:30-15:06	Crowds manager's attempts failed to contact police for support due to problems with communication devices (i.e. according to organiser: 'liason officer' as connecting person between organiser and police didn't have working walkie talkie/mobile phone)
14:30-15:15	Closing of as many remaining open turnstiles as possible
About 15:00	Start of visitors ignoring fence on main ramp's side and overcoming shortly later fences on the other side of the ramp which were installed to avoid a path with a steep slope
15:31	Formation of first chain of police forces ('police cordon') in front of the side ramp along west end of tunnel blocking all visitor traffic in and out of the festival.
15:50	Formation of a second police cordon blocking the tunnel to the east
15:50-15:57	Strong visitor flow to the festival area from the west resulting in a movement of the first cordon behind the side ramp
About 16:02	Start of an festival's in-and outflow control by police in the middle of the ramp.
16:02	Jam in the west part of the tunnel
About 16:07	Jam above the police cordon on the ramp due to festival's outflow
About 16:09	Formation of a third police cordon stopping the complete in- and outflows at the fences narrow down the ramp
16:12-16:28	Opening of the small ramp to the festival area resulting in visitors climbing over fences
About 16:13	Opening of the second police cordon in the east resulting in visitors entering big ramp
About 16:14	Start of visitors entering festival area via a narrow staircase between the lower part of the ramp with the festival area Later blockage of the staircase by two security people

About 16:17	Resolving of the first police cordon resulting in visitors moving towards the ramp and encountering there the dense flow of visitors from the east
About 16:21	Start of visitors climbing a pole in the critical area (see Figure 18) to leave the ramp
16:22	Retention of the third cordon resulting in an increasing pressure due to in- and outflow
16:22-16:24	Resolving of the third cordon
16:24-16:28	Usage of the narrow staircase by people to get up to the festival
About 16:27	Formation of a forth police cordon in the ramp's upper area resulting in an increasing density in the ramp's lower area
16:31-16:37	Increasing number of people trying to access festival via staircase, pole and container (see Figure 18)
Starting 16:40 o'clock	Command to stop inflows to the tunnel and the ramp area completely which is executed within minutes
About 16:48	Occurrence of strong shock waves pushing people to the ground between tunnel and staircase
Starting 16:53	Extremely crowded situation including scrambling and yelling people, attemps to control crowd by police
Starting 16:58	First victims being reportedt
17:02	Reduction of density due to people climbing via staircase and container
Starting 17:05	No awareness of critical situation by operation room of Duisburg city which still calls the Love Parade a big success
17:15	Relaxation of situation on the ramp
Starting 17:16	Resolving of crowd. Parked fire and ambulance cars in the south of the ramp
About 17:20	Opening of the festival area via access control points along the east and west ends of a tunnel.

Timeline adapted from: Helbing and Mukerji (2012: 8)

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2.3.15 2011 - Bombing and Shooting, Norway (ULANC-MB)
Incident (000015)
On 22 July 2011, two successive attacks, which are described as 'the worst peacetime massacre in the country's modern history', took place in Norway (BBC News 2012). The first attack was a bomb explosion at 15:25, detonated in the executive government quarter in Oslo, causing extensive damage to government buildings including the Prime Minister's Office. It killed 8 people and wounded 30. Less than two hours later, another attack took place on the island of Utøya, about 40 km northwest of Oslo, where the Norwegian Labour Party was holding its yearly youth summer camp. A person disguised as a police officer started shooting, killing 69 people and leaving 60 more wounded (BBC News 2012). The two attacks resulted in 77 fatalities, with another 90 people injured. The right-wing extremist Anders Behring Breivik (ABB) confessed to the twin attacks.
Material Damage
The buildings in the government centre in Oslo were damaged, there were fires inside one of the buildings and the shock wave blew out the glass on all floors as well as buildings on the other side of the square. There was glass and debris in the surrounding streets (2011 Norway Attacks n.d.).
Social and Human Impact
There were worries that the attacks would also lead to a spread of fear and anxiety and an increased acceptance for hard-line counter-terrorism measures. Initial studies suggest that this effect is not as strong as it was feared, with surveys showing that while there has been a normalization of attitudes toward counterterror measures, but Norwegian legislation in the security field is said to succeed in balancing the relationship between security and liberty (Fimreite et al. 2013).
Economic Impact
No information found.
Preparedness – Training, Emergency Plans, Crisis Management Models
The police had developed a special set of plans for use in the event of terrorism, relevant to an incident with a large bomb in the Government Complex. There were plans for roadblocks to prevent terrorists from getting away and initiatives for the immediate mobilisation of police personnel to reduce the response time for any further attacks. However, these plans were not used on 22 July. Oslo University Hospital's had a detailed set of plans and these were followed, supporting leaders to spend time evaluating situation reports (MIMMS (Major Incident Medical Management and Support (Rimstad et al. 2014)). When it was discovered that certain routines could lead to bottlenecks, decisions to change these routines were taken rapidly and responsibly (Bech Gjørv 2012).

Interoperability – Information Sharing Communication, Coordination, Collaboration, Information Flows
The main report after the incidents draws out a number of problems related to interoperability, including: • The police operation on Utøya Island was poorly coordinated so it took longer than necessary. • The Operations Centre was designated in the plan to lead and coordinate. It was understaffed and overwhelmed by telephone calls. Communication problems caused resources to miss each other. Informal language usage and non-compliance with basic requirements for accurate communication in a crisis helped make a poor communication situation even more challenging. • From summer 2010, the Office of the Prime Minister and the Ministry of Justice and Public Security had been informed that progress in work to secure the Government Complex gave cause for concern because several measures of great importance for security had not been implemented. This concern never reached the leadership of the Ministry of Government Administration, Reform and Church Affairs. • Advice that the Directorate of Customs and Excise sent to the Police Security Service in connection with the Global Shield Action also contained concerns. The Police Security Service has weak routines for dealing with advice and did not recognise any link between these concerns. • The Police Security Service did not take much advantage of the information and capacity inherent in the postal and customs systems. • Confusion about the interpretation of the confidentiality provisions in the Health Personnel Act meant that it took a long time for the hospitals to give the police access to information about the identities of those who were admitted. This complicated the rescue operation and caused undue distress for families and friends. (Bech Gjørv 2012). The command organization emerged from needs defined by the on-scene actors. It had its base in official and normative plans, but was modified ad hoc. The accompanying information flows followed an 'informatio forest' model with vertical flows within organsations and horizontal branching (Rimstad et al. 2014).
Responder Safety
There were concerns over secondary attacks and responder safety, which hindered the deployment of medical staff and led to lack of overview over self-evacuation (Perng et al. 2013).
Stakeholders
Police, fire fighters and medical staff, civil defense forces, members of the public who rescued people from the water.
Public Engagement
Responder organisations and the government used traditional media to informthe public. According to reports this went well (Bech Gjørv 2012).

Public Response	
Members of the public heard shots and cries for help at Utoya island and used private boats to assist people in the water. There was some evidence of self-organised response through social media (Perng et al. 2013).	
Media	
The Norwegian media covered the 22 July terrorist events by featuring a constant flow of interviews with survivors and family members of those who had lost their lives. The interviews revealed strong feelings and grotesque details. During the weekend after the terrorist attacks, respondents reported spending an extensive amount of time watching the news: a mean total of 17 hours in Oslo, and 16 elsewhere in Norway (Thoresen et al. 2012; Schultz et al. 2014)	
Ethical, Legal and Social Issues	
The Norway attacks raised a number of ethical and social challenges around the fear of terrorism – the attack was initially seen as a terrorist attack, around the role of members of the public acting as first responders, rescuing people, and the difficulties of integrating the work of members of the public into the official response, as well as difficulties in social and cultural practices of risk assessment, emergency planning and inter-agency coordination.	
Data-sets used	
gathered prior to disaster	plans of government quarter
gathered during disaster	
gathered immediately after disaster	

Lessons Learnt	
explicit	According to the official report (Gjørv 2012) • The attack on the Government Complex on 22 July could have been prevented through effective implementation of already adopted security measures. • The authorities' ability to protect the people on Utøya Island failed. A more rapid police operation was a realistic possibility. The perpetrator could have been stopped earlier on 22 July. • More security and emergency preparedness measures to

	impede new attacks and mitigate the adverse effects should have been implemented on 22 July. • The health and rescue services managed to take care of the injured people and next-of-kin during the acute phase in a satisfactory manner. • The Government's communication with the general public was good. The ministries managed to continue their work despite the devastation. • With better ways of working and a broader focus, the Police Security Service could have become aware of the perpetrator prior to 22 July. Notwithstanding, the Commission has no grounds for contending that the Police Security Service could and should have averted the attacks. • The ability to acknowledge risk and learn from exercises has not been sufficient. • The ability to implement decisions that have been made, and to use the plans that have been developed, has been ineffectual. • The ability to coordinate and interact has been deficient. • The potential inherent in information and communications technology has not been exploited well enough. • Leadership's willingness and ability to clarify responsibility, set goals and adopt measures to achieve results have been insufficient.
implicit	

Timeline	Response
15:26 (13:26 GMT)	Explosion in the centre of Oslo

17:10

Utoya Shooting

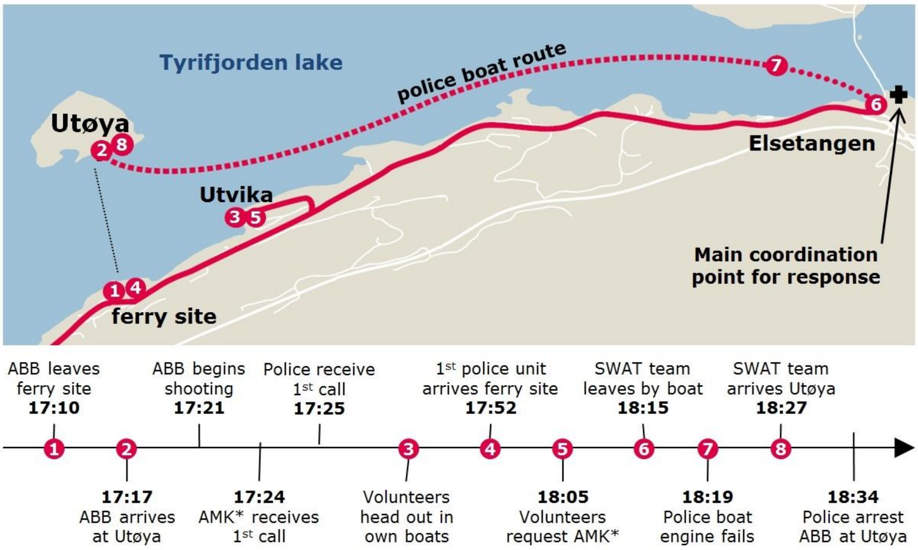

Figure 19 Simplified picture of the coordination of rescue personnel during the Norway Attacks

Source: (Perng et al. 2013; Gjørv 2012). **AMK is the Norwegian ambulance service. (Redrawn from the newspaper Aftenposten, Aug. 12, 2011).*

Figure 19 shows an overview of important events during the emergency response around Utøya. ABB, dressed as a police officer, entered the island using the ferry (1&2), gathered the youths, and then started to shoot. The emergency agencies were alerted. At the same time, many participants of the youth camp made contact with their family and friends using their mobile phones (calls, SMS, Twitter, Facebook). These fast and widespread updates of horrifying situations on the island alarmed parents and raised questions about the emergency response efforts. Shooting was first reported from the island at 17:24. The first police patrol arrived at 17:52 at the ferry site (4) searching for boats to carry the Special Weapons and Tactics (SWAT) team across the lake (dotted line in Figure 1). There was confusion over the location of the mustering point, and a heavily loaded police boat despatched from the more distant Elsetangen (6) soon suffered an engine failure (7), and private boats transported the police to the island (8).

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2.3.16 2011 - E.Coli Outbreak, Germany (ULANC-ML)
Incident (000016)
A novel strain of Escherichia coli O104:H4 bacteria caused a serious outbreak of foodborne illness focused in northern Germany in May through June 2011. The illness was characterized by bloody diarrhea, with a high frequency of serious complications, including hemolytic-uremic syndrome (HUS), a condition that requires urgent treatment. Epidemiological fieldwork suggested fresh vegetables were the source of infection. Initially German officials made incorrect statements on the likely origin and strain of Escherichia linking the O104 serotype to cucumbers imported from Spain. Later, they recognised that Spanish greenhouses were not the source of the E. coli and cucumber samples did not contain the specific E. coli variant causing the outbreak. The agriculture minister of Lower Saxony identified an organic farm in Bienenbüttel, Lower Saxony, Germany, which produces a variety of sprouted foods, as the likely source of the E. coli outbreak. The farm has since been shut down. Although laboratories in Lower Saxony did not detect the bacterium in produce, a laboratory in North Rhine-Westphalia later found the outbreak strain in a discarded package of sprouts from the suspect farm. A control investigation confirmed the farm as the source of the outbreak. On 30 June 2011 the German Bundesinstitut für Risikobewertung (BfR) (Federal Institute for Risk Assessment), an institute of the German Federal Ministry of Food, Agriculture and Consumer Protection, announced that seeds of fenugreek imported from Egypt were likely the source of the outbreak (Source: E.coli Germany, wikipedia) Special characteristics of this outbreak • Very large: > 3000 EHEC cases (normally 1000/year) • Very dramatic: 55 fatalities • Many hemolytic uremic syndromes (HUS): 20% (normally 10%) • Mostly adults (median age: 46 years) (normally 5 years) • Over 60 % women affected (normally equal distribution) • Serogroup o:104 very rare in Germany (normally 0:157) • Unusual resistance pattern against antibiotics • Very long incubation period: 2-18 days (normally 2-4 days) • Mainly limited to Northern Germany • Imported sprouts as vehicle (normally meat, raw milk) (Stark 2011)
Material Damage
Disease, no damage in infrastructure

Social and Human Impact
In all, 3,950 people were affected and 53 died, 51 of which were in Germany.
Economic Impact
Spain expressed anger about having its produce linked with the deadly E. coli outbreak, which cost Spanish exporters 200M US$ per week. Russia banned the import of all fresh vegetables from the European Union until 22 June. By 7 June, the EU's farmers had reported they had lost millions of dollars in exports during the outbreak, with Fepex, Spain's fruit and vegetable industry group, saying its growers had $256,000,000 in turnover. French, Swiss, Bulgarian, German, Dutch, Belgian and Portuguese producers have also been similarly affected. On 8 June, The EU Farm Commissioner Dacian Ciolos said that the EU had increased its offer of compensation to farmers for the losses caused by E. coli outbreak to C$210,000,000 ($306,000,000). On 8 June, it was reckoned that the EU's E. coli O104:H4 outbreak cost $2,840,000,000 in human losses (such as sick leave), regardless of material losses (such as dumped cucumbers). (Source: E.coli Germany, wikipedia).
Preparedness – Training, Emergency Plans, Crisis Management Models
The process has been publicly criticized for being too slow and for initial false press announcements linking cucumbers and not sprouts to the outbreak. Retrospectively, this criticism must be viewed with some restraint. In the early days of the outbreak, the median reporting times for HUS cases were 8 days to diagnosis, about 10 days to inform the local health department, and about 12 days for reporting to the Robert Koch Institute (RKI). In a U.S. study on *E. coli* O157 infections, an average reporting time of 7 days was achieved. There are two reasons for the slower reporting process in Germany. Germany has a less-centralized public health system, and these cases presented with an unusual profile, confronting physicians with a new clinical entity (Muniesa et al., 2012).
Interoperability – Information Sharing Communication, Coordination, Collaboration, Information Flows
Foodborne disease reporting system in Germany Robert Koch Institute (RKI – the federal institution responsible for infectious disease surveillance in Germany) implemented SurvNet –an electronic surveillance system for infectious disease outbreaks in Germany in 2001 (Faensen et al. 2006). SurvNet captures outbreak reports and allows timely and easily retrievable epidemiologic information exchange on outbreaks at the local,

state and national levels (Krause et al. 2013). It is a legal requirement for clinicians to report haemolytic uraemic syndrome (HUS) cases and laboratories to notify of STEC cases to local health departments within 24 h. Meanwhile the reporting of cases from local health department through the state health department to RKI must be completed within 16 days (Wadl et al. 2011). Recently, Altmann et al. (2011) conducted analyses of the timeliness of Germany's surveillance system regarding STEC and HUS cases during 2003–2011. The median interval from notification of the local health offices to RKI was 7 days before the outbreak (1st January 2003 to 30th April 2011). Meanwhile, it took 8 days for the notification to reach RKI during the early phase of the outbreak (1st to 18th May) and 3 days during the late phase of the outbreak (19th May to 22nd June). In truth, the reporting system during the outbreak was occurring faster than the legal requirements. However, there were some delays between symptom onset and reporting for STEC and HUS cases in this outbreak. Several factors (as indicated below) may have contributed to the delay during the early phase of the outbreak. EHEC infections are uncommon in adults – hence physicians may have initially diagnosed a Salmonella or viral infection. STEC surveillance is based on laboratory analyses and HUS surveillance relies on physicians. Laboratories and physicians must report cases to the local health authorities within 24 h which will be transmitted to the state health authorities and subsequently to RKI (Fig. 2). For the system to function the physician must order a stool culture, the laboratory must identify the etiologic agent and report the positive results to the local health offices (Soon, Seaman, & Baines 2013). Faster reporting to the state government may prevent a higher number of cases. Hence, immediate improvements to the reporting system were made to centralise the information exchange and to accelerate the data flow. For example, since patients with bloody diarrhoea often present themselves at emergency (ER) departments, hence a syndromic surveillance system can be implemented at the ER facilities. From 23rd May 2011 onwards, the local health departments and state health departments agreed to report cases every working day to accelerate the reporting process (Wadl et al. 2011). Altmann et al. (2011) also revealed that the interval from the notification of the local health department to RKI could be shortened from 1 week to 3 days if data were reported on a daily basis.

This foodborne outbreak is unique because Germany practices decentralisation post-Hitler years to keep centralization to a minimum. Germany works in a federalised structure and receives information indirectly through district and state offices (Fig. 21). This starts with individuals who decide to seek treatment, followed by physicians who orders stool samples, and clinical laboratories to determine the aetiology of concern. If a notifiable microbe was isolated, then the case will be reported to the district offices before finally reaching Robert Koch Institute. Meanwhile, the tracking of foodborne illnesses is under the responsibility of the Federal Institute for Risk Assessment, part of the Ministry of Food, Agriculture and Consumer Protection. Fig. 20 shows an ideal reporting system where physicians and laboratories report directly to a centralised electronic database. Notifiable pathogens must be reported to the database.

Analysis of food safety breakdowns that occurred in the EU were based primarily

on information collected from the Eurosurveillance. The investigating and reporting of foodborne outbreaks in the EU became mandatory with Directive 2003/99/EC. The Directive requested that the EU Member States investigate foodborne outbreaks and transmit to the Commission a summary report of the results of the investigations carried out (Directive 2003/99/EC). (Source: Soon, Seaman, & Baines, 2013)
Responder Safety
Foodborne bacteria infection, no additional measures for responder safety
Stakeholders
Hospitals, physicians, laboratories, Robert Koch Institute (RKI), Emergency Departments, local health departments, state health departments, Federal Institute for Risk Assessment, Ministry of Food, Agriculture and Consumer Protection, EU Commission, Early Warning Response System (EWRS) by RKI Epidemic Intelligence Information System (EPIS), World Health Organization (WHO), European Centre for Disease Prevention and Control (ECDC), European Food Safety Authority (EFSA).
Public Engagement
Public engagement especially in blood donations
Public Response
Medical profession volunteers from other areas come to Northern Germany
Media
Ethical, Legal and Social Issues
Federal system Outbreaks of infectious disease cases are reported locally to health department by physicians and laboratories Cases are anonymized and sent on to state health department and finally to Federal Ministry of Health's Robert Koch Institute German federal system keen on data protection and against strong centralized databases Downside: information about epidemic outbreaks, but also about availability of resources not or only with considerable delay available for a central incident command Controversy about too slow reporting system between the various levels of the

state health system

Calls for faster overview by direct reporting (short-circuiting the federal system) and the installment of a central database such as PulseNet, a molecular surveillance network for food-borne infections, which has been successfully in use in the US. PulseNet consists of a real-time linked surveillance database system to detect infection clusters and investigate outbreaks such as Salmonella, verocytotoxigenic E. coli (VTEC) and Listeria monocytogenes.

Over a short timespan, it became obvious that the hospitals in northern Germany were completely overwhelmed by the rapidly rising number of severely sick patients. Most dangerous, and very difficult to treat, is HUS, which is caused by bacterial toxin. In most cases, patients need a “blood purification” (plasmapheresis), and immediate dialysis in the case of kidney failure, which can only be done under intensive care conditions.

Within a short time span the hospitals managed to allocate resources – partly through assistance of private practices and dialysis practices – to deal with the surge in admittance of suspected cases of EHEC and other emergencies. There were however shortages both of trained personnel and machines for the demand of special nephrological treatment (Bürgerschaft der Freien und Hansestadt Hamburg 2012).

Even though medical personnel and equipment were transferred from southern Germany into the treatment centers in the north, shortages in intensive care units and dialysis machines forced some hospitals to apply triage, for instance in both University Hospitals in Lübeck and Kiel where 350 patients with EHEC symptoms were treated, 115 of which were showing severe HUS syndrome. ‚At times I felt like on a battlefield’, Jürgen Steinhoff, head of the nephrology department said. On some days so many EHEC-victims arrived in the clinic that he was forced to apply triage: At first those persons with the best chances of recovery were treated (Bühler 2011, translation).

Data-sets used	
gathered prior to disaster	
gathered during disaster	reports in the RKI’s weekly Epidemiological Bulletin internet databases hosted by RKI SurvNet@RKI / SurvStat@RKI: https://www3.rki.de/survstat/ electronic reporting system for surveillance of notifiable infectious diseases teleconferences the German Society for Nephrology collected data on the HUS treatment capacities in Germany and reported these regularly via e mail to the RKI

	Eurosurveillance: Eurosurveillance is a European peer-reviewed scientific journal devoted to the epidemiology, surveillance, prevention and control of communicable diseases, with a focus on such topics that are of relevance to Europe. http://www.eurosurveillance.org/Public/AboutUs/AboutUs.aspx
gathered immediately after disaster	
Other	

FIGURE

Data flow in the German computerized reporting system

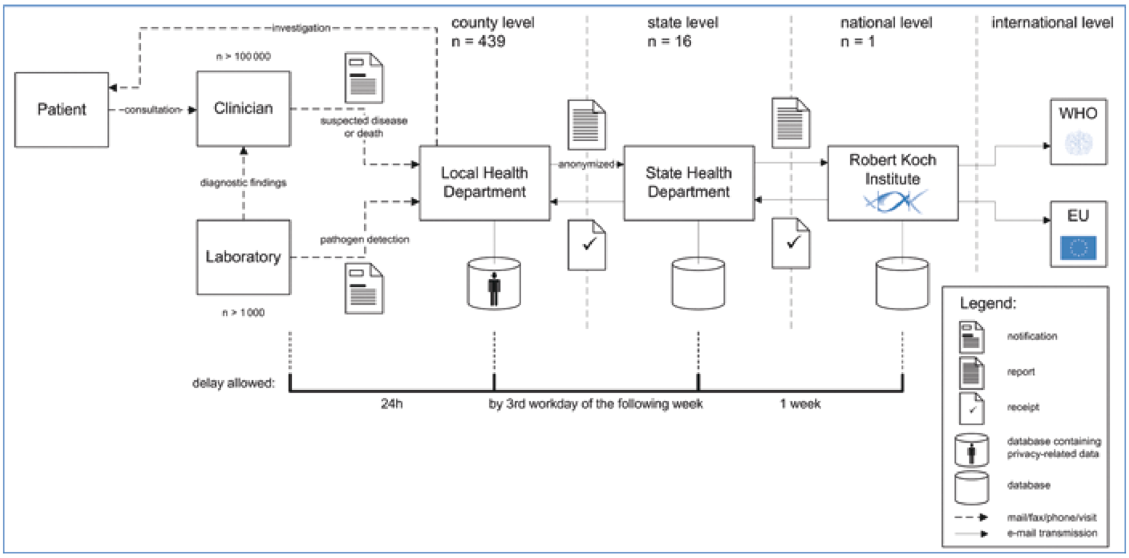

Figure 20 Dataflow in the German Computerized Reporting System

(Source: Faensen et al. 2006)

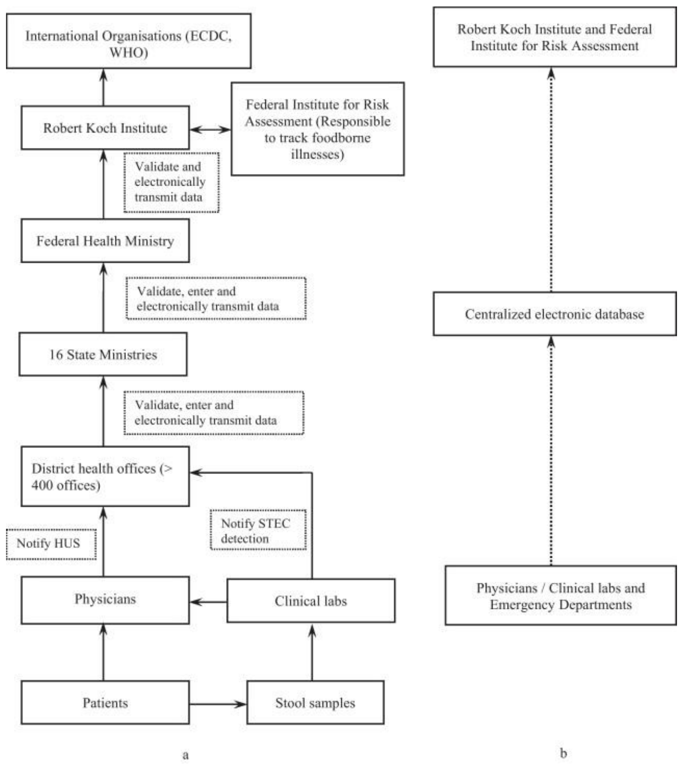

Figure 21 Epidemic Reporting System Germany

(Source: Soon, Seaman, & Baines 2013)

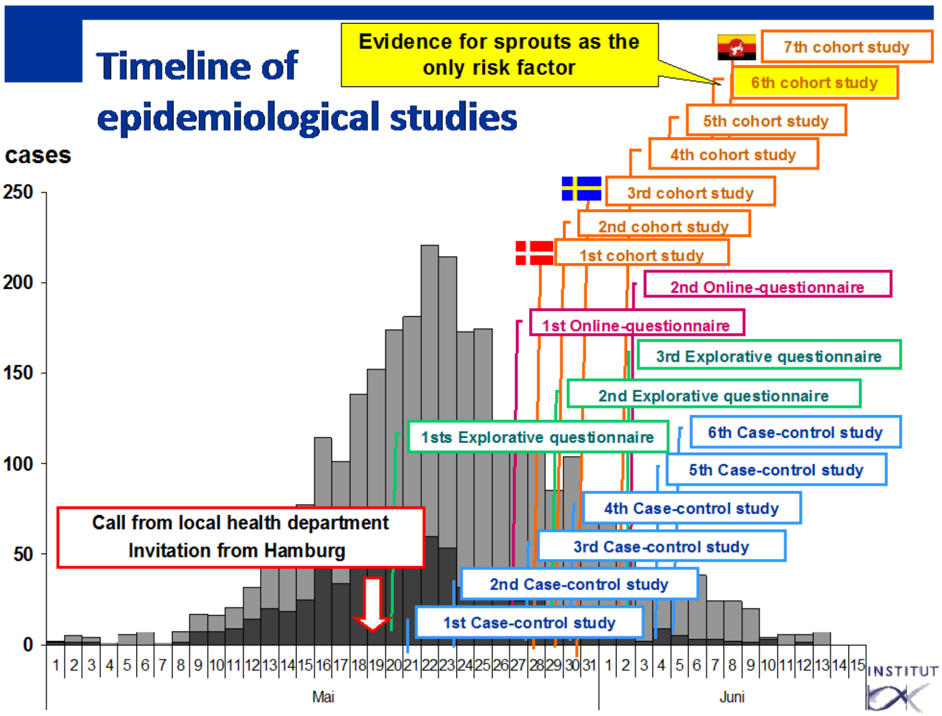

Figure 22 Timeline of Epidemiological Studies (E.Coli Outbreak)

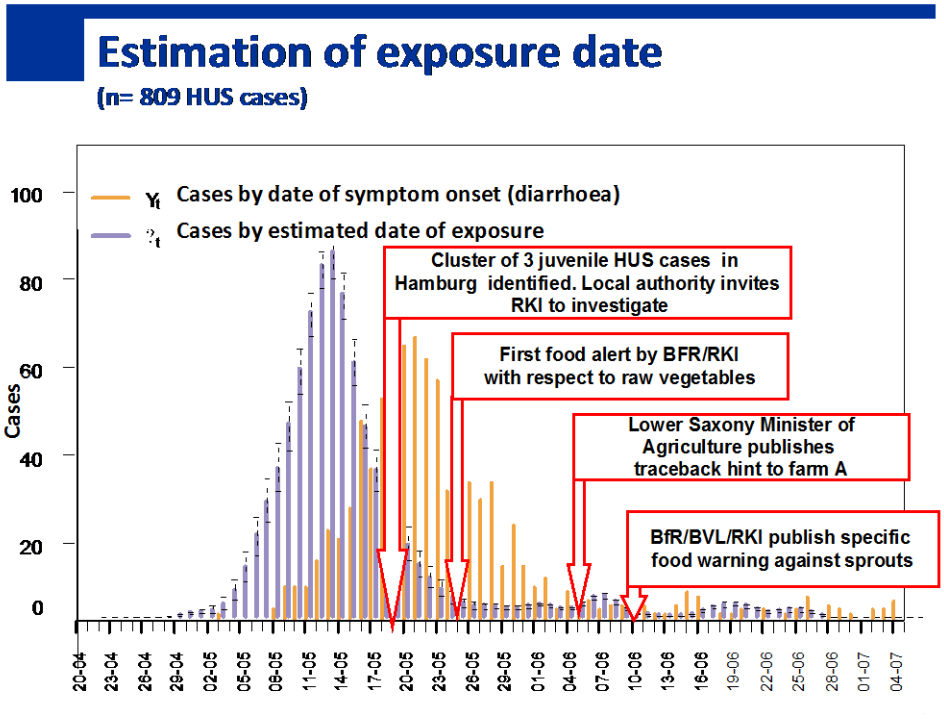

Figure 23 Estimation of Exposure Date (E.Coli Outbreak)

Lessons Learnt	
explicit	"Germany has a well established broad statutory surveillance system for infectious diseases. However, the rather long time limits permitted for communicating information on cases from the local to the state/national level led to delayed recognition of this outbreak: The first report at the national level was received on 18 May 2011, while the first outbreak-associated cases fell ill on 1 May, with a sharp increase in case numbers on 9 May. This is a limitation requiring further evaluation. In this specific outbreak situation, the mandatory surveillance system required enhancement that was rapidly and effectively implemented. Physicians, laboratories, local and state health authorities supported the acceleration and extension of the system extraordinarily well. Feedback to the public, the responsible authorities, physicians and laboratories was ensured daily, e.g. by updates on websites, teleconferences and reports. The additional surveillance instruments were voluntary and allowed for more timely monitoring of this public health emergency. Laboratory surveillance permitted assessment of the actual number of laboratory- confirmed outbreak cases

	particularly in the early stages. Monitoring capacity for treating HUS patients in German hospitals allowed us to evaluate whether or not international help would be needed. Syndromic surveillance in ED permitted us to follow the temporal trend of bloody diarrhoea patients as a proxy for potentially new STEC/VTEC cases. We conclude that infectious disease surveillance in Germany can rapidly be adapted to specific outbreak situations. Nevertheless, data flow within the statutory surveillance system should be accelerated, e.g. by use of an electronic notification system by physicians and laboratories, and a common central data base." (Wadl et al. 2011).
implicit	

Timeline	*Response*
01/05/11	First onset of disease (retrospective)
09/05/11	Sharp increase in cases (retrospective)
17/05/11	Physicians and Laboratories had diagnosed 51 cases of HUS / EHEC (retrospective)
18/05/11	The outbreak is discovered by a local health department in Hamburg, where a hospital reported 3 cases of HUS in children
19/05/11	Hamburg Health officials report to Robert Koch Institute (RKI) and ask for support
20/05/11	An RKI investigation team visited the affected area
22/05/11	Early Warning Response System (EWRS) by RKI about outbreak The RKI sent updates on the situation to EWRS, the Epidemic Intelligence Information System (EPIS) and the World Health Organization (WHO) on a daily basis.
23/05/11	In the face of rapidly rising case numbers, a need for enhanced surveillance was identified the 'Lagezentrum' at the RKI was activated as a central emergency operations centre. A large number of RKI staff was involved in coordinating the collection of epidemiologic information and organising the public health response

25/05/11	Since 25 May, the RKI has asked four laboratories for daily data transfer per email or telephone. European Centre for Disease Prevention and Control (ECDC) published rapid risk assessment
26/05/11	Preliminary case- control study (recommendation to abstain from cucumbers, tomatoes, leafy greens)
30/05/11	Assessing the capacities for treatment of haemolytic uraemic syndrome in Germany From now onwards, the German Society for Nephrology collected data on the HUS treatment capacities in Germany and reported these regularly via e mail to the RKI.
10/06/11	Investigation led to organic sprout farm
22/06/11	Similar outbreak occurred in France
04/07/11	Last onset of disease
05/07/11	European Food Safety Authority (EFSA) published technical report indicating fenugreek seeds as possible source of outbreak
06/07/11	Withdrew and destroyed all batches of fenugreek seeds from Egypt. Suspended import of fenugreek seeds until 31 Oct
26/07/11	Outbreak declared over. As of 25 Jul, 4321 cases with 3469 EHEC and 852 HUS cases and 50 deaths were reported

Timeline adapted from: Germany e-Coli n.d.; Soon et al 2013.

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2.3.17 2014 - Flooding, Bosnia (ULANC-VT)

Incident (000017)

Figure 24 Bosnian town of Doboj is submerged in floodwater.

Teams fixing power lines discovered human remains near the town. (Source: Anadolu Agency/Getty Images)

In May 2014, heavy rainfall caused the rivers Bosna, Sava, Vrbas and their tributaries to overflow and flood much of northern Bosnia-Herzegovina. A state of emergency was declared across the country, as the floods blocked roads, cut electricity, spoiled the water supply and damaged a variety of infrastructures in many communities flow and flood much of northern Bosnia-Herzegovina. A state of emergency was declared across the country, as the floods blocked roads, cut electricity, spoiled the water supply and damaged a variety of infrastructures in many communities (UNICEF 2014; UNOCHA 2014).

Material Damage

According to UNICEF (2014), more than 100,000 residential buildings were destroyed, dozens of industrial buildings were severely damaged and more than 230 public institutions (such as schools and public offices) were affected. At least 44 health facilities were damaged, dozens of ambulances were destroyed and countless medical supplies were compromised (WHO 2014a). The floods ruined many primary and secondary roads and destroyed over 20 bridges. About 70% of the affected regions are suspected of containing mines and unexploded devices, which may have been surfaced by the flooding (UNICEF 2014).

Social and Human Impact
Estimates and figures from disaster response agencies vary significantly. In its 25 May 2014 Situation Report, the World Health Organization (WHO) estimated that at least 55 people died, over 60,000 were displaced and over 2 million were affected by the floods (WHO 2014b). However, in its 24 May 2014 report, UNOCHA reported that 81,879 people had been displaced and 3.1 million affected (UNOCHA 2014). According to Cerkez & Gec (2014), "almost no one has property insurance, meaning many residents lost virtually everything." As of 25 July 2014, recovery efforts were ongoing (SCI 2014b).
Economic Impact
The economic impact of the floods has yet to be calculated because the clean-up and response are currently ongoing; however, preliminary estimates suggest that the recovery will cost billions of Euros (Cerkez & Gec 2014).
Preparedness – Training, Emergency Plans, Crisis Management Models
Interoperability – Information Sharing Communication, Coordination, Collaboration, Information Flows
Numerous reports reference coordination amongst agencies (SCI 2014a; UN BiH 2014; WHO 2014b), but very few reports provide specific details on information sharing, coordination and collaboration. According to the IFRC (2014), the Government of Bosnia-Herzegovina "worked closely" with the IFRC, ICRC and the UNDP, but no further details were provided. Additionally, UNBiH (2014) reported that "since the beginning of natural disaster, the UN [has worked] in close cooperation with governments at all levels, Civilian Protection Services, BH MAC and other organizations"; however, again, no further details were provided.
Responder Safety
Responders must be aware of the water and sanitation concerns that accompany a flood of this scale (WHO 2014). Furthermore, responders must be careful of mines that may have been shifted by the flooding and landslides (Cerkez & Gec 2014); over 9,000 minefields remain in Bosnia from the 1992-1995 war (Cerkez & Gec 2014).
Stakeholders
Citizens throughout Europe, especially those in Serbia, Bosnia-Herzegovina, and Croatia. Tourists traveling through Eastern Europe. Ex-pats with families and friends affected by the flooding. International disaster response organisations, including the ICRC, WHO, UN OCHA and UNICEF. The governments, fire

rescue units, police forces and armies of Serbia, Bosnia-Herzegovina, and Croatia. International governments.
Public Engagement
Public Response
According to Pasic (2014), the public response "has served as an example of unity, solidarity and humanity." Thousands of volunteers have aided the local police and army in building flood barriers, cleaning up debris, and searching for missing persons (Pasic 2014; SCI 2014a). Hotel owners and private individuals have offered free accommodation for displaced persons (Pasic 2014). Members of the diaspora in Europe and abroad sent funds (Pasic 2014).
Media
In the days immediately following the flood, most major news outlets were reporting on the floods. However, long-term media coverage has been very limited (Obreht 2014). Finding current reports on the floods has been difficult.
Ethical, Legal and Social Issues

Data-sets used	
gathered prior to disaster	
gathered during disaster	
gathered immediately after disaster	

Lessons Learnt	
explicit	
implicit	

Timeline	*Response*
13 May 2014	A low-pressure mass forms over the Adriatic Sea, after polar air from Central Europe combines with humid subtropical air over the Mediterranean basin. This creates cyclone "Tamara." Heavy rainfall begins late in the day.
14 May 2014	As the low-pressure area moves over the Balkans, it becomes stationary and continues to bring heavy rain to the region.
15 May 2014	Heavy rain continues, as water levels rise more than 3.5 meters in under 24 hours. Affected populations begin moving to sports halls, schools and aid centers that are set up to distribute medicine, food, blankets and clothing.
16 May 2014	Heavy rainfall continues. More people are evacuated from their homes. The Bosnian Ministry of Security requests international assistance. Mine Action Centre BiH sends out warnings that mine locations may have been affected by the flooding.
17 May 2014	Rainfall begins to subside and the skies begin to clear.
18 May 2014	The cyclone moves northwest.
20 May 2014	The Croatian Government declares a state of emergency.
22 May 2014	Water levels stagnate and begin to recede.
26 May 2014	International integrated rapid assessment teams arrive.

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2.3.18 2015 - Refugee/Migrant Crisis, Europe (ULANC KP/SB)

Incident (00018)

Figure 25: Migrants Crossing the Mediterranean Sea in an over-crowded boat

(Source: One Europe, http://one-europe.info/mediterranean-sea-of-migrants-in-danger)

The Mediterranean and the Balkans have long served as refugee/migrant crossing points for people seeking to reach Europe from Africa, Asia, and the Middle East. The men, women, and children who make this crossing come primarily from the Middle East and Africa as they flee war and conflict, human rights abuses (e.g. forced conscription into armies or armed groups, forced marriages), lack of opportunities (e.g. education for children; entrepreneurship); and extreme poverty, or family reunification [5; 6; 56]. The UNHCR notes that this is a form of “mixed migration” consisting of both refugees and migrants [2]. This movement of people challenges the European Union to control the movement of refugees/migrants without forfeiting freedom of movement between its member countries. As of July 2015, the vast majority who entered the EU were refugees legally seeking asylum, from countries at war and/or notorious for human rights abuses (e.g. Syria, Afghanistan, Eritrea, Somalia) [52, 66].

In 2013, the number of refugees/migrants who crossed the Mediterranean was approximately 40,000, down from 64,000 in 2011 but up from 16,000 in 2012 [8]. However, according to the European Council on Foreign Relations (ECFR), in 2014 this number jumped considerably to approximately 200,000 [3]. There is also an increasing number of refugees/migrants coming via the Balkans [62]. This number of refuges in 2015 has already reaches 340,000 setting the stage for a record year of refugees entering Europe [9, 70]. The numbers of people arriving continue to grow, surpassing 100,000 in July 2015 alone. Italy, Greece, and FYROM are receiving the majority of those arriving, and they are struggling

to keep up. FYROM declared a state of emergency [70]. This influx of people has stemmed a crisis of human trafficking that has placed those making the journeys into perilous situations. Those leading the trafficking have little care for life, often abandoning overcrowded ships part way across the Mediterranean or trucks full of people along the side of a highway. The death toll at sea is already at least 2,500 [62]. Moreover, Human Rights Watch reports that there are large numbers of children, sometimes unaccompanied, arriving in the EU via the Mediterranean [5].
Material Damage
n/a
Social and Human Impact

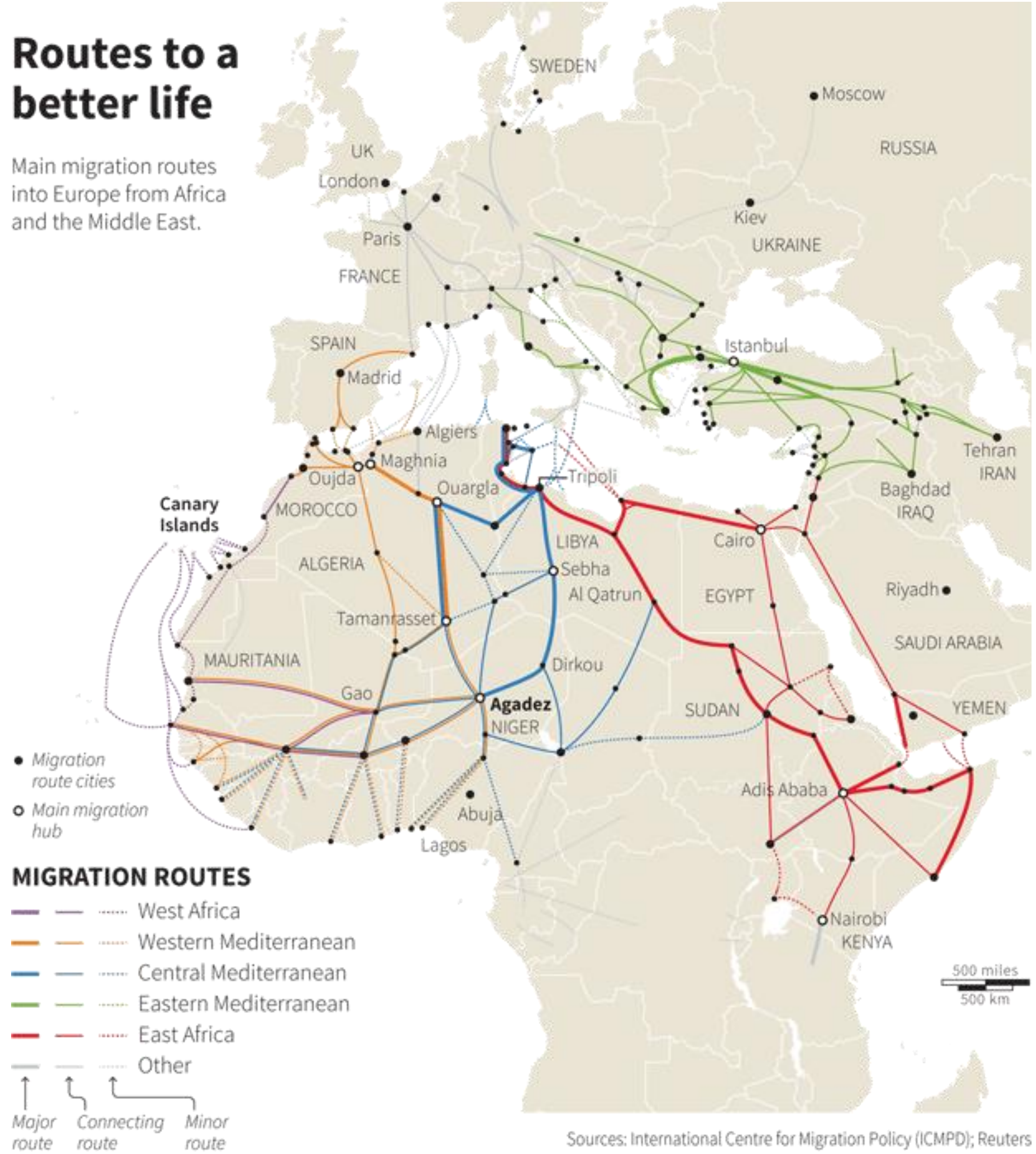

Figure 26: Routes traveled by migrants and refugees

(Source: Council on Foreign Relations , http://www.cfr.org/migration/europes-migration-crisis/p32874)

Large flows of refugees/migrants have widespread socio-economic and human impacts on both destination *and* origin countries. As this crisis is ongoing, these impacts are contested and changing.

The Journey to and Mediterranean Crossing

The refugee/migrant journey to Europe is costly, long, and perilous. Many sell all they have in order to pay thousands of dollars to human smugglers to help them move across land and then the Mediterranean [5]. The land journey is highly arduous, through desserts, and circuitous. It can take well over a year to reach the Mediterranean, with some walking most of the way [12]. Many people die during this part of the travel, a number not taken into account by the deaths tolls accounted for in the media [12]. There is also violence along the way, with refugees/migrants often mugged, mistreated, and sexually assaulted [12; 43]. Once at a Mediterranean coastal crossing point, smugglers arrange boats for refugees/migrants; these boats are often unseaworthy and overloaded. These boats are abandoned by their guides and the refugees/migrants and left to use undersized dinghies or to swim to get to shore. In 2014 approximately 3,400 refugees/migrants are estimated to have died trying to cross the Mediterranean to the EU [3]. So far in 2015 there have been 2,500 reported refugee/migrant deaths in the Mediterranean Sea [62]. Across the Balkans the land journey continues for those coming from the Middle East, many of whom can no longer take trains or other forms of transport due to increased border security and resort to being smuggled in highway vehicles [59, 62, 63].

A note: the EU is not the only political power dealing with this type of situation, many others dealing with a much larger influx. To date, the EU has pledged to take only 20,000 refugees from Syria over a two year period, and is expected to receive an estimated 500,000 refugees in 2015 [7]. This can be compared to the 1.8 million refugees currently in Turkey and 1.2 million in Lebanon, a country with only 4.5 million citizens [66].

Reception at Europe Borders

Many of the refugees/migrants that cross the Mediterranean Sea first arrive in Greece or Italy, and an increasing number are now arriving in Austria and Hungary from land passages. There have been many reports of refugees/migrants arriving on Europe's shores without any reception [37]. In part, this is due to the large numbers arriving into a single location. For example, Kos, a small island in Greece of only 33,000, has received over 10,000 refugees/migrants [39]. Also, in some places, like the shores of mainland Greece, refugees/migrant groups often have to walk long distances to get to reception centres as it is illegal for buses, taxis or residents to offer rides [37].

If travelling by land, many now arrive to four metre razor-wire fences along the Hungarian border, installed to deter their movement, as well as a negative billboard campaign [64].

Once at reception centres, they face long waits, on the scale of weeks, in uncomfortable, sometimes unsanitary, accommodation. In one place in Greece, refugees/migrants are being accommodated in an abandoned hotel without electricity [38]. Volunteers have been mobilizing to assist refugees/migrants and fill the legal gaps, but have been challenged by the sheer number of people arriving [21; 37; 39; 21]. Many refugees/migrants have resorted to living in makeshift camps [39].

For local residents the impact of so many refugees/migrants arriving has not been on two extremes. Some have shown high levels of compassion and a desire to help, with some individuals starting private rescue companies [21; 37; 39; 63]. Others have expressed resentment and anger, even committing arson in order to express their political opinions, burning down housing designated for refugees [39; 65], a sentiment that has grown as numbers of refugees/migrants has continued to increase [39]. The EU has also witnessed increased anti-migrant discourse and political movement to the right [3; 60].

Refugees/Migrants within the EU

Once on the shores, many refugees/migrants try to get to particular places within the EU. The reasons include language, family reunification, wealth of the country, or specific ideas about how welcome they will be. Germany and Sweden have taken in the majority of the refugees and asylum applicants. France, Hungary, and Italy have received the second largest number of asylum applicants. The UK and Greece have received the smallest number of asylum applicants [67].

Once refugees/migrants reach their destination they often face xenophobia and exploitation. Refugees/migrants who remain undocumented often find work in the 'black economy' and may face extreme forms of labour exploitation and precarious living conditions [44]. Some refugees/migrants may wish to remain undocumented because they do not want to spend time in detention centres or they fear their asylum applications will be rejected.

Economic Impact

The economic impact of the influx of refugees/migrants can be approached in two different ways: direct and indirect impact.

The direct impact is the amount of money that the EU and Member States are spending in their response to the refugee/migrant influx. This includes the securitization of borders, the search and rescue mission in the Mediterranean, the administrative processing of refugees/migrants, deportation expenses, the housing and care of refugees/migrants until a decision is made whether they can stay in the EU or not, when given asylum, social housing, benefits, medical care, integration courses, etc [66].

The main body responsible for securing Europe's borders and search and rescue in the Mediterranean sea is Frontex. Due to the increased number of people crossing the Mediterranean, Frontex's 2015 budget has been increased from € 97 million to € 114 million [47]. Eurosur – the EU border surveillance system – has also received a budget boost of 5.3 million Euro; it now has a total budget of 9.3 million Euro.

Much has been spent on security. The "Eurotunnel has spent £9.2m on security in the first six months of 2015 alone, including money for fences, cameras, infra-red detectors and extra guards" [20]. Hungary has spent €100 million to build a razor border fence to keep migrants/refugees out [64].

Asylum seekers may receive benefit packages depending on the nation. The UK provides £36.95 a week, France £56.62, Germany £35.21, and Sweden £36.84. In most places the asylum seekers are not allowed to work to subsidize these funds [66]. Some argue that these numbers are equal to or less than the amount spent on deportation, which has amounted to €11 billion since 2000 [66].

The refugees/migrants who are currently trying to reach the UK has hampered transportation [45; 49]. For example, the Freight Transport Association has estimated “a cost of £750,000 a day through delays and spoiled loads, with £2m of fresh produce having to be dumped each week” [48]. It also reports that: “[a] 100-mile detour to avoid Calais would cost the average HGV another £52 in fuel, and every hour’s delay adds £60 in costs, … drivers have [also] been fined £6.6m in the past year when migrants have stowed aboard” [48]. Spending is increasing on new security measures that attempt to maintain ‘regular mobility’ and to stop ‘irregular mobility’ [46].

The EU has provided € 1.74 million in humanitarian aid for refugees in Serbia and Macedonia [71].

Many have claimed that the presence of all these migrants will be the collapse of the EU. Others have argued that the migrants/refugees amount to around 0.1% of the EU population and thus will not make a dent in the economic situation [66].

Preparedness – Training, Emergency Plans, Crisis Management Models

In 2015 the European Commission set out its European Agenda on Migration, which argued that EU Institutions, Member States, International Organisations, local authorities, civil society, and third countries must all work together.

The EU Agenda on Migration argues that in order to slow the influx of refugees/migrants there must be changes in the countries of origin, including an end to conflict, increased human rights and economic opportunities, as well as increased regional cooperation and assistance in transit countries. Some of the steps the EU is and will take are as follows:

- Through Sustainable Development Goals (SDGs) increase opportunities for people in origin countries through development and cooperation assistance. Encourage better labour and human rights, and social protection policies.
- Address crisis in Syria, with humanitarian, stabilisation, and development assistance. Address situation in Libya by helping set up a Government of National Unity.
- Through Regional Development and Protection Programmes, support current refugee camps and refugee management systems in neighbouring countries (e.g. help with Syrian refugees in countries like Lebanon, Jordan, and Turkey).
- Assist third-countries to tackle human traffickers/smugglers.
- In cooperation with the International Organisation for Migration (IOM), the United Nations High Commission on Refugees, and the Government of Niger, start a Pilot Multi-Purpose Centre to provide information about migration and local protection and resettlement opportunities, as well as voluntary return options for irregular migrants.
- Through a Common Security and Defence Policy (CSCP), assist countries like Niger and Mali to strengthen their border management and crack down on the trafficking and smuggling of people.
- Increase the role of EU delegations in key countries in the area of

migration (e.g. have them report on migration issues, contribute to migration issues in development/cooperation, and help ensure coordinated action).

- Place EU migration liaison officers in key countries, to work closely with Immigration Liaison Officers Network, local authorities, civil society in the area of gathering, exchanging, analysing information.
- Use dedicated Frontex liaison officers.
- Increase legal migration routes to the EU and increase developmental aspects of legal migration through improving integration, tackling migrant-labour exploitation, encouraging ethical recruitment policies, and facilitating cheaper, faster, and safer transfers of remittances.

The EU recognises that people will not stop trying to cross the Mediterranean in the short-term. In response it has developed two EU Joint Operations: 'Triton' in Italy and 'Poseidon' in Greece. Frontex, the EU's border management agency, heads both operations, which include Search & Rescue (SAR), stopping human smugglers, and integrated border security.

- Search & Rescue: The EU acknowledges a 'duty to protect those in need'. From 2013 to 2014, Italy headed the SAR Operation 'Mare Nostrum' (including Navy, Air Force, Police, Coast Guard, Customs Service and military personnel of Italian Red Cross) [14]. During its time in operation, Mare Nostrum saved over 140,000 people [4]. In 2014 this operation was succeeded by Frontex's Joint Operations 'Triton' in Italy and 'Poseidon' in Greece. These Joint European Operations require increased cooperation and pooling of coastguard functions and resources at the EU level. Frontex's Joint Operation Triton is Europe's biggest Search and Rescue Operation [28].
- Stopping Smuggling: In cooperation with Europol and Eurojust, Frontex aims to identify, capture, and destroy vessels used by traffickers/smugglers. This will include improved pooling and better use of information to target traffickers/smugglers through the improvement of Europol's Joint Maritime Information Operation (JOT MARE), which will create a single entry point for inter-agency cooperation on smuggling.
- Integrated Border Security: Border management is currently based on a "patchwork" of documents/instruments. In 2016 these will be consolidated into a Union standard for border management, including a Smart Borders Initiative. This will seek to make better use of opportunities offered by IT systems and technology. "The EU today has three large-scale IT systems, dealing with the administration of asylum (Eurodac), visa applications (the Visa Information System), and the sharing of information about persons or objects for which an alert has been created by competent authorities (Schengen Information System)" [68: 11]. To date, the EU has developed and rolled out Eurosur, Frontex's information-exchange framework to improve management of EU's external border. This system is built on a network of National Coordination Centres (NCCs), one in each Member State, which coordinate's border surveillance and act as hub of information exchange [11].

The EU has various plans in place to attend to refugees/migrants who reach European shores. These include:

- Reception centres. As many of refugees/migrants first land in Italy or Greece, reception centres have been developed in these countries. The European Asylum Support Office helps to pool reception places in times of emergency.
- The development of a 'Hotspot' Approach, which will see Frontex, Europol, and the European Asylum Support Office work on the ground with front line Member States to identify, register, and fingerprint incoming migrants [68: 6]. The EU aims to give guidance on systematic fingerprinting and explore how other biometric identifiers can be used through the Eurodac system (e.g. facial recognition through digital photos) [68: 13].
- Asylum claimants are dealt with by European Asylum Support Office teams. Currently, where a refugee/migrant enters the EU is the place they are supposed to register and seek asylum. The EU is considering changing this policy. Frontex and Member States return those people deemed not in need of protection to their countries of origin.

A distinction is made between those persons who are categorized as refugees in need of asylum and those persons who are categorized as undocumented migrants in need of return.

- Asylum/Return: The EU is seeking to complete a Common European Asylum System, making asylum policies and asylum seeker treatment uniform across the community. The EU is proposing to trigger the emergency response system under Article 78(3) TFEU [68: 4]. "The proposal will include a temporary distribution scheme for persons in clear need of international protection to ensure a fair and balanced participation of all Member States to this common effort." [68: 4]. Thus, the aim is to relocate asylum seekers within the EU through the Dublin System. The EU wants to develop a network of national Dublin Units. As of writing, the EU is looking to offer 20,000 places for asylum seekers who meet the criteria.
- European Asylum Support Office will develop its role as a 'clearing house of national Country of Origin Information', which is the information upon which asylum decisions are made. The Commission is proposing the strengthening of Safe Country of Origin provisions, which will support the rapid processing of asylum applicants from countries deemed safe (and then return of migrants) [68: 13].
- When people are not found to meet the asylum criteria, the EU argues the need to return people to their countries of origin. It is currently running a Pilot on Return to Pakistan and Bangladesh, helping origin countries to meet their obligation in regards to supporting the management of returns, information and awareness campaigns, supporting reintegration, etc. It is also developing a Return Handbook with common guidelines, best practices, and recommendations to be used within the EU. As of now Member States must initiate return missions, with Frontex only

coordinating them. The EU is proposing to change the legal basis of Frontex to strengthen its role on return [68: 10].

Integration is primarily the responsibility of Member States. The EU's Asylum Migration and Integration Fund (AMIF) assists. Integration programmes include: language courses, professional skills, access to services, promoting labour market participation, education, inter-cultural exchanges, and awareness campaigns.

Interoperability – Information Sharing Communication, Coordination, Collaboration, Information Flows

Political Interoperability:

Despite calls from the UNHCR for the EU to act in a collaborative manner, many countries are taking their own initiatives without consideration for effects on the rest of the EU [69]. Only recently [August 2015] are individual countries starting to call for joint meetings to manage the influx of people and to create common lists of safe countries of origin, among other things, to help fast track applications and the movement of people throughout the EU [70].

Technical interoperability:

As an EU agency, Frontex is at the forefront of the border situation. It acts as an example for how interoperability is taking place in this crisis.

Before a joint operation begins, Frontex agrees with the host country on an operational plan, which includes: operation objectives, where/when the operation will be carried out, the most up-to-date risk analysis assessment, details about who is in command and how decisions will be made, description of activities to be carried out, and the code of conduct for officers. Frontex officers from many different countries are only a small proportion of the overall number of officers deployed in any single operation. Guest officers work under the command of host country officers.

Frontex has three domains for Joint Operations: sea, land, air [27]. There are three key aspects to any Frontex Joint Operation:

- Planning: including risk assessment, consultations, operational planning
- Implementation
- Evaluation

Frontex gathers a range of data from, among others: Member States' and non-EU countries' national border agencies, EU bodies/partners (e.g. European Commission, Europol, Eurostat), international organisations, academia, and the media. Frontex uses this data to create “a picture of the situation, patterns and trends in irregular migration and cross-border criminal activities at the external borders, including trafficking in human beings” [30]. Member state personnel report back from the coordination centres on this report, as well as changes in operations and factors affecting joint operation [31]. Frontex produces regular reports on what is happening around EU borders, within which vulnerabilities/risks are identified and recommendations for action and responses (e.g. Operations) are made [27].

This exchange of information is underpinned by a European Border Surveillance System (EUROSUR). Eurosur has been developed as “the information-exchange framework designed to improve the management of Europe’s external borders” [33]. It has various components, including; National Coordination Centres, Frontex Situation Centre, and Eurosur Fusion Services.

Each Member State has a National Coordination Centres (NCC), “which groups the authorities responsible for border control in a given member state. The main role of the NCC is to coordinate the border surveillance activities on national level and serve as a hub for the exchange of information” [33]. NCCs also collect local and national information about what is taking place at the border. For example, when trying to identify and stop smugglers, data is collected on: refugee/migrant departure and arrival points, size/type of boat, price paid, the main nationalities of smuggled refugees/migrants, the routes taken. Data is also collected regarding smugglers’ Internet content and financial flows. NCCs analyze such data to create a national situational picture. They are also responsible for sharing the relevant information with other Member States and with Frontex [33].

Frontex collates, processes, and analyses such input, as well as information from many other sources (as stated above), in order to create “the European situational picture and the common pre-frontier intelligence picture (focused on areas beyond the Schengen Area and EU borders)” [33]. Eurosure Fusion Services “include automated vessel tracking and detection capabilities, software functionalities allowing complex calculations for detecting anomalies and predicting vessel positions, as well as precise weather and oceanographic forecasts. Fusion Services use optical and radar satellite technology to locate vessels suspected to be engaged in people smuggling that often puts the lives of migrants in danger. Many of the services are delivered in cooperation with the European Maritime Safety Agency (EMSA) and the EU Satellite Centre (SatCen)” [33]. Frontex shares this European-wide picture and intelligence with Member States via NCCs [31].

In order to manage all of this information, Frontex has developed the Frontex Situation Centre (FSC) to provide as near real time as possible picture of Europe’s border situation and aims to act as a central point of contact [32]. In order to process data, Frontex first checks the quality and format of incoming data for further analysis [32]. To share information, it also established “Frontex Risk Analysis Network (FRAN) that links the intelligence networks of individual European countries with pan-European organisation” [30].

Frontex has also “developed its own risk analysis model, called CIRAM - the common integrated risk analysis model” [29]. “CIRAM relies on a four-tier access control model that involves gathering information from and disseminating risk analysis to a wide range of partners. Partners include border control authorities both within the Schengen area and at the external borders (e.g. Customs) as well as Member State actors in cooperating neighbouring countries and non-EU states farther afield” [29].

In order to properly follow data protection regulations, Frontex has Implementing

Rules and as appointed a Data Protection Officer. “All processing operations of personal data are duly reported to the Frontex Data Protection Officer and, if the situation requires, to the European Data Protection Supervisor” [24]. Only “[i]n a very rare cases and under a strict supervision and limitations, personal data are made available to external parties (contractors)” [24]. Data subjects have the right to contact Frontex to access and rectify their data.

As of now, “Frontex does not process personal data of any migrants. However, Frontex is authorised under very strict conditions foreseen in Article 11b of the Frontex Regulation to process personal data of certain groups of returnees. Additionally Frontex is entitled by Article 11c of the Frontex Regulation to process personal data of the suspected human traffickers but only in the situations strictly foreseen in the that provision” [24].

Responder Safety

Very little has been raised regarding responder safety in the media or in official reports. However, there are likely psychological challenges to responders’ work in the Mediterranean, especially when it includes retrieving dead bodies.

Stakeholders

Refugees/Migrants

- All people engaged in ‘irregular’ movement

Origin Countries

- E.g. Syria, Afghanistan, Eritrea, Somalia, Tunisia, Iraq, Libya, etc.

Transit Countries

- E.g. Turkey, Libya, etc.

The European Union

- Member States; Frontex; European Police Office (Europol); Eurojust; Eurostat; European Asylum Support Office (EASO); EU Fundamental Rights Agency; EU Satellite Centre; European Space Agency; European Maritime Safety Agency; European Fisheries Control Agency; European External Action Service; European Defence Agency; EU Data protection Supervisor

National Organizations

- Border Control Agencies; Coast Guards; Police; Navy; Military; Fisheries; Healthcare; Meteorological Agencies

International Organizations

- United Nations High Commission for Refugees; United Nations Office on Drugs and Crime; International Centre for Migration Policy Development; Intergovernmental Consultations on Migration, Asylum and Refugees; International Criminal Police Organisation; International Organisation for Migration, Organisation for Security and Cooperation in Europe

NGOs

- Red Cross; Doctors without Borders; Amnesty International; Human Rights Watch; Doctors of the World; Metadrasi (Greece); Pro Asyl (Germany); Asylum Aid (UK), etc.

European Citizens

- Civil Society Groups; Volunteers; Foster Families (for unaccompanied

children), etc. **Private Businesses** ▪ Transport companies (freight, ferries, etc); Tourism companies. **Research Institutions** ▪ Universities/Academics, etc.	
Public Engagement	
How public responded	Refugee/migrant advocates highlight the need for greater humanitarian responses within country of origin, in regards to search and rescue, and to those already in the EU. These same people have been marching throughout Europe against racism [72]. There are those who stress the need to tighten Europe's borders, crack down on traffickers/smugglers, and remove 'incentives' for irregular movement (e.g. benefits for migrants; black market work) [72]. In light of anti-immigration discourse, the Hungarian government is putting up a wall to help keep refugees/migrants out, but on the ground border guards may look the other way when refugees/migrants cross, and "the Hungarian policemen are mostly treating the refugees with fairness and even respect" and Hungarian citizens are assisting migrants in making the crossing by giving them information about where border guards are, what route is best to take, and have mobilised to help refugees/migrants when they enter into Hungary [12].
How public got engaged	In various different contexts NGOs and volunteers have organized to help refugees/migrants. For example, Greek volunteer groups have organized to help feed refugees/migrants. However, Kos Solidarity Project, which was feeding refugees/migrants, had to close its doors because the small volunteer group ran out of money and time; they called on the government to step in and help [21]. In Rome, there have been violent protests against the housing of migrants in certain neighbourhoods [61]. Refugee/migrant advocates have helped to highlight the dire situation to European publics. For example, in response to the drowning of 800 refugees/migrants in April 2015, Amnesty International placed 200 (volunteer-filled) body bags on a Britton beach [36]. Along with Amnesty, other NGOs and civil society groups have been involved in trying to educate the public about the refugees'/migrants' plight in order to galvanise support for increased Search and Rescue operations and improve reception of refugees/migrants (e.g. Migrant Lives Matter, https://www.facebook.com/events/373567429511407/). Some of this is also tied to anti-war movements, such as Stop the War Coalition (https://www.facebook.com/stopthewarcoalition).

	In Greece, stories have emerged of tourists handing out food to refugee/migrants [50], while other media stories have highlighted how some tourists in Greece are finding that the influx of refugees/migrants are making their holidays "awkward" and Kos "disgusting" and "dirty" [51].

Media

Reporters are in the field actively collecting stories and photographs. Discussions have been raised about how the media reports on the situation and the terminology used by politicians. Attention is paid to whether they come across as 'pro migrant' or 'anti migrant'. Depending on how one thinks and feels about the refugee/migrant influx, one will find the media coverage 'fair' or 'unfair' [53]. Photographs of immagrants in camps or making difficult parts of journeys are common, and often gathered in weekly photo-albums by online news sources. Much of the covereage is about the numbers of people coming where they are going and how. Along these lines the coverage of politics about this situation focuses on the border control issues within the EU. Very little is about why the people are coming and what needs to be done to change the larger situation.

Much media coverage has focused on Calais (the crossing stop-point between France and the UK) [40, 42]. The encampment is a visible sign of what's going on, and was set up by the French government, NGOs, and refugees/migrants. It has precarious shelters (e.g. shacks; tents), water, bathroom facilities, a canteen, a school, churches, a medical centre, a café, food shop, and bike service [20; 41; 42]. Yet, despite the high news coverage/value, this camps only amounts to 1% of all migrants [66]

Social media groups have been set up on Facebook (e.g. Mediterranean Migrant Crisis; Calais Migrant Crisis Aid Run, Migrant Lives Matter, Movement against Xenophobia) and various Twitter Hashtags pertaining to the situation have also sprouted up (e.g. #DontLetThemDrown; #migrantcrisis; #calaismigrants).

Ethical, Legal and Social Issues

These differences in terms to explain the situation could affect both the public response as well as what is legally required as action. In English the term 'migrant crisis' is being used, as opposed to, for example, 'el drama de la inmigración' (migrant drama) in Spanish or 'Flüchtlingsdrama' (refugee drama) in German.

The distinction between economic migrant and refugee/asylum seeker is important and has legal ramifications for what the individual is entitled to in terms of assistance and protection under international law. However, this distinction can be gray, something exacerbated by inconsistent application processing methods around the EU [2, 73]. In addition, the EU does not have a uniform rules for handling refugee [70]. Moreover, much of the rhetoric in the media has focused on 'migrants' over 'refugees', treating all people moving as transgressors. This makes these terms seem interchangeable and flexible, disregarding the rights that come with the distinctions. For example, refugees should be given safe passage across borders and can apply for asylum in third countries. They also cannot legally be sent back into a situation where they are in danger.

Some nations, such as Germany, are calling for all of EU nations to do their fair share. As of now, not all Member States are equally participating in attending to the situation [39]. But what 'fair' means is yet to be defined. Is it dollars spent? Humanitarian aid provided? Number of people managed? Extent to which borders are controlled? What kind of responsibility?

Calling the current situation a 'crisis' – as opposed to a 'challenge' or a 'problem' – creates a sense of urgency and begs the question: a crisis for whom? On the one hand, the situation can be understood as a crisis for those who are moving and, on the other hand, the situation can be seen as a crisis for Europe. The first conceptualization demands a humanitarian response; to help those in their time of need. The second conceptualization suggests that the influx of refugees/migrants is negatively affecting European societies; it may give rise to demands for greater border security as the large numbers of people is seen as threatening.

Treating the situation as a 'crisis' enacts emergency response tactics. However, at least one Italian politician, Riccardo Magi, suggests that "The number of refugees who have arrived would not be creating hardship if there was an established and functioning system to receive them" [61]. In other words, this perspective suggests that part of the 'crisis' is the lack of political will to create a system which can help people fleeing persecution.

As the numbers of refugees/migrants continued to increase arguments were raised that search and rescue was encouraging the influx (i.e. that if refugees/migrants knew that there was no search and rescue operation, they would be less likely to try and make the crossing and, thus, stay in transit countries) [14]. This argument helped create a rationale for Operation Triton, which initially moved from a humanitarian to a border security response. While Mare Nostrum operated in international waters, Triton initially operated only within 30 miles of the Italian coast and had a budget one third the size [4]. It also enabled the EU to halt all search and rescue operations for over 6 months, during a time, yet over 27,800 tried the journey during that time, a 4% increase [66]. These types of arguments can be used to justify specific approaches to human rights and specific claims to responsibility

A similar shift from humanitarian to security has occurred at the border between France and the UK. In 1999 Sangatte refugee camp was opened in Calais, with many seeking to reach the UK heading toward this camp [20]. This refugee camp was closed in 2002 to discourage such travel, yet refugees/migrants seeking to reach the UK still arrive in Calais. Instead of assisting refugees seeking asylum in the UK, the tactic has been border security and the increased use of CCTV, dogs, and police officers [46]. Rather than stopping people from reaching the UK, refugees/migrants have started to take greater risks – such as walk the Eurotunnel or swim the channel – as well as increasingly disrupt other forms of mobility (e.g. transport, tourism).

Poor response can help to increase anti-immigrant discourse and feelings. For example, truck drivers have reported that the influx of refugees/migrants trying to get on their trucks is causing them stress and anxiety [17, 19]. It is particularly difficult because if they are found to have refugees/migrants in their trucks – whether knowingly or unknowingly – they and their company will face fines [16, 18]. Some feel hostile towards the refugees/migrants for these reasons. According to EU regulations all refugees/migrants should be fingerprinted when they first arrive on EU soil; asylum claims are also supposed to be processed in the country where they are first registered [58]. However, because many refugees/migrants arrive first in Italy and Greece, these two countries have seen a surge in asylum claims. They do not have the capacity to deal with all claims. Consequently, there is a space of lax in regards to fingerprinting and processing in order to not have to consider these asylum seekers, allowing refugees/migrants to move to other EU countries and register there. Smugglers within the EU operate where formal agencies are not. Not formally addressing the situation puts lives at peril. Is the EU responsible for save travel within it's borders or, as the Human Rights Watch suggests, should the EU "support farther-reaching proposals to increase safe and legal channels into the EU" [6]? There is a lack of trust between EU Member States regarding different approaches to asylum and thus coordination and collaboration has been difficult. Personal data can become a problem. As of now, "[n]one of the information currently exchanged within Eurosur contains personal data" [33]. However, "Frontex has the power to process personal data within certain strict limitations" [31]. As explained on Frontex's website: "The most important among these is that the agency only process the data of persons suspected by a Member State border control authority of cross-border crime, such as migrant smuggling or trafficking in human beings. Frontex also "collects and further processes personal data in accordance with the provisions of Regulation 45/2001/EU of the European Parliament and of the Council of 18 December 2000 on the protection of individuals with regard to the processing of personal data by the Community institutions and bodies and on the free movement of such data" [24]. Knowing when these actions are legal can be a challenge if the definition and practices around the terms migrant and refugee is grey and inconsistent. No one, media or government, is publically discussing the positive economic contribution refugees/migrants often make to the communities in which they are settled.

Data-sets used	
gathered prior to disaster	
gathered during disaster	Vessel tracking/detection Main nationalities of refugees/migrants Routes of smugglers

	Size/type of boats used Departure/arrival points/times Price paid for crossing Personal information of refugees/migrants (e.g. name, birth date, nationality, family members, reasons for movement) Personal information of human traffickers Fingerprints/digital pictures of refugees/migrants Bank account details of suspected smugglers Meteorological data/forecasts Oceanographic data/forecasts Lists of resources from Member States Optical/radar satellite images Internet data regarding smugglers' online action Financial flows (e.g. international money transfers) Credit card issues Maps Refugee status Satellite data
gathered immediately after disaster	N/A

Lessons Learnt	
explicit	Closing boundaries will not provide a full solution. If you start securing one route (Mediterranean), another will open (Balkans) sometimes just as, if not more dangerous and insecure [62]. What the EU is calling a crisis is small compared to what other countries are managing. It is not the number of people arriving that is the crisis, but how the EU has been addressing it [66]. Each country individually managing the migrants/refugees to their country does not lead to a distributed responsibility [69] There is a clear public misunderstanding of why the migrants/refugees are coming, as demonstrated in the term migrants being used to cover all travelers in the media, rather than refuges, which make up the majority. Without a clear understanding of why people are arriving, and thus ethical and legal obligations, it is hard to garner public support for necessary services. The rhetoric is starting to change, but too slowly for inter-governmental organizations like the UNHCR. Changing terminology (search and rescue to border security)

	does not make the problem go away. In fact, it could exacerbate the problem.
implicit	Who is considered in the human rights doctrine of the EU is not clear. Is it all persons? Those of European citizenship? Or those within the territorial boundaries? While EU-wide organisations support aiding the refugees, the national level decision makers are often proceeding in different ways. It is clear that what is seen as ethical or best for the EU is not so for the individual nations within. This dichotomy needs to be addressed in order to action to proceed. Rhetoric/terminology matters. Choices made to avoid clear political responsibility can often lead to public unrest. Freedom of movement and border security do not have to be antitheses. Treating them as such will not solve the problem. New ways of understanding how to maintain the balance between the two need to be considered in order to address this crisis [72]. Even when EU rules are in place, they are often overlooked for the sake of national security. EU policy and International Laws do not always easily relate. Moreover, laws do not express how they will be enacted. Trying to give all incoming people one label for the sake of discussion, such as ‘migrant’ can have direct affects on decisions made.

Timeline	Response
Ongoing Situation	Editors note: Until the situation is fully defined, a timeline could lead to a false sense of beginning and, thus, end.

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2.3.19 2015 - Germanwings Airplane Crash, France (ULANC KP/SB)

Incident (00019)

Figure 27: Crash site

(Source: The Guardian http://www.theguardian.com/world/2015/apr/05/germanwings-crash-eu-concerns-over-german-monitoring-of-crew-health)

Figure 28: Rescue Workers examining a piece of wreckage

(Source: Mirror http://www.mirror.co.uk/news/world-news/germanwings-plane-crash-only-woman-5455043)

On Tuesday the 24th of March, 2015, a Germanwings Airbus A320 aircraft (Flight 4U 9525), carrying 144 passengers and 6 crew members, en route from Barcelona to Düsseldorf, crashed in the French Alps. All 150 people onboard died and debris from the crash was spread over 10 acres in a very hard to reach mountainous area. When the crash first occurred attention turned to potential mechanical failure. The cockpit voice recorder (CVR) was found on the same day as the accident and listened to on the 25th of March 2015 by French investigators. The content of the CVR turned attention to human intent, especially that of the co-pilot. It was later confirmed that the airplane's co-pilot deliberately crashed the plane in the alps.

Material Damage

The disaster completely destroyed a Germanwings Airbus A320. As the plane hit the mountain, debris were spread over 10 acres up a steep mountain slope; "[t]he largest pieces of wreckage were 3-4m long" (BBC News a 2015). Besides littering the mountain side with debris, the "ground was churned up" and "tree trunks had been uprooted" (BBC News a 2015). After a majority of the debris were removed from the mountainside, a process of decontamination commenced. When the plane crashed "there were about four tons of kerosene on board", so experts were brought in to analyze which parts of the area were contaminated by "toxic substances" (BBC News a 2015). It will take months to complete the environmental clean-up of the area.

Social and Human Impact

All 150 people onboard died. There were people from 18 different countries onboard, although the majority were Spanish or German (BBC News b 2015). Especially horrific was the affects of the disaster on one high school in Germany, which lost 16 of its pupils and 2 teachers in the crash (BBC News b 2015). Besides the grief of the family and friends of the deceased, the social and human impact was felt at other sites. For example, employees of Lufthansa and Germanwings felt nervous to go to work in the immediate aftermath, not knowing if the crash was due to a mechanical error or not. As a result, several Germanwings flights had to be cancelled the day following the crash as there was not enough crew to staff them (Huggler 2015). Once it became clear that the crash was likely the result of human intent, pilots and other crew members felt it necessary to prove themselves as trustworthy to passengers. One pilot is reported to have welcomed passengers onboard with hugs and "an emotional speech before takeoff" (Keady 2015). People who live near the crash site also indicated that they felt shocked that such an event could happen close to where they live and concern that the crash could have hit their village; many villagers came forward to offer beds to the grieving families who came to the area to see where there loved ones' lives ended (Chrisafis 2015).

Economic Impact

This disaster entailed at least two different forms of economic impact: (1) compensation to families and (2) changes in the stock market.

<u>Compensation to families</u>

Lufthansa, Germanwings' parent company, is insured by Allianz. Lufthansa promised an immediate €50,000 for every victim to be paid to families, with follow up compensation to come later. According to one news report, "[i]n the event of a death, the airline must immediately pay … around £15,000 - to the victim's families … [and] if the loss of earnings over the lifetime of the victim would have been at least £105,000, then the airline must pay that, without mounting a defence". However, families may be able to claim more if they can prove their losses are greater and if the airline is found negligent. One estimate of the total compensation bill is £100m (Espiner 2015) or more. Allianz is reported to have put aside US$ 300m for the crash (Gould, Cohn, and Clarke 2015).

After the initial €50,000 payment, Lufthansa is reported to have told "victims' relatives to turn to the state for compensation"; as one new report states: "A spokesman for the airline, which offered an immediate payment of €50,000 per passenger to their families, said under German law victims of violent acts have a claim on the government for compensation, including for events in German-registered aircraft" (Trayner 2015). This, however, does not preclude victims' families from other jurisdictions making further compensation claims on the airline.

A legal expert noted that the amount of compensation awarded to any one victim's family can also depend on the jurisdiction they come from. "Different jurisdictions have different damages that are open to victims. So for example, in the UK and Germany, damages for pain and suffering - called "moral damages" - are typically not an option". In these jurisdictions only financial damages are taken into consideration, so "families with children who died could potentially receive less". "In theory", the legal expert states, "there is absolutely no compensation for a baby". The US, on the other hand, allows for moral damages, so families of US victims could receive more compensation (Espiner 2015).

In July families were offered €100,000 (£70,880) in compensation; this offer has been deemed inadequate and the fact that families from other jurisdictions could receive more is being called divisive and unfair (Sky News 2015).

<u>Changes in the stock market</u>

After the crash on Tuesday March 24th there was an immediate effect on stock markets. Airbus, the manufacture of the aircraft which crashed, saw a 2 percent reduction in its shares. However, on Thursday, after news broke that the crash was likely the result of human intent, their shares rose again by 2 percent. Deutsche Lufthansa AG saw a 3 percent reduction in its shares, which then moved to a 5 percent drop by the end of the week. There were also losses for other budget airlines and flagship airlines as far away as the US (Menton 2015).

Shares of Airbus Group (EPA:AIR) dropped more than 2 percent Tuesday to 59.14 euros, while Deutsche Lufthansa AG's (ETR:LHA) stock price plunged more than 5 percent to 13.07 euros. Yahoo Finance

Figure 29: Stock Market after Crash

(Source: ibtimes, via Yahoo Finance

http://www.ibtimes.com/airbus-group-air-deutsche-lufthansa-lha-stock-prices-tumble-after-germanwings-airbus-1857214)

Preparedness – Training, Emergency Plans, Crisis Management Models

There were various forms of emergency preparedness in place at the global, EU, regional, national, and local levels when the Germanwings airplane crashed.

<u>Global</u>:

The International Civil Aviation Organization (ICAO) "is a UN specialized agency, created in 1944 upon the signing of the convention on International Civil Aviation Chicago Convention) … [it] works with the Convention's 191 Member States and global aviation organizations to develop international Standards and Recommended Practices (SARPs) which States reference when developing their legally-enforceable national civil aviation regulations" (ICAO ND). The ICOA works with other global agencies in preparing for natural disasters and aviation crises. It has published a three part manual regarding Search and Research (SAR) protocols (Annex 12 to the Convention on International Civil Aviation).

By issuing a DETRESFA alert regarding the rapid decent of the Germanwings aircraft, the French authorities activated the SAR protocols set out by the ICOA.

<u>EU Level</u>:

In 2010, the EU Commission and EUROCONTROL established the European Aviation Crisis Coordination Cell (EACCC) "to coordinate the management of crisis response in the European ATM network. In addition, the EC considered crisis management aspects in the NM implementing rule (NM IR) laying down detailed rules for the implementation of ATM network functions" (Eurocontrol 2015). According to the EACCC website: "The main role of the EACCC is to support coordination of the response to network crisis situations impacting adversely on aviation, in close cooperation with corresponding structures in States. This includes proposing measures and taking initiatives to coordinate a response to crisis situations, and in particular, acquiring and sharing information with the aviation community (decision makers, airspace users and service providers) in a timely manner" (Eurocontrol 2015). It is not clear whether the Germanwings crash provoked a network level crisis.

<u>Local Level</u>:

Airports have their own emergency plans, including what to do when a scheduled flight never reaches its destination airport.

<u>Private Level:</u>

Airlines have their own emergency plans, including what to do if a plane crashes, how to work with the victim's families, what needs to be done for recovery.

Interoperability – Information Sharing Communication, Coordination, Collaboration, Information Flows

<u>Before crash:</u>

Before the co-pilot was left alone in the cockpit information flows were normal between the plane and different en-route air traffic control centres. After the Marseille en-route air traffic control centre noticed that the airplane was losing altitude, it tried to contact the plane numerous times, but the co-pilot never answered. In line with protocols, the Marseille control centre informed the French air defence, which also tried to contact the airplane to no avail. As the plane lost altitude, it eventually disappeared from the radar.

After crash:

According to the French Air Investigation Bureau's (BEA) initial report of the crash, after being informed of the accident they immediately coordinated with the Gendarmerie and the authorities in charge of judicial investigation to start their safety investigation. BEA officials visited the crash site one day after the crash (BEA 2015: 5). On March 25th the BEA listened to the cockpit voice recorder (CVR) and determined that the accident was likely "an act of unlawful interference" (BEA 2015: 5). Given this finding, and following European Regulation (EU) n°966/2010 and the advance arrangement between the French ministry of Justice and the BEA, all information gathered during the safety investigation were to be reported to the French judicial authorities (BEA 2015: 5).

In order to obtain data from Spanish and German authorities, the French BEA included various foreign counterparts in its safety investigation, including: the German Federal Bureau of Aircraft Accident Investigation (BFU), which made it possible to obtain the assistance of technical advisers from Germanwings; the Spanish Investigation Commission for Civil Aviation Accidents and Incidents (CIAIAC), which made it possible to get information about the airplane's stop at Barcelona and data from the Spanish Air Traffic Control (ATC) service; and, the BEA also associated with technical advisors from the European Aviation Safety Agency (EASA), the Directorate General for Civil Aviation (France) (DGAC), the private company Snecma (on behalf of CFM International) and Airbus (BEA 2015: 5-6). Experts from Australia, Israel, and Japan were also included, as there were crash victims from these countries (BEA 2015: 6).

The BEA's safety investigation is divided into three different thematic working groups: aircraft, aeroplane systems, and operations, between which accredited representatives and advisors are divided (BEA 2015: 6). It will collect and analyse data, offer conclusions and an overview of the causes of the incident, and make recommendations for new safety protocols if need be.

Responder Safety

The area in the French Alps where the crash happened is remote, rugged, and steep. Responders were brought in using helicopters and/or had to hike 45 minutes in order to reach the crash site. Some needed to wear harnesses and be tethered as they worked to avoid falling down the mountainside (The Telegraph 2015). French responders working on the scene called the work "travail de fourmi" (the work of an ant), highlighting the "patience and perseverance" that the job entailed (Willshir 2015). The job was not only physically difficult and dangerous, "several [responders] have been struck by falling rocks", but responders also spoke of the gruesomeness of the job and thus the psychological stresses which have come with it (Willshir 2015). Psychologists were brought to the site area and responders spent meal times together in order to discuss their feelings and support one another during the difficult task of recovering body parts (Willshir 2015).

Stakeholders

Private Companies:
- Lufthansa/Germanwings (as carrier)
- Airbus (as manufacturer; sent team of technical advisors to site)
- Insurance Companies, especially Allianz Lufthansa’s underwriter
- CFM International (Snecma & General Electric)
- Public relations firms (e.g. Burson-Marsteller)

Airports:
- Barcelona Airport (as departure airport, supported family members)
- Düsseldorf Airport (as destination airport, supported family members; hosted media in special room)

French National Authorities:
- Government, Interior Minister, police, military, air force, Gendarmerie high-mountain rescue group, firefighters, Air Traffic Control, civil aviation authorities, Institute for Criminal Research at the National Gendarmerie, the French air investigation bureau (French Bureau d’Enquêtes et d’Analyses or BEA), liaisons, coroners, forensic experts, French prosecutors in Marseilles

German National Authorities:
- Government, Foreign Office, Transport Minister, Foreign Minister, German Aviation Association, air safety experts, air transport authority, police, hospitals, and prosecutors (in follow up investigations into co-pilot), Deutsche Fliegerarztverband, liaisons, German Federal Bureau of Aircraft Accident Investigation (BFU)

Spanish National Authorities:
- Government, liaisons, Spanish Investigation Commission for Civil Aviation Accidents and Incidents (CIAIAC), Spanish Air Traffic Control

French Local Authorities:
- Mayor of Seyne-les-Alpes
- Local population (e.g. helped in hosting families)
- Emergency Responders

EU Authorities:
- EU Commissioner for Transport
- EU Aviation Safety Agency (EASA)
- European Cockpit Association
- EUROCONTROL

International Authorities:
- Embassies or Foreign Offices from approximately 18 different countries from all over the globe
- U.S. National Security Council & Federal Bureau of Investigation (FBI)
- UK’s Civil Aviation Authority
- International Civil Aviation Organization
- Jewish Emergency Response Unit (ZAKA International Rescue Unit, from the Jewish terrorism response organization, assist in response)

Other:
- Eye witnesses
- Family members of the victims
- Formal and social media
- Experts on: weather, plane security, etc.

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- Psychologists and Grief Counsellors
- Public Liaisons/Communications
- Transport companies, to build road to ease access to site
- Aviation Safety Network, an accident-tracking site run by the not-for-profit Flight Safety Foundation
- Lawyers

</td></tr>
<tr><td colspan="2">Public Engagement</td></tr>
<tr><td>How public responded</td><td>Public response was extensive on social media, with many people expressing disbelief and condolences.</td></tr>
<tr><td>How public got engaged</td><td>As the crash site was very remote, only professional first responders were involved in the hands-on recovery effort. However, people living in the area near the crash site participated in the recovery effort by making spaces available for both emergency responders and the victims' families (e.g. turning a local hall into a place to sign condolence books and offering beds to the visiting families of the victims).</td></tr>
<tr><td colspan="2">Media</td></tr>
<tr><td colspan="2">Formal media:

All of the large media outlets in Europe and many beyond reported on the crash. Media outlets set up special websites offering real-time live updates on different perspectives and visuals. One analysis of the use of social media in the crash aftermath suggests that 'social outputs' drove the formal media agenda in the immediate aftermath (Hodgson and Alshariqi 2015).

Social media:

WhatsApp, Twitter, Instagram, and Facebook were all used extensively in the aftermath of the crash. Due to the remoteness of the crash site and a lack of visual images, many fake visuals and videos started to circulate on social media. Germanwings' website failed (or was taken offline) for approximately two hours in the aftermath of the crash; the company used social media to communicate with the public. As one report suggests, in the first 6 hours after the crash, there were over 500,000 Tweets referencing #Germanwings. Lufthansa and Airbus also used social media. Germanwings and Lufthansa gained numerous social media followers as a result of the crash (Hodgson and Alshariqi 2015).</td></tr>
<tr><td colspan="2">Ethical, Legal and Social Issues</td></tr>
<tr><td colspan="2">The crash raised various issues/concerns regarding the sharing of accurate and/or sensitive data/information:

<u>Before crash:</u>

Due to patient confidentiality laws in Germany, psychologists/doctors did not inform Lufthansa/Germanwings that the co-pilot was being treated for various conditions (BBC News c 2015). European regulations insist doctors should refer pilots with psychiatric conditions to the licensing authority but it is unclear if this applied to the co-pilot. Lufthansa may face corporate manslaughter if it arises</td></tr>
</table>

that its own psychologists should not have allowed the co-pilot to fly. An initial BEA after incident report highlights that “Lufthansa, Germanwings' parent company, twice refused to renew his medical certificate in 2009 due to depression … When it was revalidated, a note was attached requiring aero-medical doctors to contact the pilot licensing authority before renewal” (BBC News d 2015). Numerous discussions have now be raised regarding the right to patent confidentiality and the need to inform employers if pilot’s are deemed unfit to fly.

After crash:

There were initial reports of a distress signal having been sent out from the aircraft, which were later found to be false (DWa 2015).

There were efforts not to name victims right away to protect families, but names started coming out quickly, in some cases named by family members on social media. Various people found out via social media, such as WhatsApp, that people they knew had been involved in the crash (Badcock and Farmer 2015).

In Germany the media refrained from naming the co-pilot right away (in order to protect his and his family’s privacy), but his name and images were already being published by European and international media.

Düsseldorf airport is commended for its response. It used police officers and security office officials to keep the media away from grieving relatives (Gopalakrishnan 2015). Via Twitter, a reporter from Deutsche Welle states: “Good organization at Düsseldorf to protect privacy of passengers’ relatives. No emotional pictures” (https://twitter.com/Manasi_Gopal). The same journalist notes: “Efforts so relatives of victims know about investigations from #germanwings and not from the media.”

Fake images of the crash site started to circulate almost immediately. Journalists in Germany and France claim to have a video of last few minutes inside the plane. Officials claim this is a hoax (Paris Match 2015).

The contents of the black box were leaked before official investigators revealed contents. The French pilots union (SNPL) filed a legal complaint against these ‘unknown persons’ who broke professional secrecy by leaking the details of the black box before investigators revealed contents (Associate Press 2015).

The International Federation of Air Line Pilots' Associations criticized the premature publication of ‘early conclusions’ related to the accident (Hille 2015). Along with the European Cockpit Association, an American expert as criticized “the premature release of auditory interpretations of the aircraft’s CVR (whose condition remains unverified)” Nelson 2015). Instead of assuming it was the co-pilot, he has suggested another explanation to the crash; that it could have been external electronic hacking to the aircraft’s computerized system (Nelson 2015)..

A French report into the crash finds that the co-pilot had “practiced programming a rapid descent on the outbound leg of the flight – from Düsseldorf to Barcelona on 24 March” when the captain was out of the cockpit (BBC News d 2015).

Germany introduces compensation law for plane crash victims. Lufthansa gives an initial 50,000 Euro to the families of each victim (Akkoc, and Winch 2015);

more financial compensation will follow. Because of insurance rules, it is likely that not every victim's family will be given the same 'worth' in compensation. This is linked to forecasted expected earnings as well as the jurisdiction in which the victim came from.

Other ELSI issues related to the wider response to the crash include:

In the following days, various Germanwings flights had to be cancelled as crew members refused to fly (DWa 2015). Passengers had to be re-routed. Some pilots who did fly in the immediate aftermath made a particular point of humanising themselves and proving there were not dangerous by personally greeting all passengers as they boarded, as well as giving hugs and talks to passengers.

The family of the Israeli passenger who died in the crash secured permission from Lufthansa to allow ZAKA volunteers to go to the site and, along with general help, make sure that his body is returned to Israel for a Jewish burial (JTA 2015).

With no more human remains to collect, Lufthansa has hired a specialist firm to remove the debris of the aircraft, under the authority of the French public prosecutor and an expert in charge of environmental supervision of the operations (ABC News a 2015). The cost of the cleanup is unclear (Le Monde a 2015).

Linked to inter-airline competition and cost cutting, the poor working conditions of airline staff have been raised, with some pilots working on zero-contract hours (Moores 2015). Reporting mental health issues is problematic for pilots, as they risk losing their jobs. One pilot reports that pilot mental health is a challenge, because "if you had a mental issue that could be helped with medication, the FAA would allow you to take one drug that didn't require reporting and documentation. That drug is alcohol" (Fallows 2015).

Mental health advocates raised concerns over how mental health was represented in the media surrounding the crash (Etchells 2015).

It is widely reported that the European Aviation Safety Agency (EASA) had taken issue with some of the Germany's air safety rules, including a lack of staff and "non-conformity" with air safety rules (Agence France-Presse 2015). EU commission spokesman responds that such complaints were regular occurrences through the EASA's system of oversight, and German agencies spend time and energy being on the defensive about these reports (DWb 2015).

The crash also sparked critical discussions regarding the use of technology in future aviation. Some people highlight the danger of computerization of aircraft, noting the dumbing down of pilots and/or their eventual redundancy (Grady 2015), as well as the dangers of hacking into aircrafts' computerized systems (Nelson 2015). Others highlight the need for greater use and analysis of real-time flight data, the use of Secure Clouds to automatically upload black box information during flights, and technology that could override pilot control from the ground (Kosner 2015). Germany's air traffic control authority is considering developing technology that ground staff could use to take remote command of a plane (ABC News b 2015).

Discussions were raised regarding the quick dismissal of terrorism, with people pointing to racism and ethnicism in news reporting and the naming of terrorism (Buchanan 2015).

Data-sets used	
gathered prior to disaster	Information about location of incident Maps of crash area Satellite and topography data Flight passenger list (names, nationalities, and photographs) Names of family/relatives/contact persons Lufthansa and Airbus safety records Plane specific information (e.g. maintenance and safety records) Information regarding cockpit security systems and how they work Past airline crashes in Europe Historical records of pilot suicide/murders (Evans 2015) Co-pilot’s work and medical records Pilot flight hours Overviews of pilot psychological tests Airline policies regarding mental health and tests Information regarding airline industry and working conditions Travel and life insurance data Compensation rules and data Environmental data for area
gathered during disaster	Eye witness reports
gathered immediately after disaster	French Air Traffic radar data and flight tracking data (e.g. www.flighttrader24) Weather data: of time of incident and during recovery Aerial images (photographs of crash site) DNA of victims (through personal effects) and family of victims (for comparison) Cockpit voice recorder (which includes the latest 2 hours of voice recording and sounds from the cockpit) Flight data recorder (which includes the last 25 hours of information regarding: pressure altitude, airspeed, heading, acceleration and microphone keying or the time radio transmissions were made by the crew) Financial losses (stock market shifts; compensation claims) Internet search records of co-pilot Information regarding co-pilots private life (e.g. Facebook page, interviews with friends/former partner) Email correspondence regarding co-pilot Doctors’ sick notes for co-pilot

Other

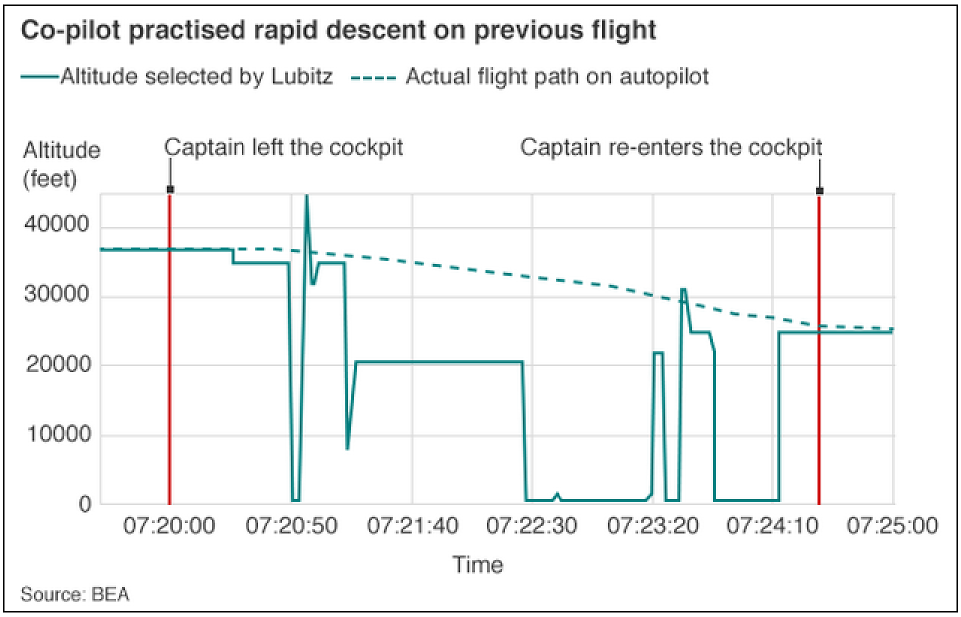

Figure 30: Graph of Rapid Descent Practices

(Source: BEA, via BBC http://www.bbc.co.uk/news/world-europe-32604552)

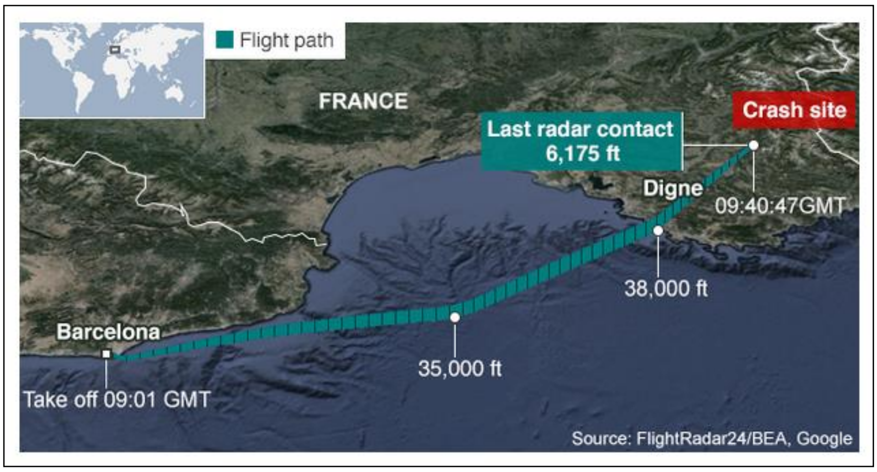

Figure 31: Flight Path

(Source: BEA via BCC http://www.bbc.co.uk/news/world-europe-32604552)

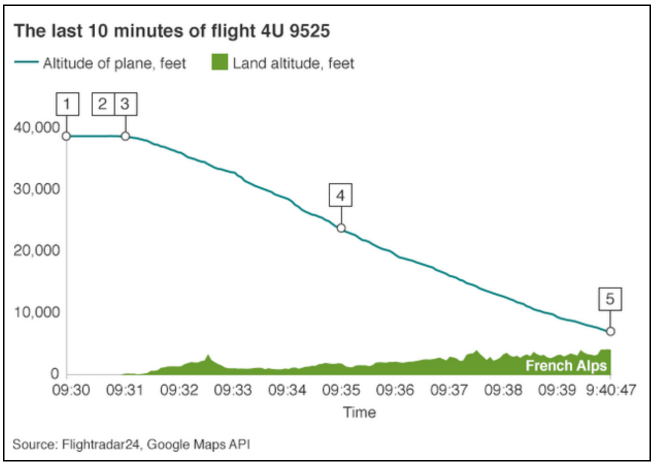

Figure 32: Descent Trajectory

(Source: BBC, via Flightrade24 http://www.bbc.co.uk/news/world-europe-32072218)

3 Main Themes for the Inventory

From the case studies, the literature on disaster response, as well as the literature on information theory it is possible to derive a set of important themes and to develop a deeper understanding of core issues relevant for the creation of SPEDI. This can inform productive and ethically, legally and socially circumspect innovation to support the production of common information spaces in disaster response. First, the case studies demonstrate that ***stakeholders*** and stakeholder capacities define the scope and efficacy of disaster response. The assemblies of stakeholders also define what kinds of sharing needs arise. The role and range of first responders varies, and a wide range of other Category I and II as well as other stakeholders are often critical. Thus any inventory needs to consider stakeholders within first responder agencies and police authorities, but also consider how they may collaborate with other actors. Second, a range of ***information management processes*** need to be included in the inventory, specifically trends and constraints in the deployment of ***crisis management models, information systems, data-sets used, and information flows*** such that it becomes possible to see their relationship to successes and difficulties faced at times of ***interoperability***. Technical and organizational interoperability is often deeply affected by the ***business models*** that underpin disaster response. Publicly funded emergency response services increasingly operate and have to join forces with actors and agencies in a world where parts of critical infrastructures are owned by multiple private companies, and maintenance and security on industrial and public sites may be outsourced to mupltiple private firms. In addition, elements of emergency service functions themselves are being privatized within many European countries – a controversial move with as yet unpredictable outcomes (Gotham 2012; Tomazin et al. 2012; Seifert & Mather 2013). These themes are especially important to consider as even though the majority of responders follow Command and Control Models of disaster response, not all do. Of those who do, not all interpret the model in the same way leading to a large number and variety of plans, regionally and nationally and even greater variation in practice. Moreover, information flows were consistently not limited to first responders, including stakeholders with different information needs and inputs into the larger response. We also develop a discussion of a set of ***ELSI*** related challenges and opportunities, where consideration as part of the inventory design can significantly add to the usefulness and value of the inventory. Building on the cases and related scholarly research, we can develop a preliminary set of criteria for SPEDI, as well as requirements and constraints for the inventory of relevant information including the conceptual integration of technologies and the design of a common information space system, against which we may also evaluate the usefulness and validity of the final results of the SecInCoRe project.

Below is a table summarizing the primary themes and issues discussed in this chapter from which the critera are derived (Table 3).

Theme	***Summary of Issues***	***Criteria for inventory***
Stakeholders	***General Conclusion:*** *not all stakeholders are at the scene of the disaster nor are first responders the only stakeholders that should be considered in an inventory of this type*	
	Informally orgnaized local community members are often involved in responding for quite a while	Include these stakeholders, how they helped, and why they were needed
	Governments cannot address all socio-cultural issues and rely on outside help	Include data about their actions as well as have portions of their data that are available to such groups
	Who is including changes what data is used and when.	should track what kind of data is regularly maintained by the different stakeholders
	Issues of different terminology/jargon	specifics about the broader range of potential stakeholders and a general list of their disaster response terms
	Different priorities, values, and requirements for trust.	Includes different stakeholder priorities and foci for specific disasters
	Different privacy and liability needs	Cannot assume all data is equal. Need to consider ethical implications of sharing data within the inventory
Crisis management models	***General Conclusion:*** *not all use command and control, and those who do not interpret it in the same way*	
	There exist a seemingly endless number of plans that derive from the general command and control model, plans that the cases demonstrated to not automatically synchronize	Need to document the variations, not just general plans. This needs to include the scalability of each plan as well as who is expected in partnership for each plan
	Plans cannot always forsee all the agencies involved and leave roles unclear	Need to record who is involved, in detail, during given disasters to help future plans be more complete
	The same terms are used to reference different procedures or decision-making positions in different plans	Need detailed definitions of and relationships between positions of responsibility as well as levels and scale of action for each plan

	The existence of a common model does not imply plans exist for all situations or that one generic plan will provide guidance for crisis management during all disasters	Need to record the range of plans that exist within each country to identify gaps in other locations. It also needs to include disaster cases where different standards and plans were enacted but struggled to be made interoperable
	ICS system does not offer much flexibility for quick change, so at times is not easily scalable or adaptable to unknowns.	Including details about models and disaster events and plans can help make visible the different potential needs and allow future users to use data to build greater flexibility into their plans
	Not everyone operaties on command and control	Need to have cases that demonstrate the variety of plans and procedures (and specifics about their frequent incompatibilities both horizontally and vertically) that are derived from the same model
	Plans that include liaisons that regularly work with multiple agencies are more successful	Need to record when liaisons are used and why
Data-sets	***General conclusions:*** *equally as important as the content of the data or the hazard during which it is gathered are details about how it is used, who gathers it in different circumstances, and why it could be useful. Moreover, there is no one set of rules for data gathering*	
	What actually gets used during a disaster is very situation-dependent	If grouped, it should not be by hazard but by the function the data plays The inventory should track background data, level fo detail, used as well
	Sometimes a data-set works for one group but not another	The inventory should be searchable for cases such as these, when typical patterns of data-set collection did not work, their causes, and their solutions
	Some data-sets were only referenced as lessons learnt	Should not just limit inventory to data sets already determined to

		be effective
	Some data sets are available but not tested/proofed and often don't make it into the formal incident reports	The inventory needs to draw on more than just incident reports and be sure to include both what is mentioned in academic research on the disasters, in the media, and in social media
	How and who does the gathering matters as much as the data content itself	The inventory needs to include not just what data sets but who is responsible for gathering in different circumstances. It also needs to track the procedures for such shifting of responsibilities
		The inventory should note when data-set was gathered and the frequency and longevity of the related data-sets
	Circumstances for public access to the data-sets are not set in stone, but important to consider when gathering the data	Details about the reasoning and effects of public release need to be recorded
	It is much easier to gather economic statistics than data on the impacts on residents	The inventory needs to address this disparity of data in order for responders to better serve the needs of victims that cannot be reduced to numbers
	Much of this data is not in numerical form, but also in video, figures, maps, forms equally as helpful as numbers.	The range of formats that the data set is gathered in should be recorded along with data type
		The inventory needs to set up a search system that is capable of managing searches of multiple data format within a single search
	Different things can be asked of the same data-set	The inventory should record to what uses the data is put (what information it is transformed into)
Information Systems		
	Too generic to structure use	Need record how generic systems were used in specific situations (both in terms of data gathered and products

		produced)
	Too local to become integrated	Need to list local systems to understand how they structure information to see the potential for flexibility and collaboration
	Mobile resources are vital to these system functioning	Need to collect when and in what formats access to information in the field was used. Also need to collect when such systems failed or were inaccessible to predict the limitations of any given system
	Use patterns are hard to break	Need to include details of why an older system is still in use to help understand why their users might not transition to a new system. It should also take note to why a new system gets adopted
	Sparsity of information from reports	Cannot rely on reports alone for Information systems data or criteria for the inventory
Information Flows	***General conclusion:*** *it cannot be assumed that working under the same model, or even the same plan, will automatically lead to unproblematic information flow*	
	Different stakeholders will have different flows. These will also vary by country, region, and potentially even hazard.	Track flow plans modifications as a disaster shifts scale Track when modifications are requested to the information flow, either during a response or recommended after the response and why they were necessary
	Different data sets have different flow patterns	Record electronic notification systems, data repositories, and criteria for specific data sets to flow to the next stakeholder/decision-maker
	Different information systems encourage specific flows.	The inventory needs to track both flow nodes and pathways, the security and restrictions at each, and who uses which ones
	Side-channels do and will exist	Case studies should be included that relied on such side channels for their operations and explanations for their uses

		should be included Document such cases where personal mobile phones get used, including what technology was supposed to be used or why the data could not follow formal pathways Data for the case studies needs to come from stakeholders involved in these side channels, news reports, and interviews with the individuals involved in establishing the side-channels.
Interoperability	***General Conclusion:*** *the abilty for different groups to work together depends upon everything from data format to definitions of risk to how much is shared at once*	
	The ability to share data affects all potential communications and collaboration	In what format is data collected and stored. It also needs to be able to search for different data combining success and problems. At what scale/resolution is data collected How often is the data collected
	How the data will be shared matters	the inventory needs to connect information about data type with information system and flow. What are the standard use procedures and protocols Need to look at disasters that successfully employed other methods of communications. Need also to collect cases when phones were relied upon to understand why they were used rather than an alternative to incorporate into our system whatever need it is they serve. needs to collect data about situations in disasters where responders successfully employed methods of communication other than

		phones and radios
	As data is shared it moves from one decision-making process to another and the criteria for assessment and definitions of usefulness frequently change	Collect the questions asked by each agency/organization of the data they use. Collect information about what each agency considers at risk during a disaster and how threat is defined for different hazards.
	too much data is shared at once, overloading the system.	Collect moments when systems get overloaded, why, and what creative solutions were provided.
	liaisons or a physical centre are vital to interoperability to help align priorities, goals, and terminology	The inventory needs to record situations when these actors or places were described as vital and what problems they solved. The inventory needs to produce a translator software or employ a common language for all data.
	The MOUs between groups are as important as data format and technologies of exhange.	Need to collect MOUs at multiple different scales (national, regional, city)
	Who has access affects the ability of different groups to be on the same page and trust each other.	Collect typical accessibility patterns for data types by region. Designing the inventory in a way that is accessible to a wider range of stakeholders can improve communication and information flow in the future.
Business Models		
	Academics are frequently expected to provide basic data, research, and analysis during disaster response.	An inventory should include not just the data and information systems academics are involved with, but the role of the institutions in the larger response process.
	the regional and higher scale plans would be written with intentional gaps and cannot be relied upon to structure the form interoperability or collaboration will take.	SPEDI needs to record all stakeholder business models.
	Focusing only on first responders or government response in general will often miss major decision-making stakeholders, would not adequately	Business models beyond government partnerships need to be explored.

	define the crisis management models in use, nor would offer a complete picture of the information systems required for a response.	
	Interdisciplinary relationships are necessary	Inventory should be able to be accessible to both public and private actors in such a disaster response.
	Outsourcing is becoming increasingly common in emergency response.	The inventory needs to be searchable by business model so users can compare the different situations and results.
	Increase reliance by emergency responders upon private data providers	The inventory needs to track where data comes from and how it is obtained. It also should track succeses and failures in the use of private data.
ELSI	***General Conclusions:*** *A wide range of ELSI to do with the exceptional nature of emergencies, fairness, autonomy, dignity, liability and responsibility arise. These can be divided into emergency, information and technology ELSI to derive some key factors to inform the design of a disaster inventory.*	
	More than numbers. Beyond money and life	There is a need for diverse qualitative information about past disaster events and response efforts, beyond economic impacts and numbers.
	Fair representation, Inference, Including the excluded Careful Categorisation Trust in Data	Stakeholders and events should be represented fairly and truthfully, in ways that can be validated, supporting trust and cooperation.
	Long term and indirect effects	The full range of effects should be reported.
	Exceptionality of exceptions	An overemphasis on the exceptionality of disasters can cloud responsibilities to predict and prepare.
	Availabilty of data	Only incomplete information may be available.

	Accessibility	Who should be able to access the information and how can this be made fair and open?
	Responsibility of producers and users	Whose responsibility is the inventory and how can they exercise it professionally?
	Multiple perspectives	Different perspectives should be represented fairly.

Table 3 Summary of Thematic Issues and Resulting Criteria

3.1 Stakeholders

Stakeholders include everyone who is involved in overcoming a disaster event. While this clearly includes first responders, emergency managers, and government agencies, this definition also leaves room for parties whose work either is incorporated by the government agencies, relied upon by the official response to complement its work, or who emerge in response to needs that are going unaddressed or are unseen by the official response. Consequently, this can mean anyone from public or private individuals/organisations. For example, such stakeholders could be humanitarian organisations who offer food and shelter, Category II responders such as utilities and critical infrastructure providers, as well as private businesses who provide aid supplies, cloud service providers - such as IBM, Google, or Amazon - who step in when information infrastructures are challenged, insurers who help victims rebuild, local community members who help in unofficial capacities, or digital humanitarians who help provide data and bring the public's voice into view of the officials responding. Defining stakeholders in this way is necessary to track what kind of information is gathered and exchanged about a disaster, why some details of a disaster go undocumented, or why there are times of disorganization during a response.

As a whole, the cases studies describe a wide-ranging list of stakeholders, outlined in Table 4 below:

World Health Organization
National Governments
Regional Governments
Public Health Authorities/Workers
Virologists and Epidemiologists, public and private
Scientists, Academics, Public Research Laboratories
Veterinary Authorities
Pharmaceutical Manufacturers
Social Service Administrators
Military
Red Cross
Telecommunication Companies
Local communities (not through a formal NGO)
Local police
National police

Civil guard
NGOs (such as Doctors Without borders, World Wildlife Fund)
Psychologists
Forensic Agencies
Firefighters
Transportation companies (e.g. train, air)
Airport Authorities
National/Regional Environmental Agencies
Public Utilities
Agricultural Departments
EU Commissions
Emergency health services
Civil Engineers
Search and Rescue Teams
Meteorological offices

Table 4 Partial List of Stakeholders Who Played an Important Role in More Than One Case Study

Drawing even further on the case studies, specific criteria emerge as to who should be considered a stakeholder and why it is important to include them.

Informally organized local community members are often the first to the scene or the longest on the scene. In large disasters that were either sudden or cross-political and/or organisational boundaries the responders are often spread thin and often slowed by practice differences between groups so outside groups (volunteers, humanitarians, public) step in to fill the gaps. For example, in L'Aquila Earthquake (000012) citizens were called upon to help the victims by sharing personal resources, during the Prestige oil spill (000003), local citizens helped accomplish much of the local clean up because the formal response groups were short on resources and time, and during the Madrid bombings (000005) the temporary confusion among the emergency medical teams meant that many of the victims were transported to hospitals using the private vehicles of fellow citizens making it difficult for hospitals to plan in advance for the number of casualties that would be arriving. In each of the cases, the public, though, received little information about the situation or what was planned for the response, the risks they faced, or what would best help the responders. Nor was there a way to record their actions such that they would be incorporated into the official response plans. But in all cases, their actions save lived and lessoned the disaster impacts. Consequently, SPEDI and its related information systems should include these stakeholders, how they helped, and why they were needed.

Governments cannot address all socio-cultural issues and rely on outside help: The Red Cross, for instance, aided in the response of the majority of the cases listed above. Also included were Doctors without Borders, wildlife and environmental aid organizations, and local religious aid groups. Many of them barely were named in the formal reports but filled in gaps, especially in some of the longer term disasters, like the Prestige oil spill (000003) or the SARS epidemic (000004) that required constant monitoring and work. These groups are often left out of the main planning process or given only restricted access to data to use in their own internal planning. Consquently, an inventory should both include data about their actions as well as have portions of their data that are available to such groups.

Who is included changes what data is used and when. Sometimes stakeholders are included merely because that can provide the data the first responders deem necessary, like forensics or microchip reading. Sometimes who is included actually changes the data collected. For example, during the Blackouts of 2006 (000009), Switzerland included as part of it's stakeholder network neighbouring power suppliers, and thus collecting data about a larger electrical grid and thus avoided blackouts that the regions that monitored more limited grids were unable to avoid. Or, during the Eyjafjallajokull Volcano (000013), the reports all focused on international air travel and air quality. While the news media reported on the affected farmers, they were not included in the response and thus very little data about them is available in those reports. SPEDI, ideally, should track what kind of data is regularly maintained by the different stakeholders.

Issues of different terminology/jargon. This was a concern commonly brought up within the case studies and overlaps greatly with interoperability and information flow. Many of the cases mentioned that locally or organisationally bound terminology affected the ability of groups to work together. These problems occurred between different first responder organisations and between first responders and external aid groups. Understanding the range of stakeholders that are frequently involved in types of disaster response can better prepare these groups for the jargon problems that will likely occur. Including specifics about the broader range of stakeholders is necessary to overcome these barriers. This means that all firefighters cannot be grouped together, nor can all be NGOs.

Different priorities, values, and requirements for trust. While a degree of this should be expected (firefighters prioritize fire response, health workers prioritize human safety), the case studies also pointed to disconnects that were greater than just the objectives of the different agencies. For example, during the 2007 Floods in the UK (000011), the fire and rescue and the Environmental agencies did not trust each other, despite sharing the same overarching goals. The differences in priorities, information about the significance of specific response needs, and personal experience lead to conflicts in their response actions. These also can lead to different assumptions about what is needed to evaluate risk/threat (Calhoun 2004; Hilgartner 2007; Steinberg 2000). Yet, trust is vital to the success of a response, and directly stated by one of the responders during the London Bombings (000006). Including not just the types of stakeholders, but the questions and priorities they will have for specific disasters can also help an inventory user to direct and coordinate work during a response.

Different stakeholders also have different privacy and liability needs in relationship to the data (Knowles 2011; Fortun 2000; Petersen 2014b). For exampe, health services need to keep patient data secure, but forensics might needs similar data to make their case. Or, one group might limit the type of data they look at to close the disaster sooner to avoid future liabilities, like a company calling a chemical spill under control so they are not liable for future toxic health issues (Fortun 2000). In other words, SPEDI cannot assume all data is equal and it needs to consider ethical implications of sharing data within the inventory.

3.2 Information Management Processes

Different stakeholders have different information flows, different organisational structures for their response, and different ways in which the flows and the data are integrated. Acknowledging a wide range of information practices will offer the greatest opportunity for a common information system to be both valued and trusted by both the users and the recipients of the aid distribution that results from the use of such a system. To do so, though, requires looking beyond just who is involved in a disaster response, but how they respond. This requires examining the crisis management models, information systems and flows, data, and issues of interoperability.

However, because there are generally no accepted definitions for 'crisis', 'crisis' management' or 'crisis management model', the form these models and the flow of information within that model and between models, take varies. In all cases, they describe management process and information exchange. In addition, information technology systems exist to assist in the efficiency and effectivenss of the management process. Consequently, there is a diversity of information technologies, practices, and expectations throughout Europe that need to be mapped and compared in order to successful develop SPEDI and a shared information space.

This section begins by explaining the range of crisis management models at play throughout Europe as well as a few models in regions that face similar issues of cross-border and cross-agency information sharing and decision management. It then describes related information systems and data sets used by various agencies under different models and under different circumstances. A discussion of the interoperability of these various models, systems, and data sets follows, focusing particularly on the strains that exist at present and the lessons learned that point to future needs. Drawing on the plans, issues, and data sets highlighted in the case studies combined with these general discussions, an initial set of criteria for SPEDI is established.

3.2.1 Crisis Management Models

A crisis management model describes an overarching and co-ordinated set of responsibilities, actions, communication processes and procedures affecting two or more agencies or organsations and aimed at the containment, management and resolution of an major incident in a controlled manner. A crisis management model is used by first responders and authorities for the to organize their actions during an emergency situation. They typically contain generalized rules and proceedures to be applied in a given operation, including responsibilities, guidelines and templates for reporting, data gathering and exchange. The aim is to encourage and ease data exchange and communication between different authorities resulting in an effective and sufficient coordination of an emergency situation. However, the organisational level at which these three functions are carried out will move – usually, but not always, in an upward direction. The actions may be carried out by one organisation or by several. There will be at some stage, identical levels of command across various organisations and also across the incident overall. But this does not always mean the processes that result are aligned.

In a project which aims to be valid throughout Europe, it is difficult to provide one single description of practises and governance procedures which will be accurate for all member States. For instance, demographic and even geological profiles of a country or region can determine the level of emergency preparedness afforded by the emergency services and other government authorities to a given crisis; organisational governance and governmental structures vary significantly. In addition, while the majority of the responders in Europe follow Command and Control Models of disaster response, not all do. Moreover, the numbers of plans following this model appears to be infinite and do not always lead to clean interoperability, as they use different terminology have distinct structural elements. However, since Command and Control is the most pervasive system, this section will focus primarily on understanding the variations within it and then discuss the issues noted within the case studies regarding the how the responses actually worked.

One example of a command and control system is the Incident Command System. It is designed to facilitate multi-agency emergency response, though to mixed success as with all the command and control systems in the case studies. Its intention is to alleviate the stressed on commanders during disaster response as they manage different organisational structures and work protocols that made it difficult to delegate tasks, identify responsibilities and coordinate priorities. It was designed to (Lindell, Perry et al. 2005; (Lutz and Lindell 2008 drawing on the Federal Emergency Management Agency (FEMA) ICS-300 course documentation):

- standardize organizational structures and terminology
- give unique functions to each unit
- limit number of units any given manager had to control
- comprise units of people from the same agency
- create a unified command with a single incident commander or command team, who is responsible for all resource allocation
- require clear action plans and objectives be stated regularly
- require ifnoramtion and intelligence management
- pre-designate incident facilities
- require integrated communications

To do so, it requires a specific order and timing for planning practices and informational briefings, planning meetings, and tactic meetings. It also requires specific branches in which to divide action (Logistics, Operations, Planning, Finance). Specific roles and hierarchies of decision are also defined.

The system is used by the US, UN, and is used in a few different countries within Europe. For example, in Norway the Enhetlig Ledelses System, or ELS, is based on the ICS and in the UK the Integrated Emergency Management (IEM) is based on the ICS, though uses terminology different than the US version of the ICS.

One of the main flaws is that the ICS system does not offer much flexibility for quick change, and does not work well in societies and cultures undergoing change or seeing new patterns of life or when outside of a community (Buck, Trainor et al. 2006). This can be a challenge for the EU context, where differences in culture, daily practice, language, and expectations are par for the course. Consequently the details of the individual plans and the details of the disaster events can be used to build greater flexibility into future plans.

The existence of a common model does not imply plans exist for all situations or that one generic plan will provide guidance for crisis management during all disasters. Often it seems as though the disaster occurred to the extent that it did because there were no plans in place in expectation of it (1999 Athens Earthquake, Toulouse Explosion, Madrid Bombings, Buncefield). Cases like these are good as they will point to the unexpected and help us see how SPEDI itself might help agencies both act at present when faced in an unplanned for situation as well as help them see a need for plans where none had existed. Also, in many cases, since the disaster occurred to the extent it did because no plan was in place since there had not been a similar incident in recent history, having an inventory of the range of plans for other regions might make visible some of the local planning needs.

Even on the most general level, terminology problems emerge within the different adaptations of this model. In some cases, the terms run in parallel, are simply require familiarity for identification, such as Gold / Silver / Bronze and Level 1 / Level 2 / Level 3 often seen throughout europe. In other situations the same words are used to mean different actions, roles, or even levels of command. For example, the initial model designed by the US has two basic command roles at different levels in the system: a tactical officer who determines field decisions and an operational officer who is in charge of the bigger picture strategies. But in the UK, the roles associated with the titles are flipped and thus the terms in general refer to different levels of response (Arbuthnot 2005). In Norway, tactical refers to actions in the field and the PBS incident commander handles keeping the media and partner organizations informed of the situation (From Bridge description – no citation provided), a role often separated from the incident commander and given to a public information officer in other interpretations of the model. Or in italy, the procedure for who is in control is through nominations.

Plans cannot foresee all stakeholders and often leave unclear roles for agencies involved, which agencies should be included at which stage of the response, who should be part of the general communication, or leave room for different call out procedures (Madrid Bombings (000005), London Bombing (000006), Buncefield (000008), 2007 Floods UK (000011)) making coordinated decision-making and leadership difficult. The plans sometimes left out the responders needs themselves in terms of safety and sustenance (Toulouse (000002), Madrid Bombings (000005), Buncefield (000008)). Even when relatively localized, like the UK Floods (000011) and protection of the power substation, the command and control structure was modified to accommodate the specific needs of the situation. As a result, SPEDI needs a range of plans to demonstrate where gaps lie in their inclusiveness. Plans can often leave roles unclear, so much so that expected functions are not followed, like during the Madrid and London Bombings , when emergency services were uncertain about when and where to arrive to the scene. In these same situations, responders showed up unannounced or prior to formal requests, making a strong chain of command and decision-making difficult to maintain. In addition, during the Madrid bombings “normal procedure” proved to be inappropriate yet was still being followed.

Moreover, there exist a seemingly endless number of plans that derive from the general command and control model, plans that do not automatically synchronize. When local variations exist, it can be difficult to move from a local to a regional scale, where different agencies take command of the response. If local adopts different variations, then the collaborative intentions of the command and contorl will not work. This is important to note considering the large number of plans listed among the disaster cases studies. Even FEMA, one of the primary proponents of command and control acknowledges this. They write “If local jurisdictions adopt a variation of ICS that cannot grow or is not applicable to other disciplines, the critical interface between responding agencies and jurisdictions cannot occur when the response expands (Federal Emergency Management Agency 2004). Variation in plans on the international scale can also cause confusion and distrust in decisions, as seen during the Eyjafjallajokull eruption (000013) when each country and each airport were acting on different criteria for closing and opening their airspace. Or even on the national scale, like in Germany where the adoption of such a system takes on a structure that minimized centralization (as seen in the E-Coli epidemic (000016)). A selection of plans discussed in the case studies are listed in the table below (Table 5). When possible, descriptions of their variation are provided.

Models/Plans	
Global Level	NGO Plans for the cleanup of oil spills
EU Level	EU Community Mechanism for Civil Protection EU contageious disease plan EU National pandemic preparedness plan
Inner-EU Level	Biscay Plan: agreement between France and Spain regarding the Bay of Biscay
National Level	**Spain*: National Salvage Plan*** - for marine events **Spain: *Cage Operation*** - designed to prevent terrorists from fleeing regions. **UK*: 2004 Civil Contingencies Act*** - set out in accordance with Command and Control Model: Gold, Silver, Bronze **United States: *National Fire Plan/FireScope*** – communication and coordination plans to encourage the collaboration among different fire agencies. FireScope was set up in response to continual failure of different fire agencies to work together during a response. **United States: *Multi-Agency Coordination System (MACS)***: a part the ICS and provides a basic plan for coordinating response between agencies, especially physical resources and information. **France*: Plan Rouge*** - designed to coordinate multiple rescue agencies to cope with a large number of casualties within a limited region. It offers general strategies but the specifics are left to each department. (http://www.sante.gouv.fr/IMG/pdf/plan_rouge.pdf). **France*: White Plan*** –plans for hospitals to manage an onslought of

	patients during a disaster. While the generalities are shared, each hospital develops their own plan. (http://www.sante.gouv.fr/le-plan-blanc.html). **Italy*: Law 225/92*** - describes the procedures by which a Prefect becomes the chief of the overall management of emergency activities. **Italy*: Direction for Order and Control*** – the procedure for nominating leaders and dividing region into operational centers.
City/ **Community Level**	County Operational Plans Local Resilience Forums Community Wildfire Protection Plans: each local community develops its own priorities and procedures for protection. Evacuation Plans Fire Brigade Plans 'Plan Territorial de Emergencias de la Comunidad de Madrid' (PLATERCAM). This plan describes the different groups (medical/logistic) that should be set up in emergencies, as well as different emergency levels; different emergency levels give command/control to different authorities (e.g. local/regional). Procedimiento Municipal de Emergencia Sanitaria'
Individual Business **Level**	Hospital Disaster Plans: to increase capacity; decision taken by hospital General Director Festival emergency plans Airline Disaster Management Plans

Table 5 Partial List of Plans Mentioned in the Case Studies

But these variations do not mean that model cannot work, it just means that the model needs to be treated in a way that acknowledge local variation. While a procedure or standard of practice may be described to increase the chances of replication from one person or place to another, in practice they always become embedded with locally contingent ways of knowing and doing rather than de-contextualized rules of behaviour (Jordan and Lynch 1992; Suchman 2007, 2000; Harrald 2006). The local and the ad hoc are what make standards possible, not elements to be excluded from the development and implementation of standards (Bowker and Star 2000). A standard requires such variations and improvisation to work, especially in situations like disasters where all the potential needs cannot be predicted in advance. In fact, understanding how these variations are enacted can help define stronger and more consistent standards as well as create better awareness of when a standard will not carry from one responding group to another or from one type of disaster to another.

One tool many command and control plans, including the ICS, rely upon to help with this issue is a liaison offers (Federal Emergency Management Agency 2004). This is a person from one organization who is responsible for establishing a line of communication between other organisations. This work involves not just the transfer of information from one place to another but an alignment of jargon, interpretations, and expectations. Liaisons were listed as vital to many of the case studies, including the Southern California Wildfires (000010), the London Bombings (000006), and the 2007 UK Floods (000011). SPEDI needs to state when liaisons were used and to what end to better identify when variations occur and how they are solved. Understanding the role of liaisons can help an inventory design know its own limitations, such as when the data itself can help coordination and when face-to-face interactions are still required. The inventory cannot replace interpersonal interactions, but can enable the decision-making that takes place.

Another issue is command and control is really designed for formal organizations (first responders and military) and often struggles to include unorganized volunteers, and they show how it hinders adaptation in response to emergent structures, geographies and scales during response phases (Buck, Trainor et al. 2006). As can be seen from the list of common stakeholders, many of the organizations involved in overcoming a disaster could have difficulty with a command and control focused response, leading to an increased chance for improvisation (Franco, Zumel et al. 2009). During the 2007 wildfires (000010), while the primary response was based in ICS, many of the workers found themselves in need of side-channels as proper procedures were making data exchange too slow for the formal information requests being made (Petersen 2014). During the UK Floods (000011) the Environmental Agency was not included in the communication procedures by the ICS and thus had to rely on time consuming negotiating tactics that delayed emergency vehicles. This issue is reflected in the reports by the absence of many details about the informal response groups involved. The lack of information in the reports about the disasters on what groups/individuals outside of the formal structure of response did – they were not visible to the ICS systems in place, despite their almost guaranteed presence (in the form of private transport, initial first aid, relocation services, etc).

3.2.2 Information Systems

To help coordinate and communicate during disaster response, tools based on information and communication technology are increasingly being used. These intend to support human actors in specific processes. These tools are used for data acquisition, processing and sharing. SecInCoRe researches on available systems (both for daily use and emergency situations) and their use cases as well as prospective application fields. This deliverable does not attempt to cover systems in use in general, but discusses the systems identified in the case studies and criteria needed for SPEDI to consider when exploring the potential of different and new information system technologies. The aim is to demonstrate the diversity of technologies and softwares in use and their potential implementations.

Not many systems are directly listed by the case studies, but the few that make the reports are listed in the table below. The *sparsity of information on information systems in the case studies* demonstrates that SPEDI needs to consider 1) the inventory needs to consider research beyond reports to gather data on and develop criteria about information systems (Table 6).

SurvNet: an electronic surveillance system for infection disaster outbreaks in Germany in 2001.
WebEOC: an electronic bulletin board accessible by first responders.
Mobile Systems: though not a formal system, consistently used.
Centro Integrado de Seguridad y Emergencias de Madrid, a collaboration between IBM, Indra, and the city of Madrid.
EU Early warning and response system: a confidential computer system allowing member states to send alerts about event with a potential impact on the EU, share information and coordinate response.
GIS: a spatial information software that allows for the spatial display and analysis of information.

Table 6 Information Systems Listed in the Case Studies

But these systems are often *too generic to structure use*; they do not define their use. For example, GIS as a system does not explain how it can and should be used as part of response (Petersen 2014). A disaster IT system requires well defined procedures, policy rules and data structures that have to be followed by all stakeholders in order for the information to be propagated rapidly to its receivers and stakeholders. Moreover, information management requires classification systems that can function as a boundary object, a system of understanding that allows for sharing between two groups even if not completely identical understandings of the information (Bowker & Star 2000). Consequently, SPEDI needs record how generic systems were used in specific situations (both in terms of data gathered and products produced) to understand the implicit information procedures not directly stated in plans.

In other cases they are *too local to be readily integrated* into a large-scale platform. Through their use they have the potential to make the local emergency operation discrete and isolated from other regions affected. This happened in the 2007 widlfires (000010) where San Diego County had implemented WebEOC, but not all firest responder agencies had included it in their practices and it was not available to agencies in neighboring counties facing the same wildfires. While it allowed for a greater level of connectivity in some respects, it also limited the collaborative potential of the county responders.

Standards and classifications are often treated as though they offer a complete picture of a sysem and its needs, but there are always situations and needs that push back on the lines drawn (Bowker & Star 2000). Bowker and Star note that knowledge about what is useful at any given moment is embodied in social roles and the accompanying mundane practices, not just the stardards that define those practices. This becomes especially visible when different roles from different systems meet: the assumptions behind the roles and standards can no longer be taken for granted, revealing details about their existence that can help explain their limits or what might need to change. SPEDI should list local systems to understand how they structure information to see the potential for flexibility and collaboration. It also needs to include disaster cases where different standards and plans were enacted but struggled to be made interoperable.

In addition, the systems are bound to local and cultural conceptions of risk and hazard. For example, Geographic Information Systems (GIS) are informatics platforms which are used to represent and map spatial (and lately spatio-temporal) geographical data in a convenient way integrated with advanced Visualization tools. A GIS platform holds information relevant to land records, property values and zoning regulations. They are also becoming increasingly common through many levels of government for everyday data gathering and storing. While the integration of a GIS platform with detailed maps can provide well defined estimates of the expected impact of a disaster event, the system itself does not define use. Combining this information with GIS layers like fire history and topography, as well as GPS data from firefighters on the ground can provide details about potential burn patterns, but to provide such a vision for the hazard, schemas for fire risk needed to be designed and established prior to any data gathering and analysis; the data itself did not provide these definitions (Chuvieco et al. 2010, Hernandez-Leal, Arbelo, and Gonzalez-Calvo 2006). In other words, the systems themselves require pre-defined definitions risk and hazard in order to function during disasters.

Mobile resources are vital to these system functioning. Consistently throughout the case studies, mobile technologies were invokes as either vital to the response or the reason for difficulties in a response. In some cases, without the proper equipment (Madrid Bombings 000005) or in difficult terrain (Helios Crash 000001) where equipment failed the leaders had to resort to pen and paper or face-to-face commands which both slowed response and left many responders out of the communication loop. The reasons for such difficulties or successes need to be recorded.

Patterns are hard to break. Some of these systems can also be quite ‘ancient’ in IT terms. For example, the London Metropolitan Police used a 22 year old system to manage the 2012 Olympics: the MetOps system. This system, which was used in the Special Operations Room, could not be linked to the Computer Aided Dispatch (CAD) system used in the Central Communications Centre because of its age. Although the two systems could be viewed together, it was only possible to move data between them manually. Having this variety of systems makes information sharing difficult when incidents cross-organizational boundaries. In addition to these constraints, there is also the issue that multiple platforms exist for the same crisis management model. There are currently at least five different system suppliers to UK police forces for Command & Control Systems. However, the remaining systems vary in what they offer and at least one has its origins in a bespoke ‘green-screen’ system from the early 1980’s which required the knowledge of an extensive system of codes for data entry. The inventory should include details of why an older system is still in use to help understand why their users might not transition to a new system. It should also take note to why a new system gets adopted.

3.2.3 Data-Sets Used

In many respects, data sets are the starting point for the inventory. One of the main objectives for the inventory is to store both historically data-sets as well as act as a common space for data-sets in active use by disaster responders for the purpose of decision-making. In general, data-sets have a few different characteristics that need to be accounted for as they are stored. First, different data-sets are collected at different times in relationship to a given disaster. Some is collected on a regular basis prior to any disaster (like social and economic demographics, power grids, traffic information), some is collected during a disaster (hazard spread and impact), and some is collected only once the situation abates but it still vital to understanding the disaster and its effects (such as damage to buildings or business losses). Data-sets also have different levels of usefulness. They can be useful because they are commonly used and have been proofed and tested. In some cases, despite being untested, a data-set can be useful because it is the only one that can be used to provide a particular set of knowledge. Finally, some data-sets do not exist (or do not regularly exist) but are pointed to as having been useful by the lessons learned or problems faced during a disaster.

This section starts by listing what data sets exist as derived from the case studies. These are split into categories that describe their basic function. It then discusses data sets called for by the reports on the cases. The data-sets should exist and thus should be accounted for in an inventory. It then discusses data-sets that exist but are not tested or proofed and the implications of including or excluding them from SPEDI. This is followed with some general observations about data sets and their implications for inventory design.

What actually gets used during a disaster is very situation-dependent. There is a wide range of data is collected and proofed to support decision-making processes. All agencies also seem to have different processes for gathereing data-sets and determining the relevance of data-sets based on different disasters. Additionally, all seem to have a certain amount of data regularly maintained about the regions prior to any disaster. This data is used either as a before-after comparison, historical precedent, or basis for analysis of disaster-time data-sets. SPEDI should track this background data. There is no one set of rules for data gathering. It is based on the specific hazard, location, and length of time of the disaster. As a result, data is not tied to disaster type or responder agency, though should still be searchable based on hazard type, agencies, and scale. Moreover, the level of detail changes even within the same general data-set category. The inventory needs to be able to accommodate such variety. In the table below the data sets listed by the case studies have been grouped by the function the data plays (Table 7).

General Incident Data	
	Number ill/injured
	Number deaths
	Number damage buildings
	Damaged infrastructure
	Damaged property
	Insurance claims
	Hazard details (like earthquake magnitude, fire perimeters, crash location)
	Evacuation orders/persons

	Shelter locations, statuses, and evacuees in each shelter
	Timeline of events
	Number and type of aid requests
	Staging locations
	ICP/Command center locations
	Affected responders
Public Health information	
	Active investigations/questionnaire and case study results and statuses
	Food/water safety test results
	Scientific models of toxin spread
Patient Health information	
	Number patients at each hospital
	Patient diagnoses
	Blood test results
	Finger print databases
Material resources	
	Hospital resources
	Food/water resources
	Transportation
Workers	
	Hospital staff, specialty, training
	Emergency responders in the field, time worked
	Tasks assigned
	Unit from
Environmental data:	
	Hazard zones
	Weather
	Hazardous materials
Economic data	
	Business income gains/losses
	Industrial activity
	Affected businesses
	Response expenditures
Spatial data	
	Demographics
	Cultural heritage/points of cultural value
	Topographic data
	Mobile phone data

	Power infrastructure
	Transportation infrastructure
	Traffic information
	Staging locations
	Command center locations
	Points of specific action (like active fire line fighting or police blockades)
	Travel restrictions
	Water authorities
	Jurisdictional boundaries
	Responsibility zones
	Land use
	Evacuation routes
Communication	
	warning provided
	call-outs
	evacuation orders

Table 7 Data-Set Collected During Disasters as Represented in the Case Studies

Sometimes data works for one group but not another. However, this situation is not consistently associated with specific data-sets. For example, in some cases health data shared well, but in other cases it arrived too slowly or without enough detail. Data sets sometimes arrived in a format that is not useful for all groups involved. Sometimes because of format, the data did not arrive at. This issue appears to most often be very case specific. For example, during the Madrid bombings (000005), data-sets about hazard location – a type of data that typically is proofed and expected – was not provided in a way that was useful for the medical teams being sent to the scenes. The result was responders who were unaware that there were two sites, not one, that needed help, leaving the victims at one disaster site underserved for many hours and forcing the responders who understood the situation to not follow orders and go to the second location. In the same case, data that is usually collected and provided to hospitals -- such as injury statistics, information about who is being sent to which hospital, and information about hospital capacity – was not being centrally collected. In response, a spontaneous, and publically posted, list was created. SPEDI should be searchable for cases such as these, when typical patterns of data-set collection did not work, their causes, and their solutions.

Some data-sets were only referenced as lessons learnt, as something that should be gathered during a future event. These data-sets are neither available nor tested, but would contribute to decision making within a crisis situation. These typically are instigated either by information needs of a specific situation that was not planned for or instigated by a data set that was informally improvised. In some cases the improvisation has more to do with information flow than the contents of the data-set themselves. Below is a table of the requested data-sets and how these requests would translate into criteria for the inventory (Table 8).

Data set wanted	**Criteria**
Resources of informal response groups Resource needs for formal response groups Food and water sources	List and monitor resources to encourage mutual aid and efficient delivery of aid to both public and responders.
Responder Movements/Location	Record where given responders are at given moments Track routes taken/planned
Information about impromptu aid and informal response	Record number of volunteers in the field and the number able to be deployed
Informal cost of recovery	Expenditure from non-first responders
Health information necessary to identify bodies or to track longer term impacts of a disaster.	Record psychological aide needs for year after disaster Special need demographics Medical records for forensics
Environmental Impact of non-chemically induced disasters. The case studies often mentioned the side-effect of air pollution or contaminated water or lost wild lands, but this data was often not readily discussed in the cases until it was a the initial hazard that triggered the disaster.	This data should be gathered regardless of cause: Environmental/land damage Pollutant data Scientific models on plumes, spreads, flows, etc. Tide charts Animal rescues Threatened species, animal and flora, and land
Victim safety. While much is recorded about evacuations and shelters, the data needed to provide the public information about the risks they face are often missing.	List food and water sources List safe areas
Public Communication data, what the public is asking for and knows, not just what they are told: The aim of this type of data is to understand public reaction to the response and to better meet the needs of the public.	Public information requests List media topics of interest in relation to the disaster Social media trends/descriptions of events

	Eye witness videos/photos Requests for information made by victims families
Responder communication activities are often the ones that make interoperability and information flows possible, so should be included as data sets to gather.	Communication between stakeholders Liaison activity

Table 8 Data Not Presently Gathered But Should Be, Derived From the Case Studies

Other than these data referenced directly by the case studies, there is also *data is available but not tested/proofed*: These types of data include social media data, digital humanitarian data, and public inquiries. These data are often used when formal data gathering breaks down or hits political barriers that do not affect the informal data gathering methods. This happened in 2007 during the wildfires in Southern California (000010) when the formal response could not collect data about the situation south of the US-Mexico border, but the digital humanitarians and public media could and did. This type of data often does not make it into the reports (and thus our case studies) but is often acknowledge in academic literature as well as in white papers and community reports on the topic. As a result, SPEDI needs to draw on more than just incident reports and be sure to include both what is mentioned in academic research on the disasters, in the media, and in social media.

How and who does the gathering matters as much as the data content itself. For example, who tracks if an incident moves beyond a jurisdictional boundary or from one agency to another? Is it the same group or a group from the other side of the line? Additionally, all the cases seem to have intense gathering during the peak of the hazard and slow down as the disaster starts to come under control (even if normalcy has yet to be reached). SPEDI should note when data-set was gathered and the frequency and longevity of the related data-sets. The inventory needs to include not just what data sets but who is responsible for gathering in different circumstances. It also needs to track the procedures for such shifting of responsibilities. This detail about the production of the data-sets to begin with can indicate indirect but vital factors that could potentially affect interoperability and information flow.

Circumstances for public access to the data-sets are not set in stone, but important to consider when gathering the data. For example, during the e-coli outbreak (000016) there was much panic around the speculation that the outbreak started with a farm in Spain (a speculation that proved incorrect) but cost both the farm and the country's economy much damage. Also, the multiple different locations accused of being the starting place led to Russia banning all produce imports from the entire EU. Yet, the intention of the release was to provide warning to the public and limit future potential cases, despite the uncertainty. Details about the reasoning and effects of public release need to be recorded.

Based on the types of data typically gathered: *It is much easier to gather economic statistics than data on the impacts on residents.* The inventory needs to address this disparity of data in order for responders to better serve the needs of victims that cannot be reduced to numbers.

Much of this data is not numerical, but in the form of hand-written notes, recorded teleconferences, CCTV data, media video footage, eye-witness accounts, responder logs. Some of it is recorded electronically, some is recorded by hand. Consequently, the range of formats that the data-set is gathered in should be recorded along with data type. SPEDI needs to set up a search system that is capable of managing searches of multiple data format within a single search.

Different things can be asked of the same data-set: we cannot assume that the data says the same thing to all stakeholders. Each model has its own way of integrating data into its organisation and practice, practices that influence the possibilities for interoperability. As each organisation decides upon information to be created, stored, and shared to meet their needs, they draw on different data, ask different questions of the data, and find different data useful at different periods of time (Fiore-Silfvast & Neff 2013; Bowker & Star 2000). How this is coordinated, who is responsible, who is the expected audience, and how it changes when faced with a fast-paced and sudden disaster all have implications for the ability to integrate one group's way of managing information into a single joint system. To account for these differences, the inventory should record to what uses the data is put (what information it is transformed into).

3.2.4 Information flows

Information flow is much more than who should hear what from who. It is, in some respects, the culmination of the prior sections. It cannot be assumed that working under the same model, or even the same plan, will automatically lead to unproblematic information flow. How information travels changes depending upon political proceedures, security measures, technological uses, assumptions about the importance of the data being shared, and the realtionship between the stakeholders.

Different stakeholders will have different flows. These will also vary by country, region, and even hazard and scale of the hazard. For example, as a disaster scales up from a smaller district event, the decision-making can move from district, to municipality, followed by state, and finally to a national and international response level. As a result, the flow plans modify as the disaster shifts scale. The inventory needs to track these differences. Moreover, including different stakeholders can require unique modifications to information flow expectations. For example, during the UK floods of 2007 (000011), new positions (pseudo-silver and platinum) were created to coordinate work, shifting what types of information went to the regular gold, silver, and bronze positions. The responding agencies also had to form a strategic coordination group to align individual nodes of their otherwise isolated information flows. In another case, during the relatively uncommon flow of ash during the Eyjafjallajokull eruption (000013), there was no common place to look for volcanic ash observations and recommendations and thus information was not well coordinated and often conflicted between airports, countries, and the scientific communities doing the observations. The conflict in information flow was in part due to the low value placed on ash data compared to other meteorological data. The inventory needs to track when modifications are requested to the information flow, either during a response or recommended after the response, and why they were necessary.

Different data sets have different flow patterns. For instance, during the e-coli outbreak in Germany (000016), it became evident that health data has its own unique inforamtion flow, a flow that was implicated in the delayed nature of the response. The plan is far from a typcially command and control model of information flow.

Below is the pathways implied by the command and control model used in Greece and the model used during the e-coli outbreak in Germany:

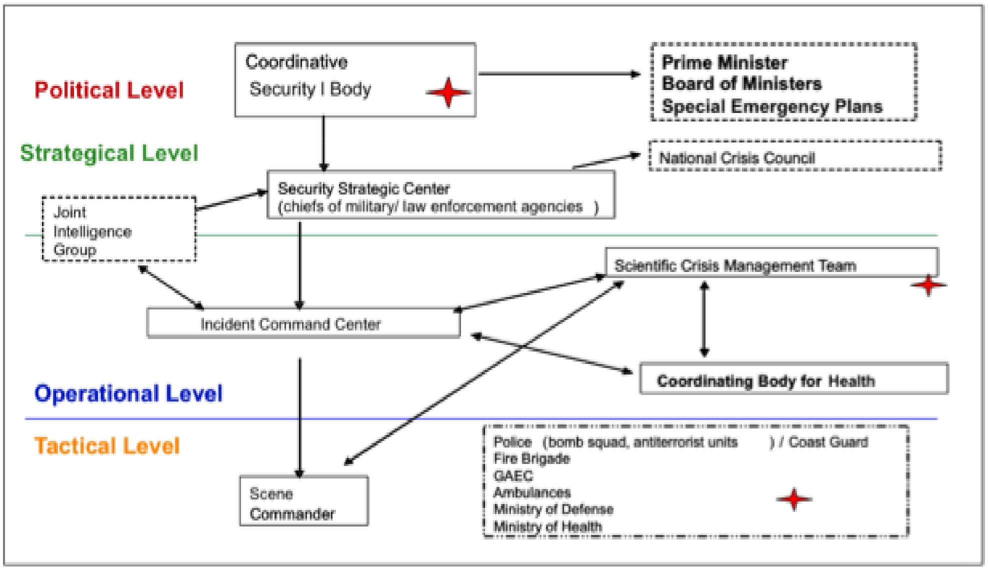

Figure 33 Xenokratis: Information Flow for Greek Incident Management Plans

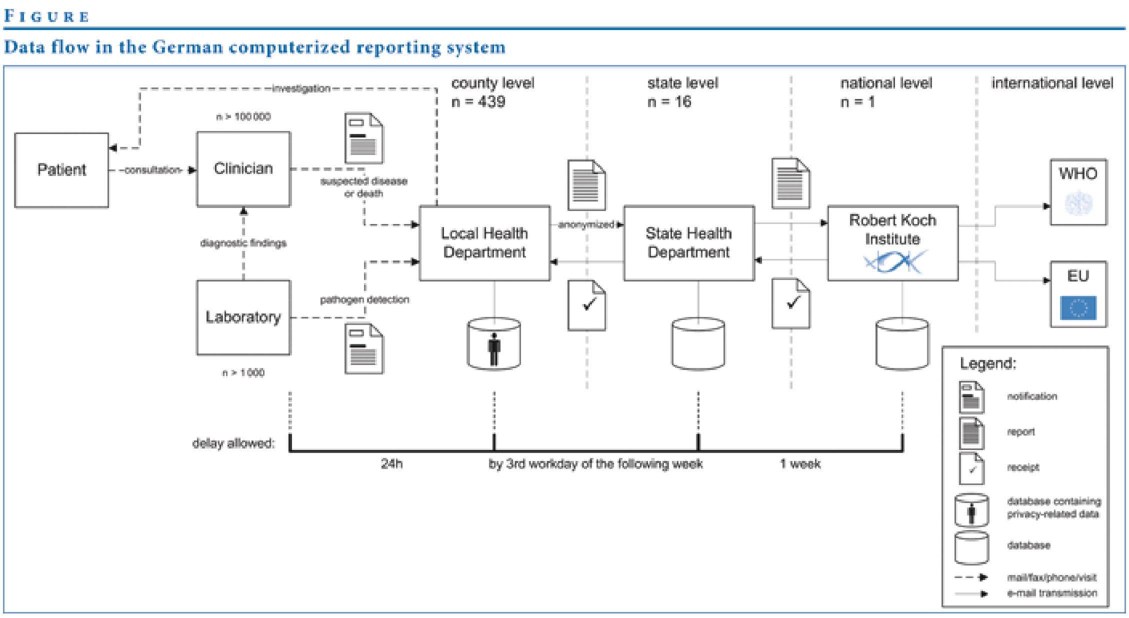

Figure 34 Dataflow in the German Computerized Reporting System

The first is used for a natural or technological hazards, the second is used for health hazards. These flow pattern models visually demonstrate that even under the same general premise of command and control, the different types of data go through unique social, political, and technological pathways, follows very different restrictions and speeds, and end up including different stakeholders. To manage these differences, the inventory needs to record electronic notification systems, data repositories, and criteria for flow to the next stakeholder/decision-maker.

Different information systems encourage specific flows over others. In the UK, for instance, there a various constraints on information flow: discrete, incompatible IT systems; inability to easily and quickly transfer paper-based data sets; IT system security. For example, data security varies by country, by organisation and by system or network. Legislation in Europe dictates who the owner of the data is in terms of personal data. Currently in the UK, the majority of public safety data is carried by commercial networks due to the inability of the TERA *Airwave* system to carry large quantities of data. Sometimes the data is transfered using the existing telephone infrastructure, mobile and satellite phones, or the networks of the National Operation Centre of the General Secretarial for Civil Protection as well as the first responder's telecommunication centres (Hellenic Fire Corps, Special Disaster Response Unit (EMAK), National Centre for Emergency Care (EKAB), Hellenic Police, Hellenic Armed Forces etc.). Each has its own level of encryption or security measures which affects what data can and should flow on those pathways. In addition, data may be transmitted across secure networks, only to arrive and be used in an insecure environment. This does not just include IT systems: for example, a classified document my be transferred electronically across secure networks, only to be printed out and passed to those who need the information but may not be security cleared to possess it. The inventory needs to track both flow nodes and pathways, the security and restrictions at each, and who uses which ones.

Side-channels do and will exist, no flow model dictates how information will travel all of the time. First of all, there is the problem of various organisations needing information held by other organsiatins and being constrained in sharing it by EU data protection legislation. Second of all, there is the problem potenitally losing leadership of a disaster if data is exchanged over jurisdictional boundaries. For example, during the 2007 wildfires in San Diego (000010), much data crossed political barriers via informal pathways that were not documented within the official reports. To formally do this trade would have changed the structure of the response. However, this information was necessary both for planning purposes (what would happen if the only evacuation route was across a national border) or for information purposes (the county could not officially release information to the public but to maintain some level of control over what the public was seeing would 'leak' its data to trusted public agencies to work with) (Petersen 2014). Sometimes side-channels are necessary because the technology systems for formal channels go down or are limited (Petersen 2014).

Case studies should be included that relied on such side channels for their operations and explanations for their uses should be included. Such data can help determine the validity of restrictions on inforamtion flow or when inforamtion MOUs need to be established. However, much of this information cannot be garnered for formal reports. It can, though, be found in the documentation of stakeholders involved in these side channels. It can also be found in news reports and through interviews with the individuals involved in those responses.

Another side channel, cited in by multiple case studies, is the use of personal communications devices (principally mobile phones) by first resonders. It is almost impossible to prevent them being used, but their use can result in a distillation of the information available centrally and a subsequent lack of centralized control. The inventory needs to document such cases, including what technology was supposed to be used or why the data could not follow formal pathways. Some of this information can be gathered by recording communication technologies failures in the case studies.

3.3 Interoperability

Interoperability involves the ability of different groups to work together, for data to be shared, and for information provided to be useful to all involved. The notion is one where different command structures and different priorities could potentially still hold for the different groups involved, yet they are capable of coordinating and delegating work, decisions, and needs. In the case studies, interoperability was affected both positively and negatively by the need to share data, by the use of different technologies for communication, and by the socio-political interactions that underline any interactions between two different organisations.

The ability to share data affects all potential communications and collaboration. This involves the need for compatible technologies, so that when different mapping technologies are used the data from the platforms can be interchangeable. One might use KLM the other might produce PDFs. It also requires compatible data formats, a prospect that involves foresight into how the data might be gathered and used. For example, some data is provided in maps, some is provided in databases, some collected via GIS, some collected by pen and paper (Buncefield (000008), 2007 Floods (000011)). While very similar, the information is not readily transformable one to the other. An inventory needs to keep track of what format the data is collected in and stored. It also needs to be able to search for different data combining success and problems. Data is also collected at different scales and resolutions that can greatly affect how they are combined. For instance, different satellites collect data at different scales and resolutions so to compile their information could mean drawing together very different levels of certainty (2007 Fires (000010)). Similarly, data is often collected at different intervals. Different frequency of data collection might mean different levels of accuracy are being combined when sharing data. For example data collected 12 hour ago might be much less accurate than data collected 1 hour ago when dealing with an unfolding disaster. The inventory needs to keep track of the scale, resolution, and frequency of different data types and data sources in order for users to be able to assess validity and accuracy.

How the data will be shared matters, too. For example, if their will likely be scattered or interrupted connectivity in the field then some data might be recorded by hand while others will be recorded using personal handheld devices or GPS. It can also be as simple as different radio frequency standards found in different brands of radios that prevent one group from talking to another. During the Madrid bombings (000005) this was a big issue, since some of the vehicles and teams recorded their actions and the overall situational details in ways that were not networked and thus only recorded at the end of a long shift. At other times it is a simple as phone lines failing (Athens Earthquake (000001) and Toulouse (000002)). Thus, the inventory needs to connect information about data type with information system and flow. It also needs to collect standard use procedures and protocols. It also needs to look at disasters that successfully employed methods of communication other than phones and radios. Need also to collect cases when phones were relied upon to understand why they were used rather than an alternative to incorporate into our system whatever need it is they serve.

Another problem that occurs is *too much data is being shared*, and a system gets overloaded and crashes. Often the technological systems put into place to offer alerts (like SARS (000004) and E-Coli (000016) or to post information (2007 wildfires (000010)) are not designed for the traffic they receive. Different cases that experienced these issues (positively and negatively) should be included to record both why the problem occurred and their ad-hoc solutions.

Along with the basic movement of data from one system to another, it also moved from one decision-making process to another. As it makes this latter move, *the criteria for assessment and definitions of usefulness frequently change*. For example: during the 2007 wildfires, Hardwick (2008) wrote “Damage assessment was conducted independently by each jurisdiction; It is unclear if they were using the same criteria for the assessment and the resulting geospatial data sets could not be integrated due to attributes and spatial geometry differences” (slide 41). It is not just about the meaning of the data points but the questions asked of it that make it valuable, reliable, shareable, and integratable (Fiore-Silfvast & Neff 2013). This is especially important if the different actors involved have different definitions of risk. To understand better how the different users might engage with the data the inventory should collect the questions asked by each agency/organization of the data they use. Information about what each agency considers at risk during a disaster and how threat is defined for different hazards should also be collected.

In many cases, interoperability only happened because all the technology was pushed aside and people from different agencies were placed in a room together. This is often achieved through *liaisons or a physical centre* that continually prove vital in collaborative work, making it possible for members of different organizations to work together to help align terminology and priorities (2007 Floods (000010), 2007 wildfires (000011)). The inventory needs to record situations when these actors or places were described as vital and what problems they solved. Along these lines, the inventory needs to acknowledge the range of languages the data will be shared in and either produce a translator software or employ a common language for all data.

Interoperability involves more than simply data or technology. The MOUs between groups help determine who is responsible for collecting and sharing data with who else. These MOUs need to be identified to determine who each group has agreements with in order to determine data/skill sharing expectations already in existence. Without strong communication lines, the teams (this is even the case within the same agency) each start to act on their own.

Who has access to data also affects interoperability. Issues of distrust occur when this data is blocked off from future researchers looking into developing a deeper understanding of causality and prevention, or groups not at the scene trying to help, which is exactly what happened during the Prestige Oil Spill (000003). As a whole, not just the information but the stakeholders got labelled as untrustworthy in this situations, which can greatly impact the success of future responses. Collect typical accessibility patterns for data types by region. Designing the inventory in a way that is accessible to a wider range of stakeholders can improve communication and information flow in the future.

3.4 Business Models

Two different types of business models are important to consider for the inventory. First are models describing how first responder organisations and police authorities offer services to citizens from local to European levels by different organizations. This leads to such arrangements as public-private partnerships, government-academic partnerships, or even outsourcing. It could also include models of service co-creation, where members of the public can be drawn into the production of emergency planning and emergency response services, for example through the use of virtual operations support teams (VOST) (St. Denis et al. 2012; Buscher et al. 2014; Brandsen & Pestoff 2006). Second are models that rely on the application and procurement of information solutions (such as data sets and information systems) to help realize the above relationships. This includes systems purchased or designed to encourage data sharing or to integrate needs and priorities. It can also mean using different data providers in order to produce a complete picture. Looking at how these business models function before and during disasters can help us determine how to propose our solutions so that they best fit the needs of our audience.

Public-Private business models appear throughout the examples in multiple ways:

1) They have to be arranged whenever the source of the hazard comes from a business practices. For example, an oil processing plant runs the risk of explosions or leaks that could affect their surrounding communities and therefore emergency plans have to coordinate both the private business' responsibilities and the public services, like police and health authorities (000008, 000007, 000002). This is also the case with transport companies, like airlines, and the private networks of satellites and radars used to track them even in situations of public danger (000007). These models can be difficult to execute if the private actors have low security or minimal training, as in the case of the AZT explosion (000002). In addition, they can be very individualized, like during the Eyjafjallajökull Volcano Eruption (000013), leading to different decision making processes throughout an interconnected network like the air travel and airports. *These interdisciplinary relationships are necessary.* An inventory should be able to be accessible to both public and private actors in such a disaster response.

2) They exist when the government authorities either do not have the plans or the resources to manage the disaster on their own and either relies through improvisation or through initial planning on the private sector to fill in their gaps. For example, during the Prestige Oil Spill (000003), the coastal communities could not have managed the clean up on their own and the national government had not written plans in advance of the situation, so the local businesses and international NGOs had to play a major role in strategic planning, decision-making, and the physical response. *Focusing only on first responders or government response in general will often miss major decision-making stakeholders, would not adequately define the crisis management models in*

use, nor would offer a complete picture of the information systems required for a response. Business models beyond government partnerships need to be explored.

3) The local communities (citizens, businesses, etc) are asked to develop their own plans. For instance, prior to the 2007 Southern California Wildfires (000010), the local communities had been asked to develop their own community protection plans, plans that were based in individual community needs and values in contrast to the generic command and control definitions of response. These plans would be used by any outside agency coming in to help fight a fire in order to help guide their decision-making and priorities. *Such relationships would suggest that the regional and higher scale plans would be written with intentional gaps and cannot be relied upon to structure the form interoperability or collaboration will take.* SPEDI needs to record all stakeholder business models.

Academics are frequently expected to provide basic data, research, and analysis during disaster response. For example, since there was no monitoring system in place or plan for how to monitor a longer-term environmental disaster, after the Prestige oil spill (000003), academics from regional universities stepped up to help to both pool their data resources used in their research and to design a system that brings together the various data and actors for decision-making and planning purposes. A slimier situation was seen during the e-coli outbreak, where the information would pass back and forth between government and academic researcher hands (000016). But one potential result, that was seen during this oil spill, is that it can become unclear who was responsible for making decisions, managing the safety of the responders and volunteers, or providing information to the public, which can delay action. An inventory should include not just the data and information systems academics are involved with, but the role of the institutions in the larger response process.

Outsourcing is becoming increasingly common in emergency response. There are many reasons for outsourcing, a common one being that the risk for disaster is low or that any disaster is a lower priority than regular emergency affairs. This is what happened during the Love Parade Festival (000014). The security and crown management planning was outsourced to private companies. While they were trained in general security measures, these companies neither regularly operated in the space of the festival nor had the emergency training necessary to manage the crowd turbulence. In addition, they did not have the communication equipment to connect with the emergency responders that were needed on scene. The inventory needs to be searchable by business model so users can compare the different situations and results.

A related phenomena is the *increase reliance by emergency responders upon private data providers*. In one respect this expands the range of data accessible and usable during a disaster, as seen during the Prestige Oil Spill (000003). But in other cases it can slow down response or create a barrier to information. During the e-coli outbreak (000016), the German government relied upon private research companies to act as vital steps in the analysis process. The movement of data between these various actors was one reason for the extreme delay in the government response. During the 2007 Wildfires (000010), San Diego County spent multiple weeks waiting for fudnign approval to purchase private satellite data that was higher resolution and more frequently obtained than any of the public satellites they had access to. By the time the request went up the chain of command to the state for the emergency funds, the flames were under control and the data was no longer needed. The inventory needs to track where data comes from and how it is obtained. It also should track succeses and failures in the use of private data.

3.5 Specification of relevant ELSI factors

The reviews of academic literatures and post disaster reports, and the construction of the collection of case studies have explicitly and implicitly surfaced a range of ethical, legal and social issues (ELSI) experienced in practice. Encountering ELSI in relation to concrete examples like this highlights their often complex contextual nature as well as their importance. In this section, we list and discuss a set of issues that are particularly relevant to the aims of the SecInCoRe project. These can be categorised along three dimensions:

- *Emergency ELSI* – how individuals (professionals and other actors) and societies deal with emergencies and potentially scarce resources
- *Technology ELSI* – ELSI that arise in and through technology design and use
- *Information ELSI* – as people increasingly inhabit informational environments and wittingly and unwittingly produce and share personal information, new dilemmas and opportunities arise

This is a heuristic division, While not always clear-cut, it is productive, because it sensitizes designers and analysts to the intersections between action, technology and communication.

From considering these ELSI, we can derive a set of relevant factors to pay attention to when designing the SecInCoRe Pan-European Disaster Inventory.At this stage in the research this is not a comprehensive overview. It will be developed further in future deliverables and publications.

3.5.1 Emergency ELSI

Emergency ethics issues arise because emergencies generate circumstances where normal moral rules are difficult to enact and there is an urgency and necessity to act, they include the need for responders to ration access to medical treatment through triage, for example, to disregard people’s right to dignity during search and rescue operations, to measures designed to constrain people’s right to move (e.g. kettling during the 2010 student protests). The aim of SecInCoRe is to intervene constructively at these junctures and, where possible, support ethical conduct, where – of course – the meaning of this may be highly contested, but it could include access to information that makes a wider range of medical treatment options available, thus reducing the pressure on triage. Legal issues may include the shifting responsibilities and the duty to involve specific agencies related to the characterisation of events as ‘major incidents’, ‘serious emergency’ or ‘catastrophic emergency’. Social issues in this category include the role of trust in making collaborations between first responders efficient, and societal issues include questions over whether better emergency planning and risk analysis could have prevented the emergency. Examples that stand out from our review include:

- Different understandings/practices around seemingly basic terminology (e.g. risk, uncertainty, accuracy, threat).
- What liability and ethical issues are there when a responder shows up to help without being called, like during the Madrid Bombings or Toulouse Explosion?
- Public communication – of risk assessments, not just during hazard situations should be enforced more (Toulouse).
- Early responder safety is often ignored (Madrid Bombings, Toulouse).
- Who ran shelters and how they were coordinated is often left out of the official reports. It seems this is frequently the responsibility of agencies outside of government yet it is work expected by governments during disasters. The disasters that get included need to reflect how the outside organizations/responder groups are involved and what is expected of them.
- How much can be asked of industry to distribute information about potential hazards (either to government or public) – such as in the case of Toulouse Explosion?
- How much can be asked of responders? What is society's responsibility towards them? What if the responder becomes the victim (SARS)?
- Some EU states have legislated powers for closing of borders, compulsory screening, medical examination, treatment, vaccination (prohibited by laws in other states), capacity for community control (e.g. prohibition of gatherings, school closures) and quarantine measures (Martin et al. 2010). Many of these protocols have the ability to infringe on basic human rights, as well as challenge the EU principle of free movement. (SARS, Toulouse).
- Do we damage the environment to save a building? (Buncefield) How do the different disaster balance these issues to decide priorities and how do we design a system that enables multiple answers/does not favor an answer to a question such like this one.
- The difference of planning for preparedness vs prevention (Lakoff, Jasanoff). Things end up being more generalized to cover a wide-swath rather than specific grounded in historical trends, because it's about planning for unknowns. While this allows some planning it also takes away the specificity of the situation leaving many nuances unplanned for.

3.5.2 Technology ELSI

- Incorporating as daily practice, if it is not daily practice then the system will never be used come disaster.
- There seems to be an expectations that typical communication channels can work during disaster time, not just among responders but with the public. For example, during the Athens earthquake, TV banners were used to get two telephone lines to the public so they could ask for inspection of their dwellings.

How was it that the public was expected to see this if they are displaced and homeless?

Relevant factors for the design of a pan-European inventory:

3.5.3 Information ELSI

- *Information sharing* - At present people often do NOT share data for fear of breaching data protection regulation or they share too much without understanding consequences
- *Information quality* – The quality, accuracy and reliability is often paramount and difficult to establish.
- *Privacy and liability* issues arise around processing, using and sharing such as: police giving information to insurance.
- *Trust* in both the data and the security of the data must be supported and warranted.
- *Sharing*. For large-scale health incidents or epidemics: what type of information can be shared and what type should be shared? Cases should reflect different techniques (and their effectiveness) of sharing information about health hazards that might be of interest to ones neighboring countries or to the larger globe.

3.5.4 Relevant Factors for the Design of a Pan-European Inventory

From this first overview of ELSI arising from case studies and the literature, some relevant factors for the design of a pan-European inventory can be derived. How past disasters are described and how, thereby, particular realities are configured and others are discounted matters. This is an unavoidable fact of language, and there are always consequences. However, it is necessary to be sensitive to a set of particularly important issues in the way in which the inventory elicits data about past disaster events. These include:

- *More than numbers*: Numbers (of people killed or injured, buildings and businesses destroyed and insurance claims filed) can give the impression that the severity and impact of a disaster can be objectively measured. However, numbers can hide more than they reveal – for example the fact that the poor are disproportionately affected by disasters (Steinberg 2006). When recording details about disasters, there is a need to set up the inventory to describe the disasters in a way that is not entirely based on statistics and numbers, but on patterns, experiences, practices as well.
- *Fair representations.* There should be be a dedicated effort to refrain from relying on myths and metaphors to filter the empirical evidence.
- *Long term vs short term effects.* Lasting psychological issues were often noted but neither tracked nor fully considered part of a recovery, just an after-effect separate from the recovery. In other words, the reports all closed the disaster at the end of the short-term immediate needs rather than the long term issues that need aid (Athens Earthquake, Toulouse, Madrid bombings). The same can be said for long term effects. For example, during the Toulouse Explosion, the issue of toxicity in

the plume that spread was declared closed early on, making future claims to causality difficult. After the Buncefield oil explosion, the reports acknowledge environmental issues (a need for a longer term cleanup) but these aspects were barely considered when describing the effects of the disaster, thus distancing cause from potential future effect. Kim Fortun (2000) terms this way of managing liability ‘anteriorizing the future’.

- *How exceptional are exceptions?* Disasters are often represented as unexpected, exceptional events. But this may be (intentionally or unintentionally) rooted in political or economic interests. Floods, eartquakes, industrial etc. may be rare, but they are often predictable, but it not in the interest of parties who profit from the areas potentially affected to make those dwelling or working there aware of this (Fortun 2000; Steinberg 2006).
- *Beyond money and life*. The reports all focus on the economic and health aspects of recovery, rather than what it means to return to a ‘normal’ life for the impacted residents (in other words, they prioritize some issues over another). An ELSI conscious system would make these elements more prominent and also consider quality of life.
- *Availability of information.* While much of what has been used to build these initial case studies was in the public domain, in some cases the resources are proprietary or closed. How should such literatures be referenced for a public database?
- *Accessability.* Who should be able to access the inventory and under what conditions?
- *Responsibility.* The researchers’ and eventual keepers responsibility for what is done with the data in the SecInCore Pan-European Disaster Inventory needs to be clarified.
- *Careful Categorisation.* Categorisation includes, but also excludes and creates relaities. For example, currently data about environmental damage is classed under material, social, economic damage. But environmental damage can also be seen as cultural, social and personal, even psychological, and it is not necessarily measurable in economic or other material terms. The inventory should be alive to debates in the public realm and capable of adjusting its categorisation scheme.
- *Inference*. Some important data had to be inferred, because it is currently not collected or made public. What are the consequences for the inventory producers and users? What does it mean that we cannot see much about information flow in the data provided? How should inference be documented for evaluation and validation?
- *Comparison and synergy*. There is a need to compare criteria for the production of case reports, extraction of information and validation of sources with existing disaster inventories.
- *Indirect results of disasters.* The inventory needs to record indirect results of the disaster. For instance, during the SARS case, the direct results were the sick and dead. The indirect results were the ethnic stereotypes that lead to lost tourism and business.

- *Multiple perspectives.* Disasters need to have reports that cover a range of perspectives. For example, as written, the 2007 Floods in UK focus entirely on what was done to save the substation, rather that what happened that the flood was able to reach the station or what else might have been flooded. Having only that perspective on the floods would seriously limit the type of questions asked for data gathering and future planning.
- *Supporting Trust in Data.* Disaster cases should discuss what was required to establish trust in: 1) the data; 2) other agencies; 3) public behavior (2007 Floods, 2007 Wildfires).
- *Include what is excluded*. Only a few cases actually brought up the public's role in the response (Norway Attacks). But these roles, be it via social media (Norway Attacks), to provide information from the scene (2007 wildfires) or to ask questions are important to include – this way a responder using the database can see where communication strategies fall short and potentially foresee issues from lack of public awareness.
- *Anonymity and Encouragement to Learn from Mistakes*. If response agencies and other stakeholders are to be encouraged to contribute data to the inventory, there have to be ways to encourage comprehensive and honest recording, free from concerns about blame.

4 Conceptualizing the SecInCoRe Inventory

A basic assumption underpinning the production of a pan-European inventory is that societies and emergency response agencies can learn from past disasters. However, historical studies show that this is far from straightforward. The reviews of policy and practice changes after the Bhopal incident show that there are complex 'economic, political, and institutional constraints on our ability to learn from failure' (Jasanoff 1994). Studies find a cyclical rhythm where communities and societies hit by disasters draw lessons and implement new preventive measures and response processes in the immediate aftermath, but then forget, with lessons rarely lasting more than a generation (Bergmann & Egner 2012). We agree, up to a point with the understanding that:

> *Technology that provides the right information, at the right time, and in the right place has the potential to reduce disaster impacts. It enables managers to plan more effectively for a wide range of hazards and to react more quickly and effectively when the unexpected inevitably happens. (Koua et al.,in Hiltz et al. 2009: 3)*

However, important lesson have been drawn from past IT development projects, complicating the underlying assumptions in the above statement:

> *The belief that more data or information automatically leads to better decisions is probably one of the most unfortunate mistakes of the information society. (Hollnagel & Woods 2005: 7).*

This is because information does not easily move across organizational and cultural boundaries. It is not a 'raw material' or 'resource', it only is useful if people can make sense with it. Therefore just giving people more information can be counterproductive. What needs to be supported is practices of sense-making and collaboration. The inventory can do this in innovative ways, by creating pathways and more easily navigable information landscapes.

The analysis documented in this deliverable also highlights criteria and conditions that can support more sustained learning and the criteria we have formulated in the previous chapter resonate with these. However, there are many open questions, including questions about how learning from past disasters actually might proceed and also, more pragmatically: Learning from what? The inventory needs to discuss causes and remedial actions in some depth to enable understanding. Users will need to identify some of the causes of why things went well or wrong and will also need to be able to search for 'solutions' to difficulties they may be concerned about. There need to be criteria for including those in the inventory.

To conceptualize the inventory:

The inventory could, firstly, be purely a more qualitative and detailed database of past disaster events than existing resources, such as the Emergency Events Database (EM-DAT), the CAST project Database on Emergency Response Major Incidents (DERMI), the European Major Accident Reporting System (EMARS), ARIA: Lessons Learnt From Industrial Accidents and ZEMA Informationssystem zum Stand der Sicherheitstechnik (Information System about the Status of Safety Technology), initiated and constructed by SecInCoRe and adopted by an authoritative agency like the European Emergency Response Centre (ERC) or the Centre for Research on the

Epidemiology of Disasters (CRED) to develop and provide access. An example of use would be an emergency response agency in the process of developing new emergency plans, turning to the inventory to understand the breadth of and real world unfolding of potential risks and to learn from past experiences to formulate the best possible plans. Or, in a more dynamic scenario, a group of first responders actively engaged in a mission may be faced with a potentially toxic chemical spill. They could search the inventory for potentially similar cases and glean information about lessons learnt, crisis management models employed, stakeholders involved, and so on. Secondly, the inventory could include acces to a library of past disaster reports and other bibliographic resources that its entries are based upon, enabling users to follow up research. Some of these resources may be openly available, others only on a basis of subscription or special request. Thirdly, the SecInCoRe Pan-European inventory could be a community resource, initially set-up, managed and monitored by the SecInCoRe project and adopted by the ERC or CRED or similar organization, where interested parties can contribute under the guidance of experts, as well as being granted access to the information. Examples of use would include the above, but also contributions, such as response agencies providing information about past events, difficulties, their causes and solutions found during the response to a disaster, which had not been captured by official after-action reviews or which had been represented only partially, but which allow important lessons. Thirdly, the SecInCoRe Pan-European inventory could also be a gateway to data that are referred to in the inventory, utilising advanced ICT to support construction and maintenance of temporary shared information spaces. A use example would be reference to the inventory by a response agency during the response or recovery phases of a disaster, discovery of useful open or proprietary or otherwise closed datasets, and the ability to access such data either directly or request access by following links.

To realize these benefits, advances in related areas are needed. Emergent interoperability between 'adhocracies' of emergency response may involve statutory response organisations, such as the police, fire and ambulance services but also NGOs, environmental experts, affected populations, Virtual Operations Support Teams (VOST), supermarkets, insurances, etc. (Mendonça et al. 2007). Each party comes with its own information systems, data and devices. To share information, responders need support for flexible assembly and orchestration of a '*system of systems*' appropriate for the specific emergency at hand (NATO 2006; Bridge Project: http://www.bridgeproject.eu). The utilization and synthesis of information requires collaboration and information sharing between actors e.g. through *emergency management information systems*, *common information spaces* or *Precision Information Environments* (Kamel Boulos et al. 2011; Schmidt & Bannon 1992; Turoff et al. 2004). And approaches that can safeguard security and privacy, such as *firewalling*, *encryption* and *privacy preserving techniques*, are needed (e.g. Wang et al. 2010).

5 Literature Index

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6 Appendix 1 – Definitions of 'Crisis'

Different Definitions of 'Crisis'	
[1]	"Crisis is a process of transformation where the old system can no longer be maintained." (Venette 2003)
[2]	"Vom Normalzustand abweichende Situation mit dem Potenzial für oder mit bereits eingetretenen Schäden an Schutzgütern, die mit der normalen Ablauf- und Aufbauorganisation nicht mehr bewältigt werden kann, so dass ein Besondere Aufbauorganisation (BAO) erforderlich ist" (A situation divergent from normal condition with the potential or the occurrence of damages to protective goods, which cannot be managed with normal operational and organisational structures in order that special organisational structures are necessary). (BBK 2011: 17)
[3]	"The goal is often to describe large, out-of-the-ordinary exchange-rate and sometimes interest-rate changes" (Eliasson and Kreuter 2001: 3)
[4]	"A crisis is a change, which may be sudden or which may take some time to evolve, that results in an urgent problem that must be addressed immediately." (Government of Hong Kong Special Administrative Region 2009: 1)
[5]	An "incident affecting a society with the potential to cause loss or damage to persons, property or the environment which requires extraordinary coordination, resources, and skills in response" (ACRIMAS Project).
[6]	"…a decisive or critical moment or turning point when things can take a dramatic turn, normally for the worse…" (Allinson 1993: 93)
[7]	"Short period of extreme danger, acute emergency" (D&E Reference Center 1998)
[8]	"Crises involve events and processes that carry severe threat, uncertainty, an unknown outcome, and urgency [...]. Most crises have trigger points so critical as to leave historical marks on nations, groups, and individual lives. Crises are historical points of reference, distinguishing between the past and the present [...]. Crises come in a variety of forms, such as terrorism (New York World Trade Center and Oklahoma bombings), natural disasters (Hurricanes Hugo and Andrew in Florida, the Holland and Bangladesh flood disasters), nuclear plant accidents (Three-Mile Island and Chernobyl), riots (Los Angeles riot and the Paris riot of 1968, or periodic prison riots), business crises, and organisational crises facing life-or-death situations in a time of rapid environmental change [...]. Crises consist of a 'short chain of events that destroy or drastically weaken' a condition of equilibrium and the effectiveness of a system or regime within a period of days, weeks, or hours rather than years [...]. Surprises characterize the dynamics of crisis situations [...]. Some crises are processes of events leading to a level of criticality or degree of intensity

	generally out of control. Crises often have past origins, and diagnosing their original sources can help to understand and manage a particular crisis or lead it to alternative state of condition" (Farazmand 2001: 3-4).
[9]	"…an event and/or a situation which endangers the established system, the health, life, and property of its members….the term 'crisis' is treated as being separated from…other concepts based on the intensity and scope of influence. The terms disaster, hazard, accident, etc., refer to only one event and/or situation, while crisis includes the concepts of natural disasters, man-made/technological disasters, and social disasters." (Kim and Lee 2001: 502)
[10]	"Crises act as *focusing events*, demanding public attention to a policy failure or problem [...]. A great war, a major depression, or an epidemic may set into motion a number of important changes in public policies." (Nice and Grosse 2001: 55)
[11]	"…a hard and complicated situation…or a turning point—a decisive crucial time/event, or a time of great danger or trouble with the possibilities of both good and bad outcomes" (Porfiriev 1995: 291-292)
[12]	"A collective crisis can be conceptualized as having three interrelated features: (1) a threat of some kind, involving something that the group values; (2) when the occasion occurs it is relatively unexpected, being abrupt, at least in social time; and (3) the need to collectively react for otherwise the effects are seen as likely to be even more negative if nothing is done sooner or later [...]." (Quarantelli 1998: 257).
[13]	"…a situation that, left unaddressed, will jeopardize the organisation's ability to do business." (Ziaukas 2001: 246; citing other sources)
[14]	"A time of instability for an organisation in which the impacts of event(s) threaten its operations, survival, or reputation". (Cockram and Van Den Heuvel 2012: 4)
[15]	"a difficult or dangerous situation that needs serious attention" (Merriam-Webster Online Dictionary)
[16]	"An inherently abnormal, unstable and complex situation that represents a threat to the strategic objectives, reputation or existence of an organisation." (BSI 2011)
[17]	"A national or international situation where there is a threat to priority, values, interests or goals." (NATO)
[18]	"An abnormal situation, or even perception, which is beyond the scope of everyday business and which threatens the operation, safety, and reputation of an organisation." (BIS)
[19]	"An unstable time or state of affairs in which a decisive change is impending." (Fink 2002)
[20]	"A specific, unexpected, and non-routine event or series of events that create high levels of uncertainty and threaten or are perceived to threaten an

	organisation's high priority goals." (Seeger et al. 2003).
[21]	"A serious threat to the basic structures or the fundamental values and norms of a system, which under time pressure and highly uncertain circumstances necessitates making vital decision." (Boin et al. 2005).
[22]	"Crises defy precise characterisation, but typically they are unexpected, abnormal and novel, volatile, inherenty unpredictable and giving rise to conflict between objectives." (MacFarlane 2010: 2).
[23]	"Crises are events or trends that threaten the viability of the organisations within which they occur." (Pearson and Sommer 2011: 27).
[24]	"The perception of an unpredictable event that threatens important expectancies of stakeholders and can seriously impact an organisation's performance and generate negative outcomes." (Coombs 2011).

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