BELICE

Building
Experience to
Lead
Initial Assessment in
Challenging
Emergency

Co-funded by
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Civil Protection

MANUAL OF ASR1
WIDE AREA ASSESSMENT PROCESS

Technisches Hilfswerk

VALABRE ANTICIPER VOTRE PRÉSENT

PROTEZIONE CIVILE
Presidenza del Consiglio dei Ministri
Dipartimento della Protezione Civile

TIMESIS

EN

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During the development of the Manual of ASR1 – Wide Area Assessment Process various experts have participated in drafting, checking, improving and consolidating the methods and tools contained.

The experts and their contribution are identified below.

The overall checking and approval of all the information contained has been carried out by Director Giuseppe Romano, BELICE Project Leader, Directorate of Tuscany for National Fire Corps.

The general coordination of the Manual drafting has been carried out by Paola Milano (BELICE Project Technical Co-ordinator).

The drafting of the general and introductory aspects of chapter 1 have been carried out by:
Philippe Meresse (EcASC, French USAR Focal Point), Fabrizio Graverini (CNVVF, Battalion Chief), Massimiliano Mori (CNVVF, Battalion Chief) and Massimiliano Russo (CNVVF, Deputy Chief Fire Officer).

The drafting of all methods and tools described has been carried out by:
Antonio Annecchini (CNVVF, Deputy Chief Fire Officer), Alessandro Fanfani (CNVVF, Fire Fighter Coordinator), Domenico Fiorito (ICPD, Expert Officer in Emergency Planning at Emergency Management Office of ICPD), Francesco Giordano (ICPD, Expert Officer in Seismic Risk at the Scientific Advisor Unit of the ICPD), Gianmario Gnecchi (CNVVF, Assistant Chief Fire Officer), Fabrizio Graverini (CNVVF, Battalion Chief), Massimiliano Mori (CNVVF, Battalion Chief), Luca Padroni (Director of Civil Protection of the city of Pisa - IT), Massimiliano Russo (CNVVF, Deputy Chief Fire Officer), Paolo Vaccari (ICPD, Expert officer in International relations and activities at the Volunteering, promotion and integration of the National Service Office of ICPD), Christophe Debray (DGSCGC, INSARAG National Focal Point), Philippe Meresse (EcASC, French USAR focal point).

The drafting of training methodology and correlated issues described in chapter 4 have been drafted by Peter Goxharaj (THW, Senior Program Officer for USAR at THW HQ) and Nils Uhlenbrock (THW, Program Officer for EU CP projects at THW HQ).

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PREFACE

The following testimonies of the Mayors of Irpinia (Italy), an area hit by a devastating earthquake in 1980, demonstrate how it is difficult, for local authorities directly and personally involved in an earthquake, to manage rescue operations in the early stages after the event.

For this reason, BELICE Project experts believe it is of fundamental importance to provide local authorities and all rescuers with tools and methods that can help to define the affected area, to quantify the needed resources and to set priorities after a seismic event.

The Eternal Moment (taken from the Treccani Encyclopedia "Inside the Crater: The 1980 Earthquake In The Mayors' Memory"):

"It was Sunday night.

The earth shook for 90 seconds which marked a violent caesura in everyday life. The memory of those seconds still chokes those who unsuccessfully have been trying to find the most suitable expressions to describe the anxiety they experienced. For some, the recalled emotion – after more than thirty years – still makes them teary-eyed, still makes them feel a lump in their throat while feeling shameful for their legitimate pain which is yet perceived as a weakness.

Angelo Colantuono, Mayor of Lioni, upon leaving the darkness of the garage of his home was struck by a profound anguish while watching the scene before his eyes: the skyline of the roofs had changed, under a beautiful moon light; the streets were invaded by clouds of dust and one could hear cries of terror and pleas for help. Someone kept screaming regularly, "What happened!?". Bartolomeo Mazzei, Mayor of Pescopagano, gaped seemingly dazed at the stones of the clock tower fallen near his feet, injuring his legs. Sometimes, blood-curdling memories can still be described *in great details. The then Mayor of Palomonte, Manlio Parisi, said,*

"That night the City Secretary and I were in the City Hall. We heard a terrifying rumble! We tried to reach the door but it was stuck! In the meantime, houses were collapsing loudly. The City Hall had been built recently and was made of quake-proof reinforced concrete.. I heard such a noise.. as if the building was forcefully crushed! When the ground stopped shaking, the door unblocked and we were able to get out. What a show... someone was screaming, "We are over! We are over!" I was shocked!"

The Mayor of Ricigliano, after being buried under the rubble of his home, was extracted by some friends who heard him cry. He was then taken to the village fountain to wash the deep cut on his head.

Also, early actions were prioritised in a very subjective manner, understandably searching first for family members and relatives. Mr. Repole for instance, jumped in his car and drove to Naples to reassure his parents and then went back to Sant'Angelo dei Lombardi at six o' clock in the morning after travelling all night. The Mayor of Caposele, Antonio Corona, immediately searched for his mother and found her cuddled up in a corner of her home; he then ran to his brother's home and realized that it had collapsed and his sister-in-law and her children were under the rubble. He burst desperately into tears and thought, "How am I going to tell my brother?".

1 INTRODUCTION

1.1 The Purposes Of This Manual

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Every day the earth is shaken by several earthquake tremors all over the place, with areas being affected more frequently and others never experiencing such a event.

Earthquakes are part of natural hazards and, when an earthquake hits an urbanized area, it puts a strain on the resilience of the local population, the continuity of services, the local authorities and the government of the country.

It is a phenomenon that can cause a large number of victims, displace people, destroy buildings and infrastructure, while isolating locations and affecting the local economy and, often, having consequences which shall be much increasingly devastating as the local authorities are poorly prepared to face the crisis. In the immediate aftermath of the event, there will be a situation of enormous confusion worsened by the occurrence of other aftershocks that may cause additional damages. An earthquake is a injury that leaves a scar in the history of the country and therefore countries have to be prepared to limit consequences as much as possible in order to restore normal conditions in a fairly short time.

Preparedness plays, in fact, a fundamental role through careful and regular planning, over a fairly long period of time, while studying the territory and its vulnerabilities both in terms of natural resources and man-made endeavours, such as vulnerable buildings and infrastructures and related risks (e.g. dams collapsing after an earthquake and flooding surrounding areas, etc.).

It is important to carry out a “wide area” study, imagining how the ordinary conditions of the area under examination may change before and after the event (pre and post event) in terms of emergency management in order to plan all the resources that need to be deployed to face the crisis. That is to say: to allocate adequate areas for the creation of Bases of Operations for the rescue teams and for assisting the homeless population and to monitor access to affected areas, taking into consideration the changes suffered by transportation system that shall be used for allowing the local, national or international rescuers to reach the affected locations, in case the size of the crisis requires international deployment.

It is therefore necessary to divide the areas into sectors which, taking into account the natural configuration and the degree of urbanisation, will be sized appropriately on the basis of the time needed by the rescue teams to be deployed after the event. This is necessary for the assessment and search and rescue phases including the assessment of those buildings/ infrastructure that may suffer extensive damage and will not allow for the evacuation of the occupants.

For a correct sectorisation, in addition to knowing the area and using all the theoretical tools that Local Authorities have contributed to define during the pre-event phase, it will be also necessary to draw up a pre-sectorisation plan.

Unlike in the past, the constant technological developments including satellites, computer systems and software, drones and social media will allow to improve the pre-sectorisation plan immediately after the event (post-event), and to adapt it to the aftermath of the crisis, thus providing optimal response based on the coordination of the deployed resources in order to allocate them where really needed during the rescue activities, with the ultimate goal to save as many lives as possible in the shortest possible time.

Why is it so important to prepare for wide-area assessments? An extensive knowledge of the effects of the disaster will allow a better evaluation of the resource needed and a better optimisation of their deployment. In this way, a major number of lives can be saved in the first 24 hours (Golden Day), statistically in that a period more than 80% of the victims found survive. This rate decreases to less than 10% after 24 hours.

1.2 Quick start guide

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1 ASSESSMENT?

Topic	Where
PRE ASR	2.1 / 3.1 / 4.1 and 4.2
ASR 0	4.1 and 4.2
ASR 1	4.1 and 4.2

What is wide area assessment and its phases?

2 DATA COLLECTION

Topic	Where
Population	3.1
Activities	3.1
Building vulnerability	3.1
Infrastructure	3.2.2

Collect data to prepare ASR before the event.

3 SCENARIO

Topic	Where
Calendar	2.1.2
Shake map	3.4.1
Barrier effect	2.2

Simulate different situations with scenario.

4 SECTORS

Topic	Where
Preparedness	2.3.3/3.3
Methodology	2.4
Outputs	2.5/3.2.3
Pre sectors	3.3

Build sectors in the territory linked to ASR.

5 ASR RESOURCES

Topic	Where
Satellite / Drone / Aerial	annex 3.6
Social media	3.6
Self - assessment	3.4.2

Inventory of the best tools available to do ASR.

6 RESPONSE

Topic	Where
Priorities	3.1
USAR resources	3.2
Plan of action	2.3.3

Organise and anticipate the response.

7 DISSEMINATION

Topic	Where
Method	3.9.1
Alert	3.9.2
Training	4.3

Share information and skills with partners

1.3 INSARAG and the importance of sectorisation

"The International Search and Rescue Advisory Group (INSARAG) is an inter-governmental humanitarian network of disaster managers, government officials, non-governmental organisations (NGOs) and USAR practitioners operating under the umbrella of the United Nations, UN, and within the realm of its mandate contributes to the implementation of the International Strategy for Disaster Reduction (ISDR). INSARAG was created in 1990 following the initiatives of the specialised international USAR teams who operated together in the Mexican earthquake of 1985 and Armenian earthquake of 1988"[1].

"The INSARAG Guidelines are an internationally accepted document that provide a methodology to guide countries affected by a sudden-onset disaster causing large-scale structural collapse, as well as international USAR teams responding in the affected country"[2]. These documents also describe the methodology for international Urban Search And Rescue (USAR) operations, explaining the minimum standards and procedures for building up a USAR team, as well as on training, readiness, classification and operations.

"Worldwide, fire services (volunteer and professional), civil defence, and militaries along with non-governmental organisations (NGOs) and charities have assumed a major role as primary responders to rescue incidents that involve, among other things, structural collapse, trench cave-ins, confined spaces, industrial and agricultural machinery water emergencies, and people trapped above or below grade-level. These emergencies are grouped into a category of rescue called technical rescue"[3].

All the rescuers, USAR teams, first responders, national or international teams, needs to achieve a technical capacity to realize operations on site in order to save people under the rubble. Indeed, "technical rescue incidents are often complex, requiring specially trained personnel and special equipment. Earth quake, precipitation, extreme temperatures and swift water currents often complicate technical rescue incidents. Also, the presence of flammable vapours and toxic chemicals can increase the level of risk.

First responders[4] everywhere the world perform technical rescues on a daily

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1 INSARAG Guidelines, 2020, Vol. I Policy, paragraph 2.1, **www.insarag.org**. The INSARAG Guidelines comprise three volumes: Volume I: Policy, Volume II: Preparedness and Response and Volume III: Operational Field Guide. The Guidelines can be downloaded from **www.insarag.org**.

2 INSARAG Guidelines 2020, Vol. I Policy, paragraph 1.1, **www.insarag.org**.

3 INSARAG Guidelines 2020, Vol. II: Preparedness and Response – Manual A: Capacity Building, paragraph 2 "Building Local Capacity", **www.insarag.org**.

4 First Responders are usually formed based on voluntary basis, although in some areas/countries, these types of services are provided by the fire services (volunteer and professional), Civil Defence and Military -

basis. Some complex technical rescue incidents may last many hours or even days as rescue personnel carefully assess the situation, obtain and set up the appropriate rescue equipment, monitor scene safety, and remove hazards before they can finally reach, stabilise, and extricate the victims.

The presence of hazardous substances or elements such as flammable vapours or dust often forces rescuers to take additional precautions and time to ensure that operations are conducted safely. Experience has shown that hasty rescue operations can endanger the lives of both rescuers and victims. At the same time, rescuers know that a victim's survival chances are often dependent on quick extrication and transportation to hospital. Some organisations are better prepared than others to perform technical rescue operations. To deal with complicated rescue operations, many organisations have created special technical rescue teams. A technical rescue team is a specialised group of personnel having advanced training and specialised equipment to safely and efficiently conduct complex rescue operations"[5].

An earthquake is a large-scale event that "may just involve one city or it may affect a wide area involving several cities and even more than one country. Geographical sectorisation of the affected areas can be needed to ensure effective coordination of Search And Rescue efforts"[6]. Sectorisation allows better operational planning, more effective deployment of the arriving national/international USAR teams and other responders so to better manage the overall disaster.

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"Sectorisation should be undertaken at the earliest possible stage of a disaster response to ensure its effectiveness. It is expected that the Local Authority or LEMA[7] should have a sectorisation plan in place and USAR teams should follow it.

However, if there is no sectorisation plan, it should be developed at the earliest possible stage of a disaster response and in close liaison with the LEMA. If the LEMA has no sectorisation plan, then a Wide Area Assessment may be necessary to get the relevant information to design a sectorisation plan, as it described in the following chapters"[8].

INSARAG Guidelines, Volume II: Preparedness and Response, Manual A: Capacity Building.

5 INSARG Guidelines 2020, Vol. II: Preparedness and Response – Manual A: Capacity Building, Paragraph 2 "Building Local Capacity", **www.insarag.org**.

6 INSARAG Guidelines 2020, Vol. II: Preparedness and Response – Manual B: Operations, paragraph 5.5 "USAR Coordination Method", **www.insarag.org**.

7 INSARAG Guidelines 2020, Vol. II: Preparedness and Response, Manual B: Operations, paragraph 3.6: "The LEMA is the ultimate responsible authority for the overall command, coordination and management of the response operation".

8 INSARAG Guidelines 2020, Vol. II: Preparedness and Response, Manual B: Operations, paragraph 5.5 "USAR Coordination Method", **www.insarag.org**.

1.4 Assessment Search and Rescue Levels

According to INSARAG methodology, a level is a type of work, normally needed during a major USAR disaster. This can range from initial assessment of the affected area all the way through to deconstructing a building to recover the last casualties.

"Having a clear definition of all the possible operational levels allows the coordination actors to be specific about planning, tasking, specific USAR operations needed as well as progress made"[9].

The five levels are identified and shortly described in Figure 1.1:

Annex B20: Assessment, Search and Rescue Level

ASR Levels	Descriptions	Definition and Purpose	Carried out who/when
1	Wide Area Assessment.	Preliminary survey of the affected areas for the purpose of developing the Sectorisation plan, BoO options and overall plan of action.	LEMA/UNDAC/first Responder few USAR Teams in country at the onset.
2	Sector Assessment.	Fast pace methodical assessment to identify viable live rescue sites within assigned sector.	USAR Teams assigned to respective sector.
3	Primary Search and Rescue.	Conduct in early stages – Fairly rapid progress through assigned worksite to maximise lifesaving opportunities.	USAR Team(s) assigned to respective side.
4	Secondary Search and Rescue.	Thorough search through all survivable voids involving full range of USAR capabilities usually at one worksite.	USAR Team(s) assigned to respective side.
5	Full Coverage Search and rescue.	Complete search of entire worksite to locate all life and deceased victims. 2 options for use complete delayering of collapsed structures or room to room clearance of non-collapsed structures.	LEMA, sometimes together with USAR Teams at the of rescue phase.

Fig. 1.1: INSARAG Guidelines – ASR Levels[10].

This Manual aims at explaining Level 1: ASR1 or Wide Area Assessment, referring to process statements intended to designate this particular moment in the organisation of rescue operations allowing to define the

9 INSARAG Guidelines 2020, Vol. II: Preparedness and Response, Manual B: Operations, paragraph 5.7 "Assessment Search and Rescue Levels", **www.insarag.org**.

10 INSARAG Guidelines 2020, Vol. III: Operational Field Guide, Annex B, page 44, **www.insarag.org**.

Wide Area Assessment Process (WAAP).

Chapter 2 includes all those activities that Local Authorities can perform during the Pre-event phase including Prevention and Preparedness activities such as using Civil Protection Emergency Plans and studying the parameters of their areas to draw up a Sectorisation Plan. This plan will contain all those elements that shall be useful after the event in order to save as much time as possible to perform ASR1 and subsequent phases, thus saving the highest number of people involved in the scenario.

Chapter 3 shall deal with what happens after an earthquake (post-event). To reach the "real and complete" ASR1 level it is necessary to go through another assessment phase: the initial action phase, where Local Authorities proceeds to overlay pre-event activities with the early information available post- event. This phase can be defined as "ASR0" and could also be carried out off site. Afterwards, it is possible to start ASR1 and sectorise the wide area using on site technologies to improve the awareness of "what happened."

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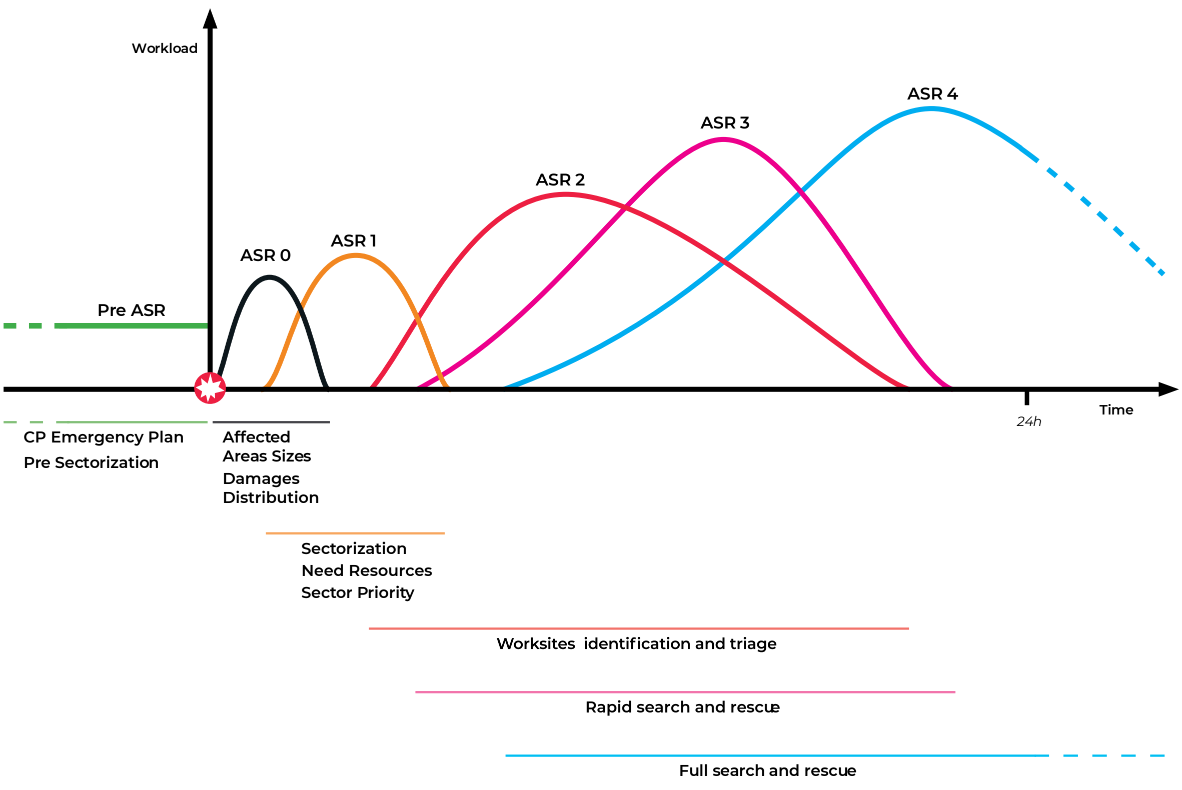

Fig. 1.2: ASR concept timeline

Figure 1.2 shows all these levels/phases using a timeline describing different actions that can contribute to the good organisation of the rescue operations if really applied.

A summary table with the hypothesis and cases described in this Manual is also present in Annex 1.1.

2 WHAT COMES BEFORE WIDE AREA ASSESMENT?

2.1 What Is The PRE Assessment Phase?

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According to the INSARAG Guidelines, Volume III, "Operational Field Guide", a Wide Area Assessment is the preliminary survey of the affected area in the aftermath of a crisis.

The purpose of this analysis is the awareness about at least these following elements:

- scope and magnitude of the event;
- location and types of damage, in terms of entire affected area with all its identifying natural and/or industrial man-made hazards;
- establishing priorities and resource needs;
- infrastructure issues;
- identify residential and strategically areas and buildings;
- locations for logistical issues;

considering any barrier effect on site, with main aim to:

- minimize the total number of fatalities;
- optimize performance of USAR teams during the first few days.

To reach such objectives, it is necessary to draw up a **sectorisation plan** that includes all the information that may be useful to first responders or incoming rescuers to avoid wasting time while deploying. The sectorisation plan is key also to: i) improve the services of the focus area; ii) prevent disasters iii) reduce consequences of a disaster (i.e. planning the infrastructure/building behaviour and building resistance to seismic strain).

2.1.1 Information Management

The "Information Management" process is a very important task of the preparedness phase for Local Authorities who have to preventively prepare themselves before a crisis, by capitalising on the Emergency Managers' experience to improve the safety of their area.

As shown in Figure 2.1, when a disaster occurs, Authorities on site need lots of information during the early aftermath and increasingly so as they want to know how to respond, while, on the other hand, information is likely missing and hard to get, thus growing very slowly. So, to fill this gap, preparedness is very important. Local Authorities have to prepare a pre-earthquake preparedness plan that identifies the future needs during the first few hours after the crisis as well as information gaps. By using for example, the contents of this manual, it is possible to gather the necessary information in a shorter time (dashed curve), thus providing a faster response after the crisis.

The information gaps, such as information flows between all the actors involved in the scenario and any other useful information that could save time when the local response will start, are shown in Tables 2.1 and 2.2.

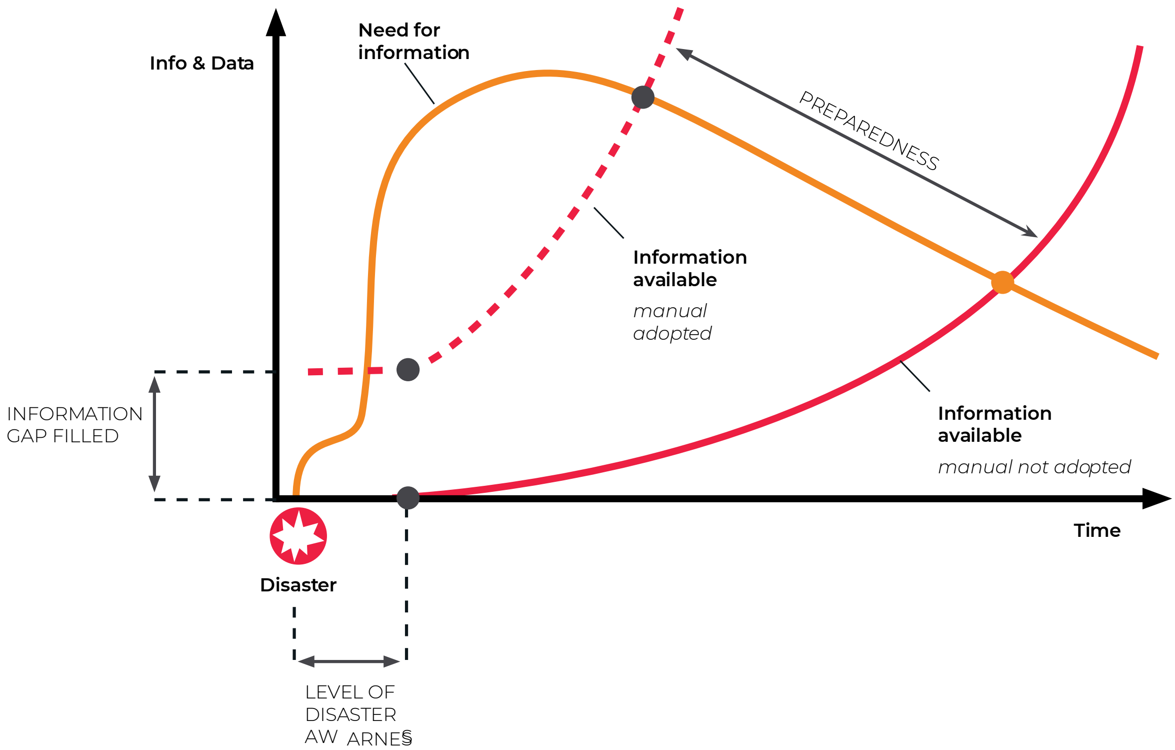

Fig. 2.1 – Information Trend when a disaster occurs: relationship between the need for information from the population and information available. Two cases are shown: if the contents of the manual are not adopted and the very high benefit using the preparedness (pre-disaster phase) by adopting the contents of the manual.

Information gaps
Estimated number of victims
Natural risks/vulnerable areas
Buildings' vulnerability
Key Infrastructure
Major Accident Hazards (MAHs) Plants
Remote areas (es. Rural areas)
Emergency and Civil Protection Plans
Safety and Security requirements
Coordination with other authorities
Lessons learned

Needs
Time management
Strategical/Logistical areas
ICT & network coverage
experts
First responders
USAR Teams
EM Teams
Civil-Military coordination
EU assistance
How to disseminate the information

Tables 2.1, 2.2 – Most common information gaps and likely needs of Local Authority in the aftermath of an earthquake.

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Assessment is a process that starts with preparedness. In the emergency response context, an assessment is an ongoing process by which available information is gathered, collected and analysed to prepare the response, i.e., make decisions. Thus, as shown in Figure 2.2, it can be divided in four different phases: Collect, Process, Analyse and Disseminate.

Fig. 2.2 – Assessment fundamental components: affected population, scenario. and rescue management are linked by the passing of time.

This process that ranges between the “collect” and “disseminate” phases is iterative (Figure 2.3): each step is built on the previous one so as to increasing levels of detail progressively. The findings of each phase drive the design and focus of next phase.

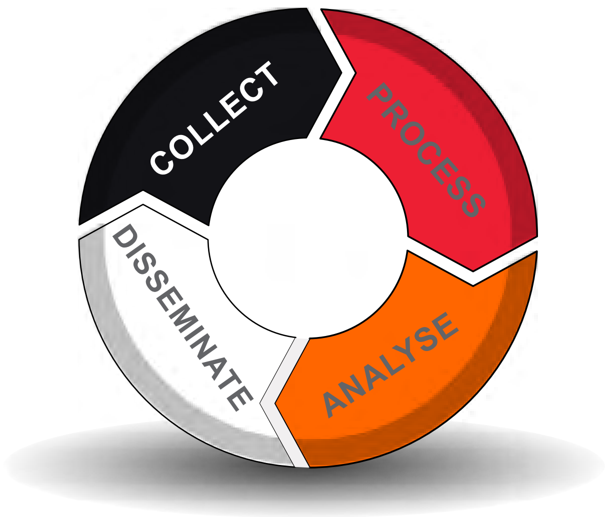

Fig. 2.3 The circular iterative process of Information Management.

The process always starts with collection of any previously available data to compare it with actual findings to identify the disaster impact. First, it starts with the big picture. Afterwards, it needs to go more in-depth on issues identified by this comparison. Assessment moves from a life-saving focus to an increasingly recovery-oriented focus.

Good situational awareness is key to an effective and accountable response. To achieve this, it is necessary to maximize one’s ability to make sense of the available information. Good information management, assessment and analysis are key interdependent processes that require careful planning and attention to context. It is also necessary to effectively communicate knowledge to others.

During the collect phase, it is helpful to use:

- maps, aerial and satellite imagery and street view;
- digital resources like pictures, video;
- any other useful information that can be caught with special equipment (i.e. drones).

Indeed, Local Authorities can improve existing Emergency and Civil Protection Plans and any document which is available for the area, like a seismic or landslide assessment, lessons learned from other similar emergencies and any other useful solution.

This information has to be processed for building a strategic document for the crisis. Then, it is important to Analyse all data to make correct decisions and to contain the consequences of the disaster.

At the end of the study, Local Authorities have to Disseminate data, e.g. with field exercises, as well as improving and revising the analysis.

2.1.2 Correlation Between Affected Population, Scenario and Rescue Management

After an earthquake, three factors are linked in the first few moments such as the **affected population**, **scenario** and **rescue management** as shown in the figure 2.4.

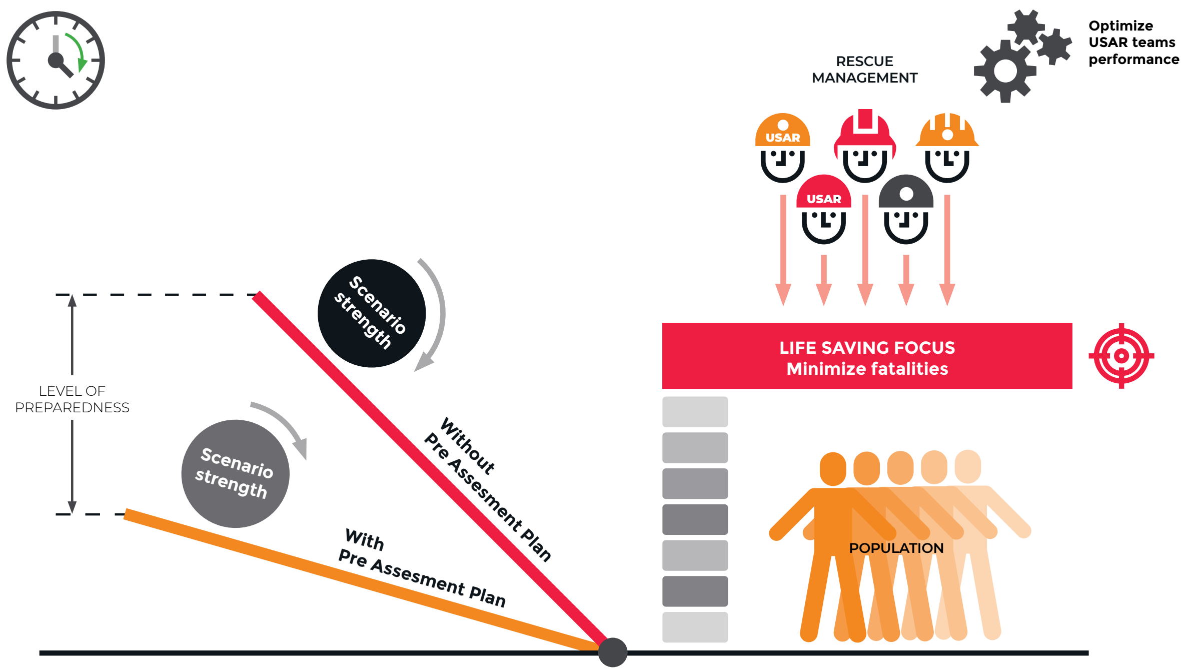

Fig. 2.4 – Assessment fundamental components: affected population, scenario. and rescue management are linked by the passing of time.

As described above, the purpose of this pre-assessment analysis is "**minimize the total number of fatalities – LIFE SAVING FOCUS**" optimiz-ing USAR teams' performance in the first few days". This goal is directly linked to the affected population and the optimisation of USAR teams and indeed it is important to correctly deploy the rescue teams as well as to take care of rescue management. The scenario and its characteristics are paramount and knowing its parameters and all available technolo-

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gies to have an extensive knowledge of the situation is key. The greater preparedness based on knowing the possible scenario, the parameters influencing it and the technologies available to evaluate and respond to it shall be, the less violent the impact of the earthquake shall be on the affected population as well as of the "scenario strength" due to the preparedness of the local authorities for reducing the impact on the area.

The Time is the most important element because the conditions of the affected population and of the scenario could change anytime when crisis occurs as described as follows.

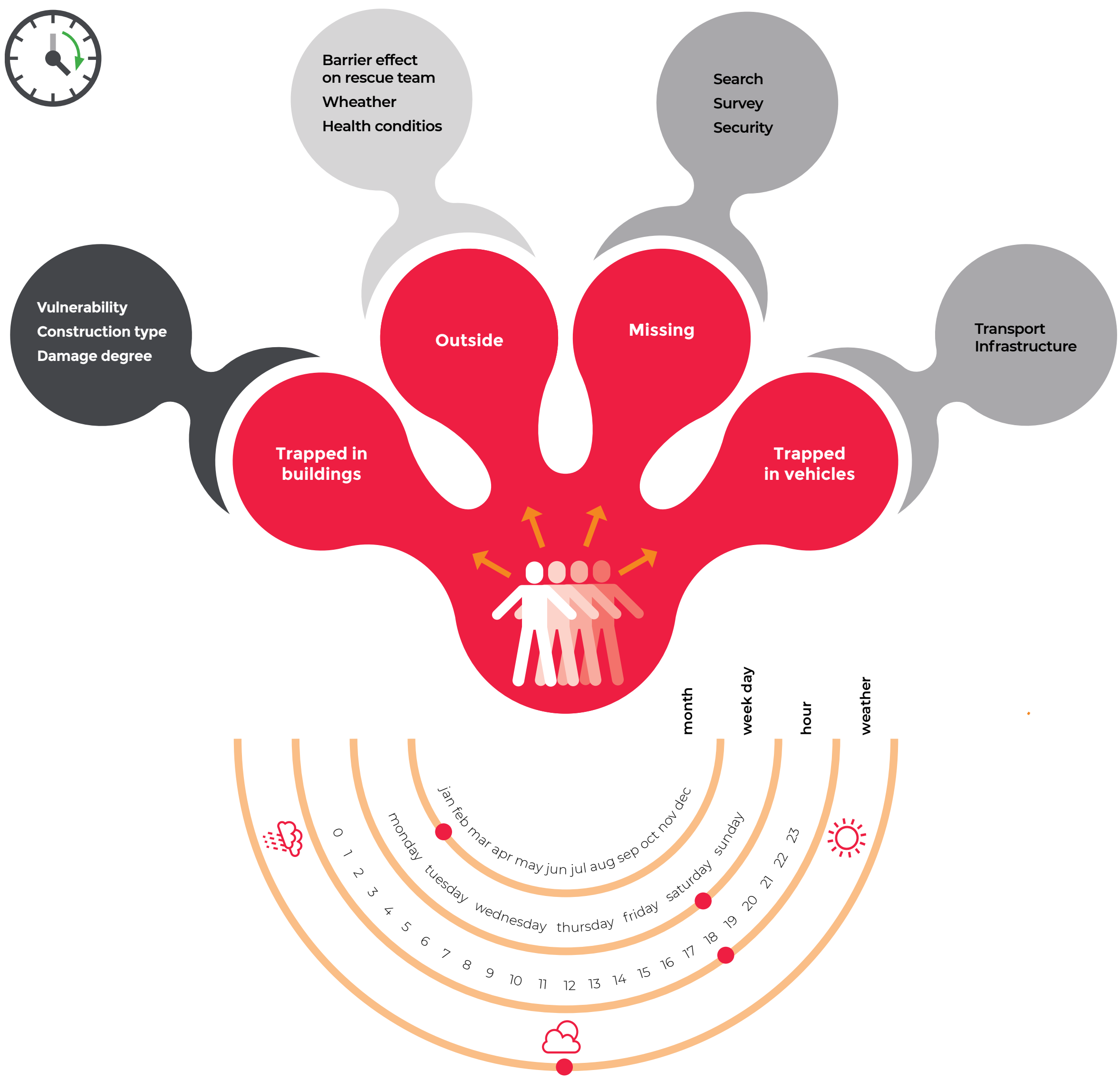

Fig. 2.5 – Some factors that affected population is involved in.

The figure 2.5 shows that when a seismic emergency takes place in urban areas, the affected **Population** could be trapped inside buildings or infra-structures, could be outdoor, could be in temporary safe conditions, or could be missing or trapped inside vehicles on the transport infrastructure. In this pre-assessment preparedness phase, in order to prepare a correct wide area plan, to rescue as soon as possible the population potentially trapped in buildings or vehicles, it is necessary that Local Authorities focus on being familiar with construction types and on the likely damage suffered by the constructions and infrastructure located in the affected area. Other important factors are knowing where high-occupancy, high-rise and low-rise buildings, rural or peripheral areas are located and the road network in order to reach them.

In order to consider the estimated number of likely victims is important to consider the "**time**" disaster occurred, whether daytime or overnight, since it can heavily change the number of people involved in the scenario.

Examples are provided by the number of passengers driving across the Morandi's bridge collapse in Italy in the morning of August 14, 2018 or in case of an earthquake hitting a summer resort town in winter time with ensuing low number of victims.

Furthermore, seasonality counts: if a sector includes summer vacation apartment buildings and the earthquake took place in winter time, the likelihood to have victims is very low and vice versa.

All these issues above are described to draw attention *to the sector that has the highest priority in terms of deployed teams to assess the situation:* thus, sectors including maximum **density of inhabitants** that live in highly vulnerable **ancient buildings** (e.g. masonry buildings) have priority as in case of an earthquake they could be extensively damaged with huge numbers of trapped people needing to be rescued.

Also, the affected population is subject to natural events as aftershocks and weather conditions or it may be needing medical attention, also for previous conditions or be subject to other different risks in the area resulting from aftershocks.

Last but not least, it is also necessary to think about missing people and therefore local Authorities have to plan for coordination with Police Department and other law enforcement agencies through research, surveys or security protocols.

Figure 2.6 shows, as Fig. 2.5, how important is that pre-assessment plan data about the expected degree of damage suffered by the buildings. For such reason, it is necessary to think about a sort of classification code to differentiate the damaged structures, the strategic buildings such as hospitals, governmental buildings and airports and other logistic facilities that are essential for rescue operations. To make the pre-assessment plans functional, it is necessary for the Local Authorities to be familiar with the road network for routes and access[11] to the areas and the sectors/

11 As detailed in Chapter 3, § 3.3.1

subsectors where an accountability and security system is essential after the event occurs.

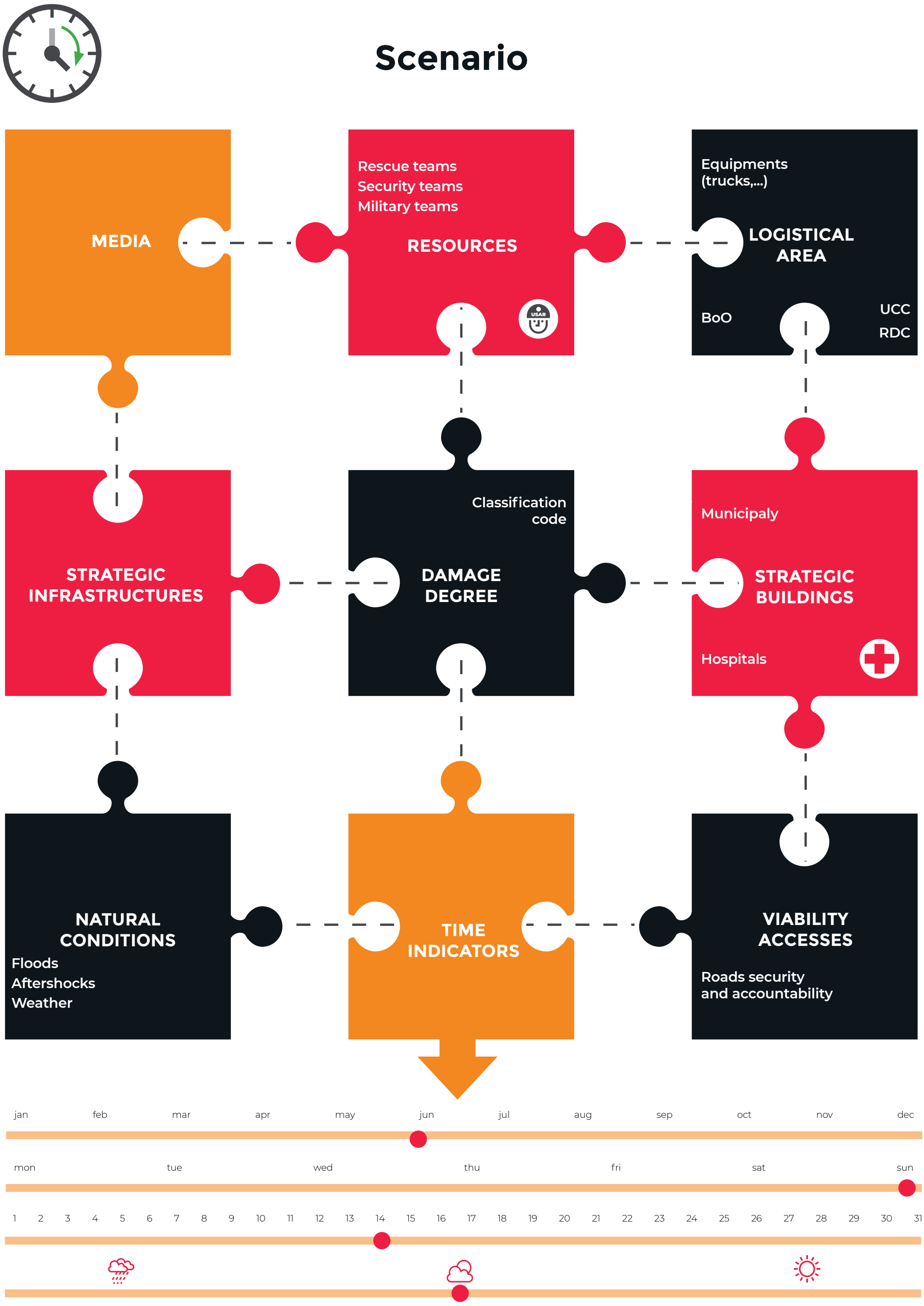

Fig. 2.6 – Main factors that influencing the scenario.

No disaster plan is likely to predict the exact circumstances to be dealt with but if it contains at least the elements above, it will allow to focus on the needs and the resources to be displaced in the affected area.

On the other hand, it will allow to deploy the resources (rescue, military and security teams) on site and shall also foresee natural events as after-shocks, flooding and weather conditions, under the media attention, that are barrier effects for the rescuers.

Local Authorities have to include all the issues above in the pre-assessment plan.

In the end, in order to complete the pre-assessment plans, as provided in Figure 2.4 and subsequent ones and for having a correct deployment of rescue resources on site, it is also necessary to consider the deployment of national or international resources, depending on the extension of the crisis area or if asked by the host Nation, as shown in Figure 2.7. These teams must reach the affected areas travelling through roads, highways, airports and harbours.

Moreover, the pre-assessment phase should consider barrier effects and their influence on the teams[12].It would be also necessary to facilitate the deployment of incoming USAR teams and their resources as vehicles, tents, equipment, identifying logistical areas for the Base of Operation (BoO) and the USAR Coordination Cell (UCC[13]). Furthermore, in case of international response, a Reception Departure Center (RDC[14]) for the incoming teams and other organizations would be also needed.

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The pre-sectorisation could be improved with the above-mentioned data, taking into consideration the scenario consequences' and the time needed for the teams that will deploy to reach the sector assigned to them.

In case of real event, like described in chapter 3, the analysis will be dynamic, and Local Authorities could improve it, during the crisis, with data about the areas that still need to be investigated with Search and Rescue (SAR) activities and which other ones have been already assessed.

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12 See §2a and the specific Annex 2.1

13 INSARAG Guidelines, 2020, Vol. 1- Policy, paragraph 4.3.8: The UCC is a specialised and integral part of an OSOCC during an earthquake or collapsed-structure emergency. If not already established by the national authorities/LEMA, it is established by the first incoming USAR Team to assist and coordinate multiple international USAR Teams during the search and rescue phase of disaster. Depending on the situation and in discussion with the national authorities an OSOCC may be established by the UNDAC team close to the LEMA and support the national authorities in coordinating international responders. The OSOCC coordinates international responders and supports the initial inter-cluster coordination mechanisms such as health, water, sanitation, and shelter.

14 INSARAG Guidelines, 2020, Vol. 1- Policy, paragraph 4.3.6: "As part of the needed support and if not already established by national authorities/LEMA, the RDC is established by the first arriving INSARAG USAR Team or the UNDAC team, in collaboration with local airport/entry points authorities. The RDC is established to coordinate the incoming international USAR Teams and other humanitarian assistance, and reports to the LEMA through the OSOCC. The RDC also serves as a tool to coordinate the departure of the teams in a proper manner.

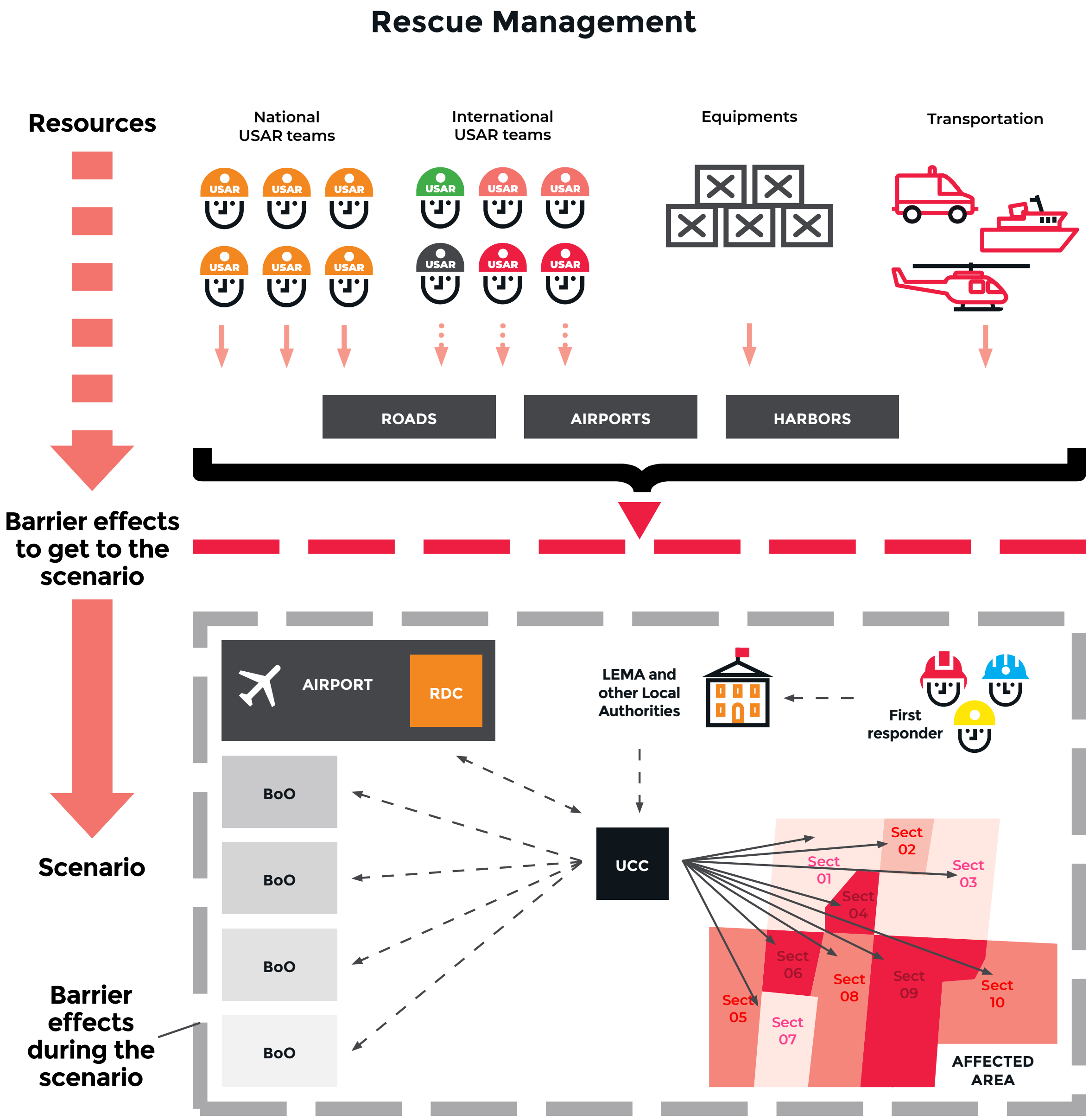

Fig. 2.7– Planning incoming assistance in the rescue management.

2.2 Barrier Effect

2.2.1 What Is A Barrier Effect?

A barrier effect can be any kind of obstacle due to a wide range of environmental factors such as: heavy snow, traffic due to damage to the road system fleeing in narrow/limited escape routes, road interruptions, non-coherent management of information flows (dissemination of false/fake information, correct information not taken into consideration, missing basic information). These factors can severely hinder the general assessment in SAR and a project called EASeR, also co-funded by European Union Civil Protection (**https://www.easerproject.eu**), intended to provide a practical strategy to carry out assessment in SAR more efficiently with a positive cascade effect on the general performance of all subsequent operations.

Some players that are involved in the assessment operations can play a critical role for the efficiency of the rescue missions and help in facing the barrier effects, as follows:

- National Civil Protection authorities at EU and extra EU level
- National Operations Centre
- Local authorities (e.g. self-government, municipalities, public administration on different levels)
- First Responders
- Assessment teams – all teams that carry out assessment activities in search and rescue (SAR) during emergency interventions in response to natural disasters and that face one or more “barrier effects”.
- Any other entities/teams involved in the assessment.

2.2.2 Which Barrier Effects Can Be Related To The WAAP/ ASR1 Activities?

Not all the barrier effects that were identified during the ESAeR project can be related to WAAP / ASR1 activities, thus the barrier effects linked to WAAP / ASR1 phase shall be identified in the following paragraph.

Each of the mentioned barrier effects will be described in the Annex 2.1 including examples to show the negative influence to the overall effort of emergency services involved in search and rescue operations.

1 Access to the Area

2 Time pressure

3 Communications & IT

4 Incident management and management of all the emergency

5 New technologies dependency and support

6 Media management

7 Use of aircrafts / helicopters and generally air, land and water vehicles

8 Activities outsourcing

You can access a video describing the barrier effect included in the EASeR project rationale following the link:

https://www.easerproject.eu/category/download/ .

2.2.3 What recommendations Can Be Drafted In Order To Face The Identified Barrier Effects?

Annex 2.1 describes actions, good practices, suggestions and examples of effective solutions to increase the effectiveness of response, avoid duplicating efforts, and promoting adequate resilience of regions and population in case of major emergencies.

2.3 How To Draw Up Sectorisation

2.3.1 Identification Of Needs: Example: USAR Needs

In order to reduce the timing of the sectorisation activities in case of a real event, it is necessary, during the planning phase called Pre-Event, to perform the following activities:

A) sectors were identified by local authorities (following the available data at local level)

B) If data coming from the local authority are missing, rescue teams have two options:

1 using data available from census to define affected areas

2 use other data sources if data from census are unavailable or missing.

Both options are described in Annex 2.5. while in Annex 2.8 a dedicated plug-in is described.

2.3.2 Local Authority Assessment Activities For Sectorisation

The Local Authority Assessment Activities For Sectorisation are:

- Defining the territorial framework, identifying Risks, urbanistic area and relevant territorial structures (dams, industrial area, airports, etc.);
- Identifying the Emergency Facilities and Emergency Areas;
- Identifying the road network, access points and Lifelines;
- Finding building data;
- Drawing up a sectorisation plan, using collected data and following the procedure provided for in the previous paragraph and summarised in Annex 2.6 (Local Authorities Data collection possibilities);
- Density of population in different time of day, week, season.

All these activities are described in Par. 2.3.3. Preparedness Plans and Sectorisation.

However, if no sectorisation plan was drawn up during the pre-event phase, it should be developed in close liaison with LEMA after the event. The suggested procedure to draw up a sectorisation plan is summarised in Annex 2.6, and it is based on easily available information while Annex 2.7 includes how to manage different sectors and working sites and assign names to sectors.

The concepts are summarised in Figure 2.8.

Local Authorities activities

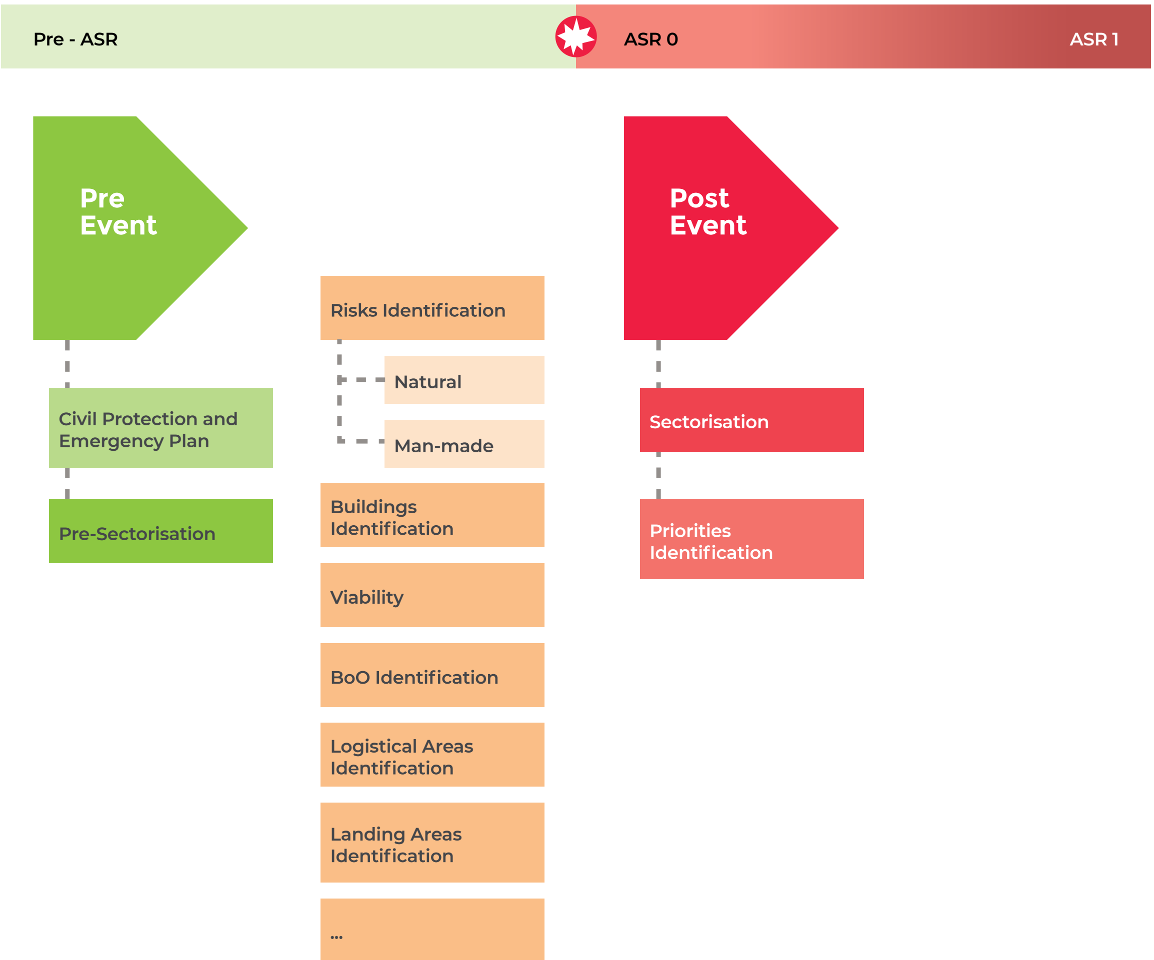

Fig. 2.8 – LEMA Activities.

2.3.3 Preparedness Plans And Pre-sectorisation

As described in the previous paragraph, the Assessment activities should be carried on by local Authorities of the area within their administrative limits, before the event, identifying a pool of experts who are familiar with the territory, well knowledgeable in emergency management and in using territorial and geo-database information systems.

Local Authorities should also inform higher-level Authorities of their work by sharing the results of the sectorisation. The feedback with higher-level Authorities is important also for the implementation and monitoring of planning resources as well as to identify the overall plan of actions. The information linked to the Preparedness and Sectorisation Plans should always be available to all the operative levels, also bearing in mind the worst case scenario so as to make them accessible, for instance storing them in the cloud.

The first step is to define the territorial framework to allow for the intervention of local resources and, in any case, for the intervention of external resources to support local ones. It can be done by describing the cognitive elements of the territory such as territorial references, orography, urban settlements and demographic data, geology data, hydrography and meteorological and climate context. For drawing up a better intervention model for the first emergency response according to the event scenarios, each type of risk should be considered; more details are included in Annex 2.2 (How To Analyse Each Major Risks).

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For a proper emergency management, it could be appropriate to identify all the potentially usable buildings, such as strategic infrastructure and strategic operating offices located in the local area whose operation during seismic events is key for civil protection purposes.

For emergency areas, in addition to reception of the population and first aid, the local authority, in cooperation with governmental authorities, should define the following two types of areas in the emergency plan:

- Rescuers and Resources Areas (BoO), in which to deploy the rescuers, the resources and the means necessary for rescuing the population. These areas guarantee a rational use of rescuers and resources in the intervention areas: they must be sized appropriately to accommodate the logistic structures and store the means and materials needed for rescue operations. They must be located in open safe zones, which are easily reachable from the main road network and, as far as possible, other than the population shelter areas, in order to avoid barrier effects. The Rescue and Resources Areas will be used for the entire period necessary to complete the rescue operations. It is important that local authorities identify such areas proportionally to the needs identified during the risk analysis phase.

- Emergency landing zones or heliports, necessary to reach areas that are difficult to reach and where the landing of rotary-wing aircraft is envisaged. The emergency landing zones allow to reach, by helicopter, areas which are difficult to access, thus allowing also for emergency-technical and health rescue activities.

The choice of emergency management facilities and emergency areas has to be linked to accessibility criteria based on road connections on a municipal scale. Useful information could be collected by local authorities in the planning phase on road network and roads data, highlighting any critical conditions present along the main access routes to and from the identified site.

Auxiliary Procedures and identification form regarding BoO Areas, Landing Area, and Road Network, are contained in Annex 2.4. (Auxiliary Procedures and Identification Forms For Local Authorities).

2.4 How To Build A Tool That Helps To Identify The Sectors

While the Local Authorities draw up the local emergency plan, it is necessary to always consider the rescue operations on site and the needs of the rescue teams.

It is important to underline that during a wide area assessment, the time factor is key for saving lives since the survival rate of survivors trapped under rubble decreases very rapidly over time (Fig. 2.9).

“Estimates of numbers of people being rescued alive after being buried under collapsed earthen building types in Italy, Turkey and China indicate that after six hours less than 50% of those buried are still alive.”[15]

For this reason, it can be assumed that, in order to increase the chances of survival for victims trapped under the rubble, the ASR1 phase shall be completed within 6 hours after the event.

15 Source: Coburn A., Spence R. (2002) - Earthquake protection - second edition.

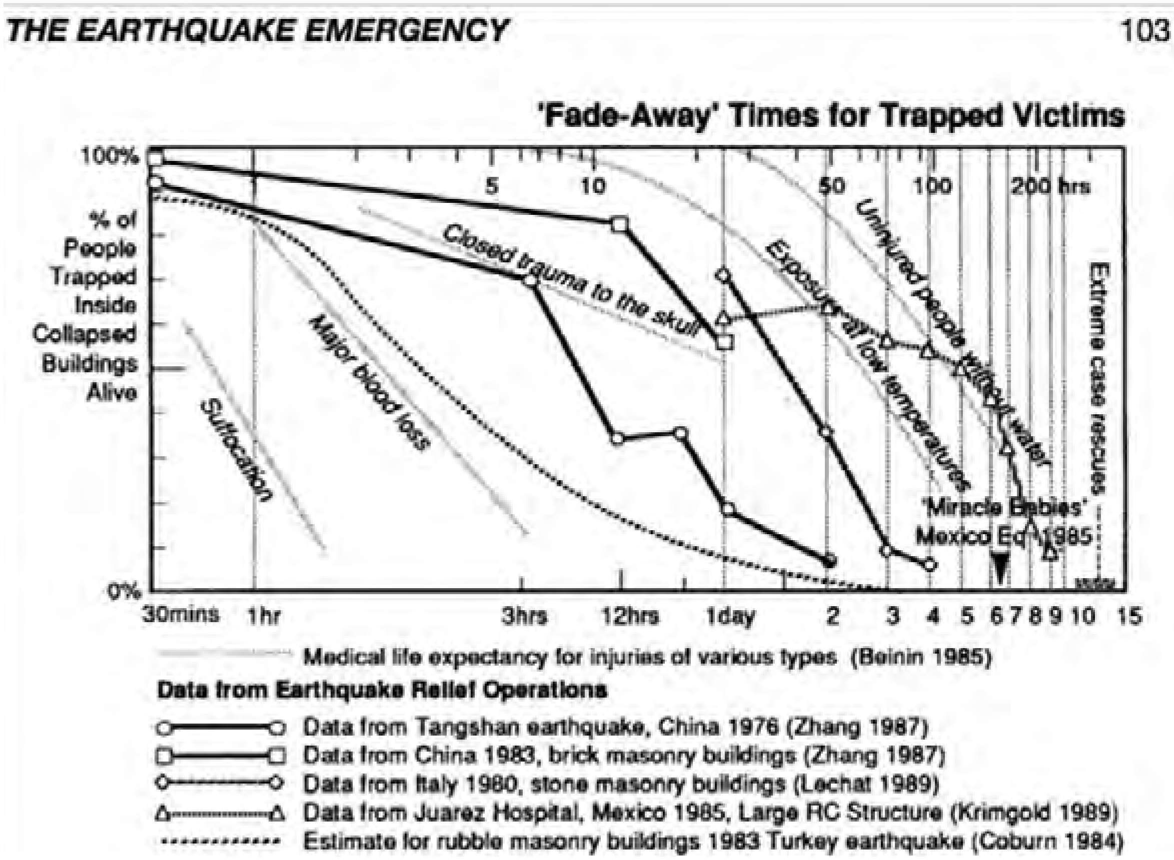

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Fig. 2.9– Survival rate of the people under the rubble in the last recent worldwide earthquakes

In particular, to find an appropriate **size of each sector** where, in the first few hours after the disaster, to deploy the rescue teams to fast pace methodical assessment and identify viable live rescue sites, (ASR2), some suggestions about how to optimize the size of sectors based on previous experiences and lessons learned about crisis that have stricken Italy and other countries in the world follow.

Although sectorisation, during the first phase of the emergency, is an indispensable activity for the coordination of relief on site, it has not yet been regulated in all countries. The few general indications come from the INSARAG guidelines which define the fundamental elements to be followed, leaving extensive space for the definition of any procedures. In other words, nowadays there is no shared procedure to follow for the sectorisation at a national and international level. On the other hand, it should be pointed out that sectorisation is a complex activity involving many aspects and data, including: data about the territory in terms of geographic conformation, urbanisation, natural risks, data about building's construction technologies, of course also being familiar with the activities of the rescuers, with particular reference to the timing for conducting the activities also in relation to the operational capacity that it is thought to be deployed on site.

Local Authorities have to identify the single structural aggregates on the maps (Figures 2.10, 2.11), understood as a set of buildings (structural elements) that are not homogeneous, in contact or with a more or less effective connection, which can interact under a seismic action in general. A structural aggregate can therefore be made by a single building, as it usually happens in case of reinforced concrete buildings, or by several buildings merged with generally different construction characteristics. The presence of external discontinuities gives rise to the identification of two very distinct structural aggregates. If it is not possible to identify in advance the presence or location of those discontinuities, it is advisable to consider the whole block as a single aggregate, provided that modifications can be made during the inspection on site.

Fig. 2.10 – Marina di Pisa, Italy - An example of aggregate of buildings – plan view

Fig. 2.11 – Marina di Pisa, Italy – In yellow a polygon, aggregate of buildings

The aggregates and the buildings that make them must be uniquely numbered on the maps, with a code assigned by Local Authorities, as well as with cadastral code if existing.

Within the structural aggregates, buildings are identified, defined as homogeneous units and generally distinguishable from adjacent buildings by construction type, height difference, period of construction, as indicated in Fig. 2.12 and Fig. 2.13 that show only four buildings of this aggregate.

The buildings therefore are unique static items and can be distinguished and identified on the basis of the following criteria:

- period of construction;
- construction materials;
- including floors at different heights.

The identification of buildings is not always easy and unambiguous as shown in Fig. 2.12 and Fig. 2.13, especially in case of aggregates of typical masonry buildings of historic centres. A masonry building can be defined as a building with structural continuity, delimited from top to bottom by load-bearing vertical walls.

In case of reinforced concrete buildings, the definition is generally less complicated since, in general, buildings are considered isolated from spaces or joints, in which case the building and the aggregate coincide.

Fig. 2.12 – Marina di Pisa, Italy - Four buildings belonging to the aggregate – plan view

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Fig. 2.13 – Marina di Pisa, Italy - Four buildings belonging to the aggregate – front view

2.5 Sector Sizing

One of the objectives, during the writing of the Manual, was to try sizing the sectors during the sectorization phase (ASR1), in order to be able to ASSESS them quickly and effectively (ASR2).

We can try to reverse the reasoning.

If the assessment within the sectors (ASR2) is carried out quickly and effectively, it means that the sectors have been dimensioned correctly.

From the diagram (fade away times for trapped victims) illustrated in the previous paragraph we can deduce that the total assessment activities (ASR1 and ASR2) should be completed in a maximum time of 9 hours.

How described in the previous paragraphs, the wide area assessment (ASR1) must be performed as shorter as possible and in a maximum time of 6 hours. Therefore, math and previous experiences indicates 3 hours as the maximum time to assess the assigned sector, “tmax”; thus, tmax = 3 hours.

The maximum time to assess each affected building depends on its size, destination and number of people living in it.

In general, this time is estimated between 15 and 20 minutes, considering also the time used by the team spend to move between buildings; if each team could complete, quickly and effectively, the damaged building’s assessment in 15 minutes, then *the number of damaged buildings assessed per hour* “$\mathbf{n_{ba}}$” is 4, hence **$\mathbf{n_{ba}}$ = 4 buildings/hour/team**. We deduced this data from real experiences and from an exercise carried out in Poggioreale, where the assessment teams, despite the barrier effects, identified six work sites in an hour and a half.

Following the "span of control" method, in order to have quickly and effectively coordination, we can hypothesize that a maximum of 5 assessment teams can be assigned to each sector (**"A_T"=5 teams**).

So, to determine the size of each sector, *the total number of buildings to assess per sector* **"N_b"** can be chosen in according to:

$$N_b = A_T \cdot n_{ba} \cdot t_{max} = 60\ buildings \quad (1)$$

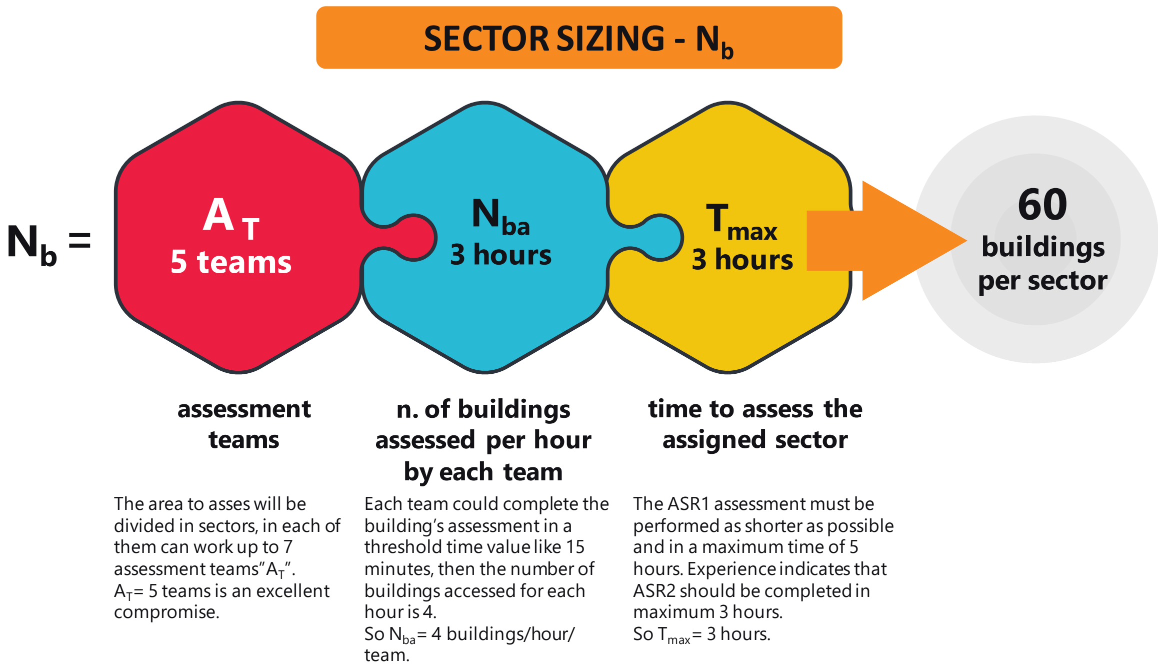

Fig. 2.14 – Sector sizing: Total N_b of buildings assessed per sector

The *maximum number of buildings to assess for each sector*, **"N_{bs}"**, is function of the buildings' characteristics as their construction's parameters, age, type and their population density (high-occupancy, high/low-rise buildings); also the viability represents a critical issue to consider in the analysis. These factors can be very variable and highly dependent on the site affected by the event. In order to take into account the typology of building, the population density and the accessibility on the site to the teams, factors whose degree of knowledge by the Local Authorities is very variable, it is possible to group them in a coefficient "δ" that deducts 20% of the result obtained in the formula (1) in order to achieve a conservative reduction in the workload of teams which, in case there are heavy damaged buildings, they need more time to carry out the assessment but, on the other hand, where there are poorly affected buildings or infrastructure without presence of people, the teams, after they have completed the analysis, can be used by the Coordination Cell in other sectors. With these considerations, starting from the formula (1) it is possible to obtain as maximum sector's size:

$$N_{bs} = N_b \cdot \delta = 60 \cdot 0{,}8 = 48 \approx 50 \; buildings \qquad (2)$$

For maximum optimization, the number to consider is *50 buildings*. Of course, such number can be modified since, in practical cases, it depends on the environmental and man-made borders and the size of the town.

Fig. 2.14 and 2.15 show a synthetic description of the steps that can be followed while applying the formula.

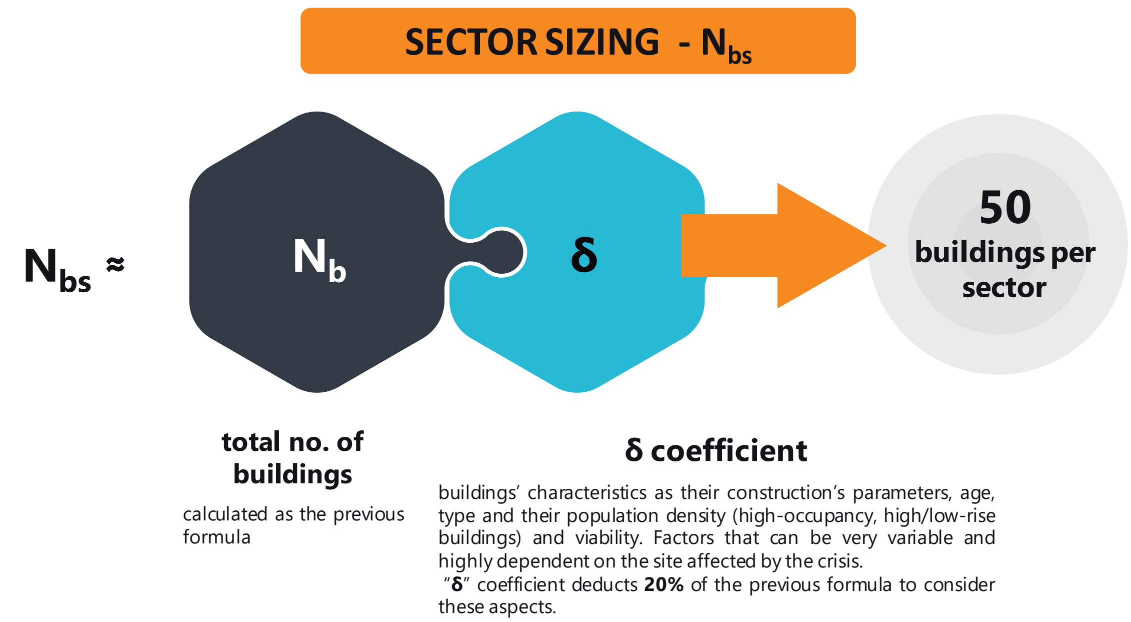

Fig. 2.15 – Sector sizing - Maximum Nbs of buildings assessed per sector considering buildings' parameters, population density and the accessibility.

Such elements, as already mentioned, are described to focus on the sectors that have the highest priority to be assessed: i.e. the sectors having maximum density of inhabitants living in ancient buildings (e.g. masonry buildings) are the most vulnerable. Such sectors are very critical in case of an earthquake because they could suffer have a huge degree of damage with very large numbers of trapped people that need to be rescued.

Figure 2.16 shows a densely populated residential area in Istanbul (Turkey). According to the criteria shown, the sector containing about 50 buildings will have a limited surface area compared to rural or low population density areas (see Annex 2.3 for details). In the case shown here, for example, the sector, highlighted by a white line, will have a limited surface area because it has a high density of buildings and population.

Some other examples of sectorisation adopted in some recent earthquakes are given in Annex 2.3.

Fig. 2.16 – Istanbul, Turkey. Residential Area. Maximum Nbs of buildings assessed per sector.

2.6 Local Authority Provides Data For Pre sectorisation

According to the INSARAG guidelines, this activity is initially performed by local Authority which, thanks to their knowledge about their territory and preventively before the event, can perform the sectorisation. In case such activity was not previously carried out by the Local Authorities, it can in any case be carried out by the first emergency teams supported by Local Authority during the emergency.

Of course, nobody knows the territory and its features better than Local Authorities and as a result, the information flow at the basis of sectorisation during preparedness can be an important opportunity for getting to know the strengths and the weaknesses of the territory.

Annex 2.6 (Local Authority Data Collection Possibilities) describes in detail a possible tool which is useful for pre-sectorisation.

3 AFTER THE EVENT, DRAWING UP ASR1

3.1 Assessing The Situation, From Pre ASR To ASR1 Through ASR0

Chapter 2 described the Pre-ASR phase or, in other terms, what the Local Authorities have to do in order to manage correctly the crisis and save as much time as possible to reach the main targets: save lives by optimizing resources management.

As the statistics in the lessons learnt about the earthquakes around the worlds explain, in six hours 50% of the buried victims can be found and saved.

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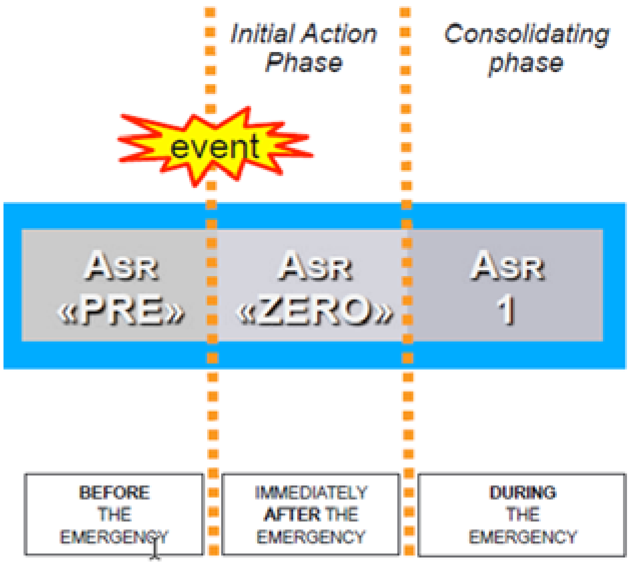

Fig. 3.1 – Reaching ASR1: starting from Pre ASR in pre-event time and then, after the event, reaching ASR1 passing from ASR0

Referring to Figure 3.1, the occurrence of an earthquake initiates the awareness phase[16] that, starting, as described in Chapter 2, ranging between

16 See figure 2.1, Chapter 2.

the pre-event activities, and getting to know the situation in a cyclic work where on-site details grow over time.

Thus, during the early times after the event, Local Authority/first responders/USAR teams present in a country start an initial action phase, proceeding to overlay pre-event activities with the first information available post-event. This phase is what can be defined as “ASR0” and it could also be carried out off site.

In case of an event, in order to identify priorities and urgencies, it’s necessary to assess the situation to identify the maximum affected area and the distribution of the damage above it. All reports concerning an earthquake and available data/information during a seismic crisis must be carefully analysed to identify their soundness, the priorities, the urgent actions and the operations required. Assessment shall be thorough while decisions must be made and actions must be taken quickly.

After the initial action phase, cyclically, it is necessary to complete the analysis with the “real” ASR1, during the **consolidating phase**. It’s a more detailed picture of the situation obtained overlaying the initial action phase result with other information that will come from:

- operators/staff on-site;
- helicopters and drones;
- satellites.

Performing these two phases (ASR0 - initial action phase and ASR1 - consolidating phase) it is possible to suppose what may have happened to the survivors using a set of known facts plus some carefully considered assumptions. It is also important to re-assess all scenarios and assumptions regularly as new information becomes available. This process is particularly critical.

As a result, Local Authorities have information about the situation that makes it possible for them to make an informed decision after the event.

All this flow is necessary to best perform the other following phases of Assessment Search and Rescue during the emergency, described in INSARAG Guidelines, as shown in Figure 3.2:

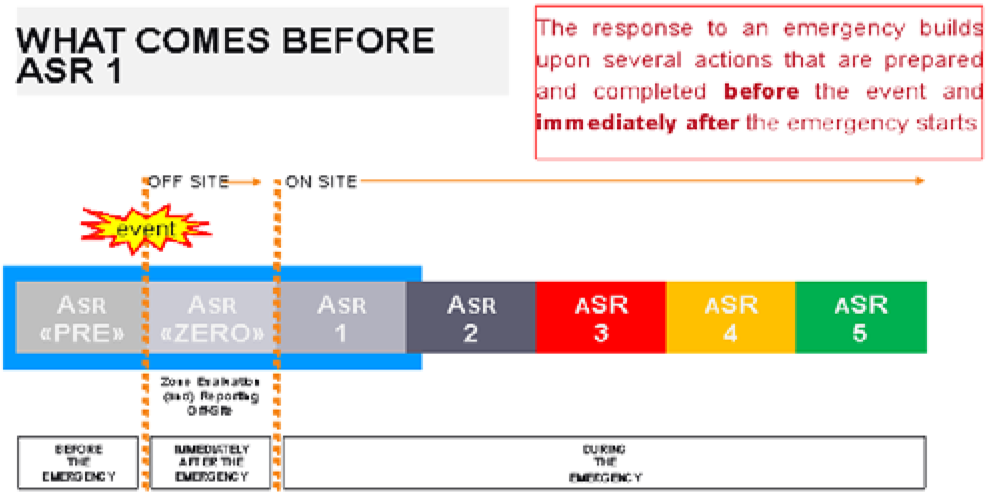

Fig. 3.2 – Reaching ASR1: starting from Pre ASR in pre-event time and then, after the event, reaching ASR1 and other following phases

During this assessment, it is necessary to consider some factors as "aggravating" factors occurring at the same time of the event while mitigating factors are distributed over the time, as shown in figure 3.3.

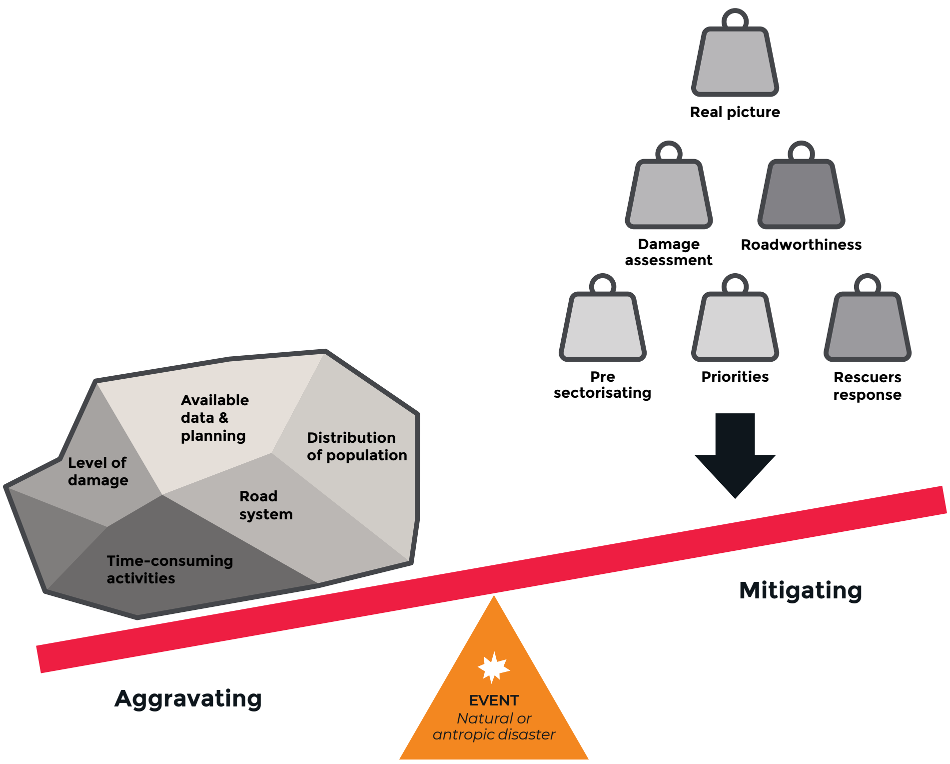

Fig. 3.3 – balance between aggravating factors and mitigating elements

Before the event it is the time to pre-assess and pre-sectorise (emergency plan, risk identification, buildings identification, BoO identification, Landing Zone areas) while after the event, Local Authorities need to obtain a near real-time situational awareness as soon as possible (Buildings identification, road access, BoO identification, Landing Zone identification, Sectorisation plan, Identify priority). This cyclic phase is continuously updated each time new data are available.

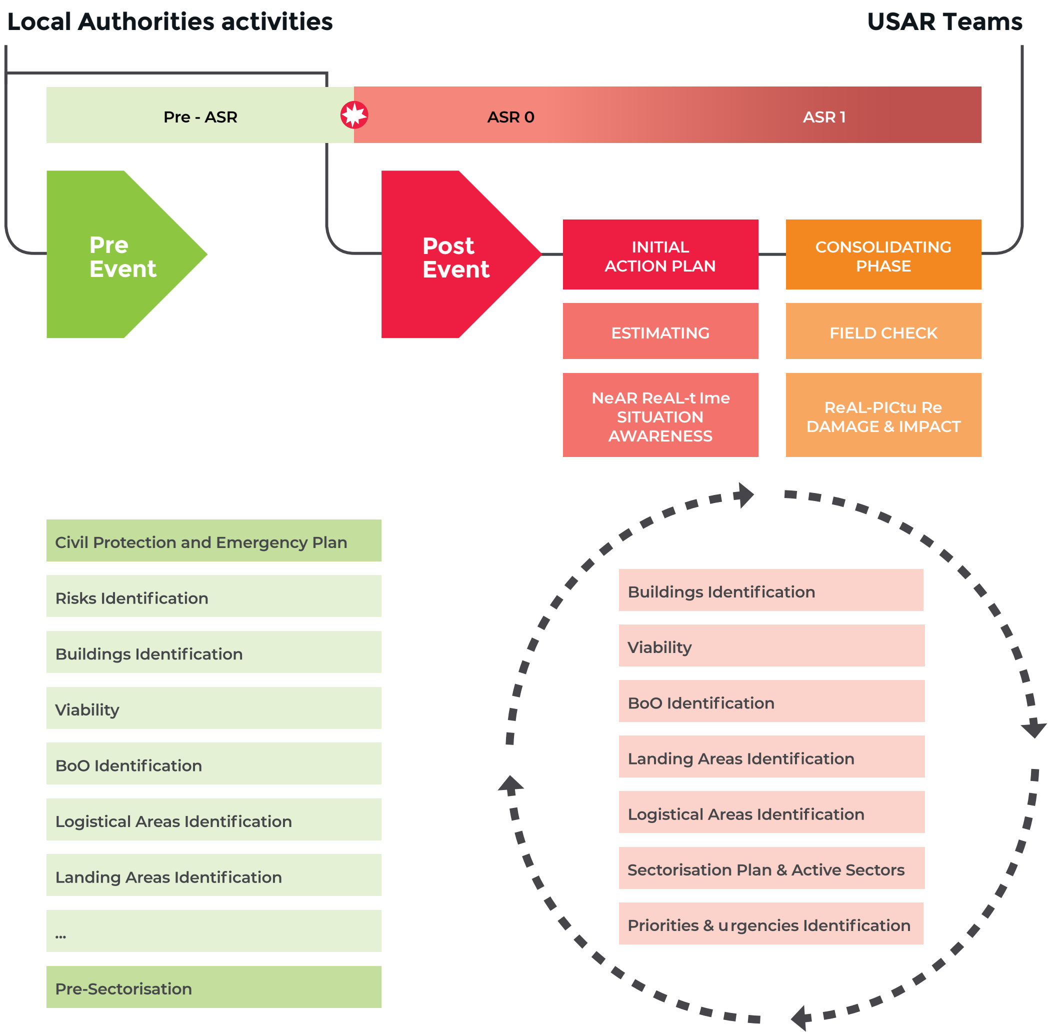

Fig. 3.4 – workflow path.

During the initial action phase the first information could come from:

- scientific community;
- “last minute” information from LEMA;
- information from social media.

This phase is usually performed determining the maximum area reasonably including damaged buildings with their level of damage based on a macro seismic scale and overlaying the factors that could change heavily the number of people involved. Thus, as described in Chapter 2, "time" when a disaster happens is a very important element to manage because it is essential to consider people's location when the disaster strikes the buildings or the infrastructure.

Indeed, if the disaster occurs in daytime or overnight, the number of people involved in the scenario can change heavily just like if the earthquake takes place during the winter in a summer resort, the likelihood to have victims is very low. But there are also other special conditions such as a concert or other aggregations at a stadium or during other events that could not be previously predicted, or else industrial areas where during daytime when there is a large number of workers who nonetheless do not reside there, thus leading to not consider such areas as densely populated[17].

On the one hand, some of these, **"time-dependent factors"** are therefore directly linked to time, i.e. while other **"time-independent factors"** are not.

The main time-dependent factors are:

- **density of inhabitants**: how many people live in that area or building;
- **building's primary occupancy**: residential, commercial, offices, strategic, public services, school, industrial, agricultural, etc.;
- **building's damage level**: aftershocks and migration of epicentres could aggravate the level of damage over time. A damaged building may present progressive damage phenomena thus making it a time-depending variable that should not therefore be seen as a constant.

The main time-independent factors are:

- **building's period of construction**: it is important to have information about when the building was built and, in some cases, when it underwent significant structural renovation. Period of construction is relevant for the construction materials that were used. In general, modern buildings could be built with seismic criteria and so they are more safely than older ones;
- **building's typology and configuration**: type of construction (e.g. reinforced concrete frame, concrete shear wall, steel frame, masonry, wood frame, etc.) and its main geometric characteristics (e.g. high/

17 Some of these concepts are described in Annex 3.7

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low-rise buildings, industrial, rural, etc...).

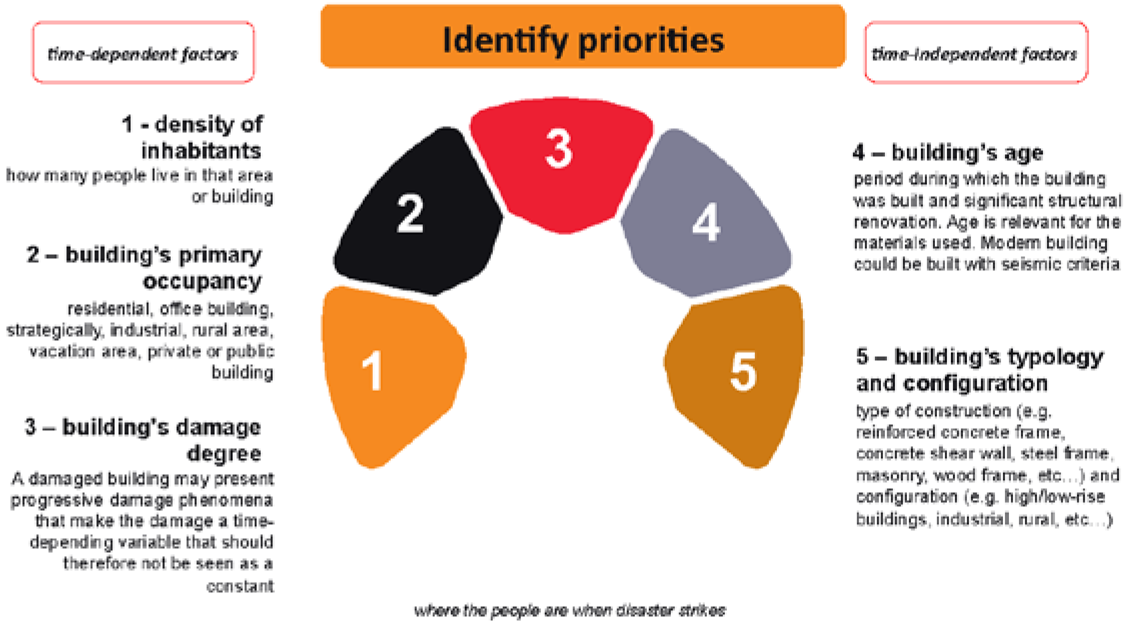

Fig. 3.5 – identify priorities: time-dependent and time-independent factors

All above factors (Fig. 3.5) are interlinked. The number of victims may depend on their combination at the time of the earthquake and Local Authorities should play a strategically role in providing information related to those factors, starting with drawing up a pre-assessment plan defining also the resources to be deployed in case of an earthquake.

Knowing where the possible damage may be on the basis of a macro seismic scale allows the search planner to set priorities so that, in the early stages, Local Authorities can decide where to deploy resources.

The operations described are led by Local Authorities so as to obtain a near real-time situational awareness that is the only way to identify urgently the needs immediately after the event. In this way, it is possible to reach post-event informed decisions linked to expected exposure of structures, lifelines, utilities and transportation corridors, worksite ranking.

3.1.1 Safety And Security Issues

While planning the deployment of rescue teams, the assessment of the general Safety and Security conditions of the identified affected areas should also be included.

Safety could be linked to chemicals in industrial areas, the risk they pose, the presence of personnel, and also dangerous industrial processing.

Security is defined as areas at risk within special local conditions such as at risk of looting, due to the presence of banks, ATMs, jewellery, prisons and any good on site that are on site that could be stolen by people having easy access to damaged structures containing them. Security is also linked to the coordination activities performed by Local Authorities to search for missing persons in the first aftermath of the earthquake, with Police Department and other law enforcement agencies through research, surveys or security protocols.[18]

3.2 Priorities And Basic Elements

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The constant comparison between the operational response and request is one of the most important elements of planning.

In the early stages of a macro emergency such as an earthquake, there is no balance: the available teams are limited in number to cover the needs of the scenario so it is important to identify priorities.

Local Authorities are the entities that have to set priorities and urgencies because they know the characteristics of their territory, its needs and weaknesses.

Typically, the effectiveness and efficiency of the operational response depend on the balance between the available data about the territory and the operational response, as described in Figure 3.6 that are the main characteristics that should be identified for each component of such balance.

18 As described in chapter 2, paragraph 2.2.

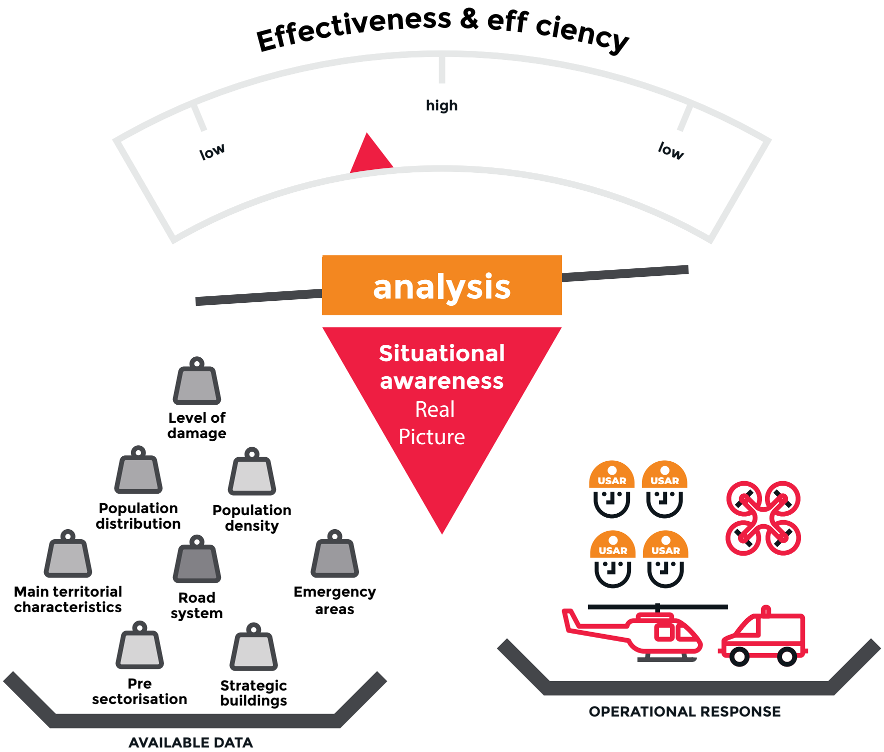

Fig. 3.6 – operational response' effectiveness and efficiency

The availability of accurate data and territorial distribution is a prerequisite to assess active sectors along with their priorities and urgencies.

Knowing the operational response, from the first local responders and national/international teams allow Local Authorities to define a deployment plan of the resource based on priority and urgency (rescue management).

3.2.1 Active Sector

An active sector is simply a sector in which rescue teams are needed because Search and Rescue Operations are necessary. Figure 3.7 shows the relationship between areas, sector and active sector. In fact, when an area is affected by the event, some sectors may have suffered damages while others may not. For management convenience Local Authorities should divide the wide area under their administrative limit of competence into different sub-areas, Area1, Area 2, ..., Area no. Each area shall then be divided into sectors.

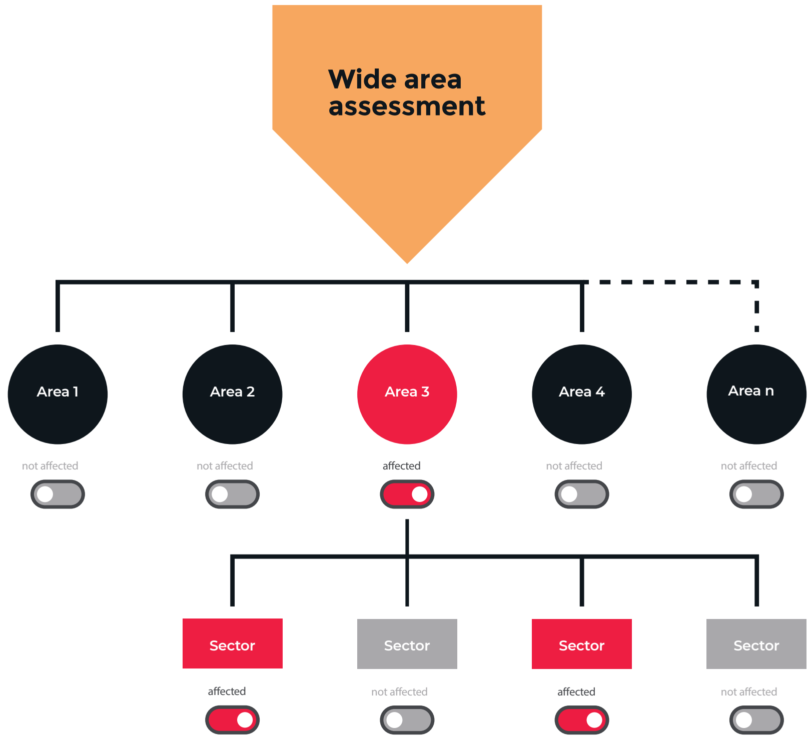

Fig.3.7 – Areas, sectorisation and active sectors like outcomes of wide area assessment

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By doing so, the first pre-sectorisation plan is drafted and Local Authorities have the possibility to define the size of the rescue operation which shall be necessary to operate in all the active sectors and, in general, deal with all the critical issues.

3.2.2 Strategic Buildings And Areas

Strategic buildings and strategic areas shall be identified exclusively for the rescuers. These areas are important in managing the arrival of rescuers, in order to avoid traffic jams in the access roads leading to the most affected areas.[19] For this reason, a logistical area must be identified for rescue vehicles, also located miles far away from the affected area assigned to the team, where the early registration of the rescue teams, entry points, takes place.

The helicopter landing areas are also strategic, as the use of aircraft allows to speed up the response time and overcome some of the barrier effects that are normally found during a disaster. By the same token, the area for setting up the Base of Operations shall be quickly identified among those previously identified in the emergency planning.

19 e.g. barrier effect see Annex 2.1

It is evident, as for the sectorisation and preparedness both key, how important it would be to identify the strategic areas in "peacetime", so as to be able to save precious time during the first post-event phases (ASR1), as described in chapter 2.

3.2.3 Situational map

The completion of the previous phases, including pre-sectorisation and its updating, provides a cartographic base that faithfully represents the near real-time situation of the main elements necessary for the rescuers[20].

Below are reported the main element represented in this technical map:

- location of strategic buildings and access to them;
- location of emergency areas and whether they can be accessed;
- main territorial characteristics;
- distribution of population densities;
- areas, affected areas, sectors, active sectors and their level of damage.

Strategic buildings, strategic areas, sectors and active sectors (basic elements used to face the real situations) are linked together through the access infrastructure thus building a sort of network which could be defined as "**access infrastructure network**".

The entire area affected by the event will be accessed through the primary access infrastructure network, which is the main general access roads, while the elements described above are linked together by the secondary access infrastructure network. So, while drawing up the map, the road system plays an important role. In fact, access infrastructure plays a fundamental role in identifying the boundaries areas of intervention within each sector.

Generally, sectorisation is carried out on the basis of the identification of the base elements listed above and of the access infrastructure, attributing the level of damage of the buildings to each sector.

3.2.4 Access Infrastructures Network

Access infrastructures network is an essential element because it allows to reach the sectors, the intervention areas and the worksites. Related details are clearly described in Annex 3.1.

20 Technical map with a level of definition not less than a scale ratio of 1:10,000.

3.3 Pre-sectorisation And Sectorisation Cases

Depending on the previous assessment activities that Local Authorities have carried out, there can be two different sectorisation cases:

- pre-sectorisation plan available;
- pre-sectorisation plan not available.

In the first case, it's possible to complete ASR1 by using available elements and tools and starting ASR2 directly as soon as the rescue teams are deployed on-site.

In the second case, the rescue teams will carry out sectorisation, using a methodology agreed with the Local Authorities, also during the mobilization if possible.

In any case, all the activities shall be verified with damage assessment methods and approved by the Local Authorities before the teams start ASR2.

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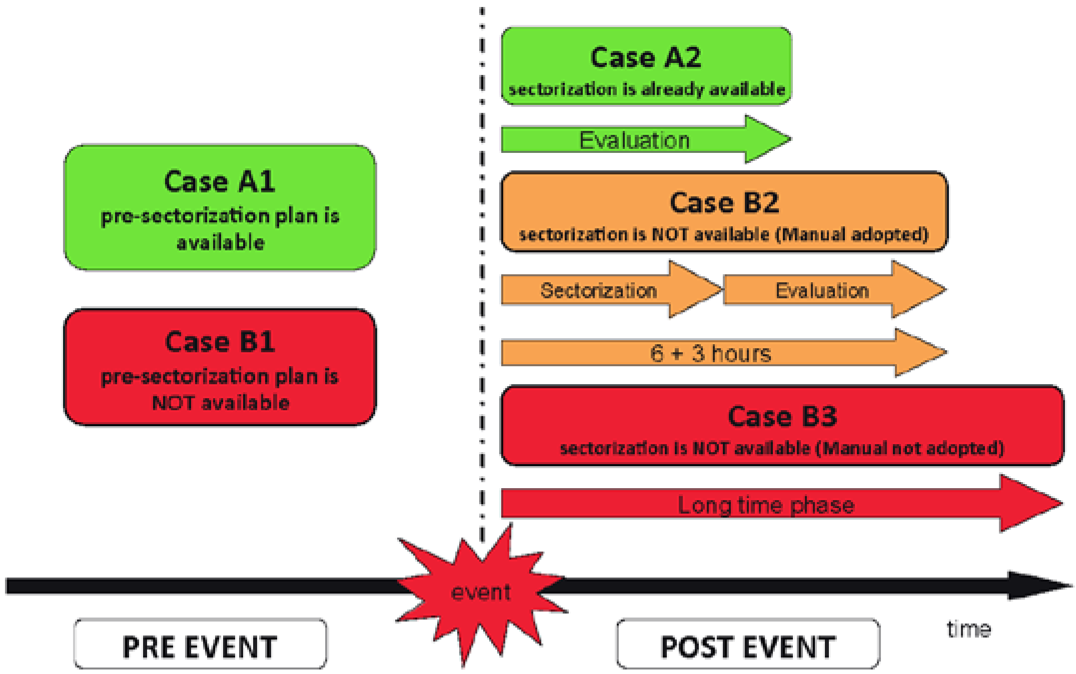

Fig. 3.8 – Sectorisation Phases Scheme

Figure 3.8 shows that the difference between the two cases is time.

However, the main topic of ASR1 is to get near real-time situational awareness to make informed decisions for post-event response and it's important to draw up plans and collect data: in the first case using the available data too, while managing only the collected data in the second one.

Reasonably, a wide area assessment referred to the pre-sectorisation plan if available, shall be completed within 6 hours following the event, otherwise, many rescue teams would already be deployed on-site and it would become difficult to effectively coordinate the operations. As a result, informed decisions for post-event response must often be made while information is still incomplete.

Starting from the reference time, it is understandable that it is important to draw up plans and collect data, even to achieve a pre-sectorisation, during the pre-event phase, as these operations can hardly be carried out in the early hours of the post-event phase.

3.3.1 Pre-Sectorisation Plan Available

As described in Figure 3.8, the following cases can be identified:

PRE EVENT – Case A1:

The Local Authorities have drawn up a **pre-sectorisation plan** as prevention activity on the basis of the methodology described in Chapter 2. It may include any useful information to be easily found including a technical detailed map with a good level of definition. This should be available to the rescuers on the Local Authorities' websites.

POST EVENT – Case A2:

Rescuers may find the sectorisation ready and fastly available while mobilising. Through the information acquired about the wide affected area and the priorities indicated by LEMA, it is possible to complete ASR1 using available elements and tools, timing defined as "**assessment**" time. Then, the ASR2 activity shall be completed and the rescue of victims trapped under the rubble shall be planned in a short time.

3.3.2 Pre-Sectorisation Plan Not Available

PRE EVENT – Case B1:

Local Authorities have neither drawn up a **pre-sectorisation plan** nor the plan is provided to the rescuers or it is difficult to analyse it to find the most useful information for their activity. The situation could evolve to cases B2 or B3 described below.

POST EVENT – Case B2 – Manual Adopted:

In this case, rescuers have to carry out the **sectorisation** *using the methodology described in this manual*, in agreement with Local Authorities. Sectorisation is made during mobilization, but it has to be verified with damage evaluation methods and approved by Local Authorities. Then, it will be possible to complete ASR1 using available elements and tools.

ASR2 shall then be completed and the rescue operations shall be planned. Timing shall not be as fast as in the previous case A2 because there are two main phases: the sectorisation and assessment time as shown in Figure 3.8. To perform the rescue activities at best, both phases should be completed in maximum 9 hours[21].

The following Figure shows the main points along with available elements and tools (see Annex 2.5 for details).

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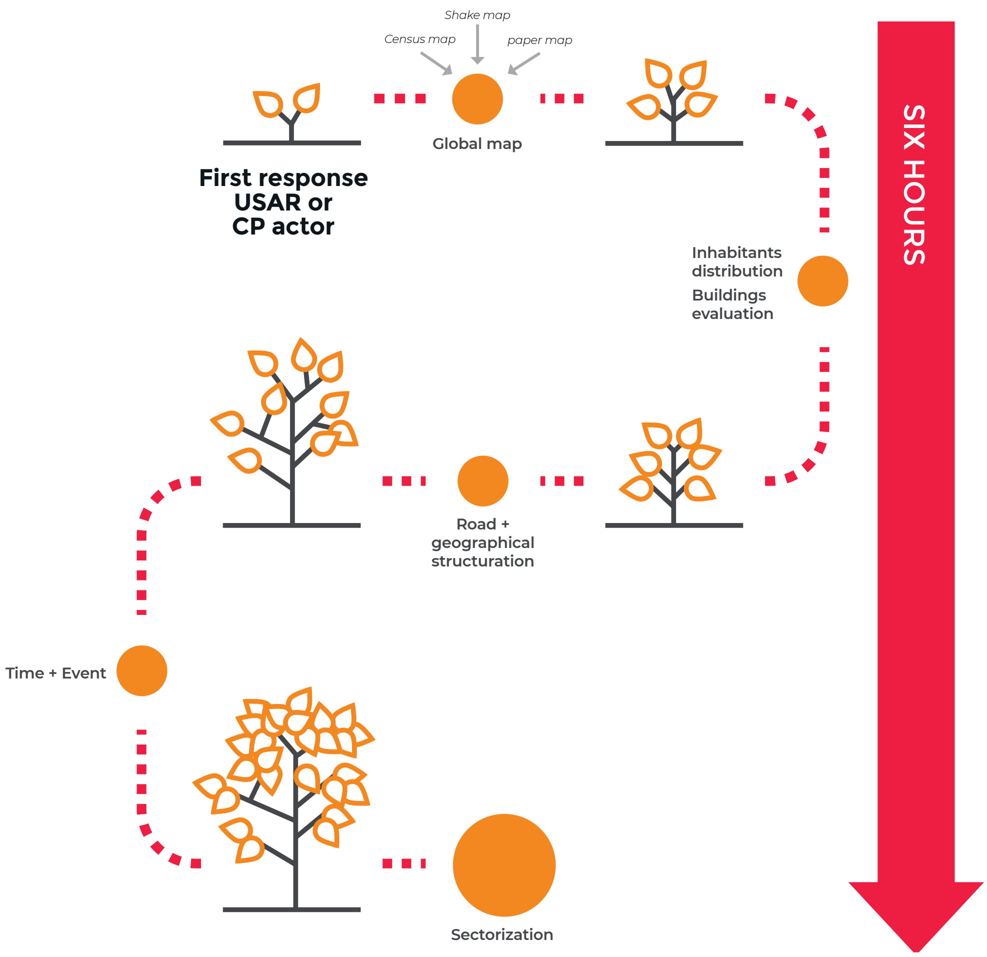

Fig. 3.9 - process of information feeding for first responders and CP actors to organize a sectorisation in 6 hours

21 See as described in the Chapter 2

POST EVENT – Case B3 – Manual not adopted:

In this case, rescuers have to sectorise using a method agreed upon with Local Authorities as for the B2 case but they do not adopt the method described herein. Sectorisation is made during mobilisation, but has to be verified with damage evaluation methods and approved by Local Authorities. Then, it will be possible to complete ASR1 using available elements and tools. After this, ASR2 is completed and rescue operations are planned. It is foreseen a much longer time to complete it, so this could be called a "**long time phase**".

3.4 Initial Action Phase Tools

Immediately after the event, emergency managers must take quick response decisions using limited information. Situational awareness can be achieved overlapping pre-sectorisation with the situational map, built taking the information into account according to the two approaches described.

3.4.1 Analytical Approach

In this first case, it is possible to use scientific tools like:

- Shakemaps;
- Alert System[22];

An analytical approach phase, based on scientific analysis of the affected area, can support rapid post-event emergency management decision-making because the location of the event (e.g. the epicentre for an earthquake) suggests only where the event started, not necessarily where the impact was the greatest. On the basis of such data, it is possible to obtain very detailed maps of damage suffered by buildings and show a regional situational awareness. All the details related to this approach are described in Annex 3.2 (Analytical Approach details).

22 As alert system the United States Geological Survey have set up "Did you feel it?"(DYFI) that collects information from people who felt an earthquake and creates maps that show what people experienced and the extent of damage – www.earthquake.usgd.gov.

Observation-based Approach

In this second case, it is possible to use tools like:

- Direct knowledge;
- Self-assessment.

The use of such tools requires an extensive knowledge of the territory and a channel of communication between local authorities and citizens.

Often, **direct knowledge** means that information is available and related to situations known directly by Local Authorities or reported to them by citizens who attended the event and/or who were rescued.

The considerations made should lead Local Authorities to increase their knowledge of the territory and to adapt planning tools with damage scenarios directly from experience. Similarly, they should develop methodologies to foster a dialogue with citizens in order to have a known and routinely used channel of communication available.

Such methods can extremely efficiently allow to collect information on initial damage from survivors and potential claimants when the damage is not easily visible or when the damage is extremely widespread.

Information on initial damage collected through **self-assessment** methods should be verified by the assessment teams. More details about the composition and the aims of the assessment teams are included in Annex 3.6 (Assessment Teams Details).

The assessment method requires effective communication while developing systems needed to get information, and can drastically reduce the time needed to carry out early wide assessment.

The method herein uses the community and potential applicants to quickly conduct initial assessments and can be adapted to provide more granular information although information shall be confirmed and, in order to be effective, validation systems must be in operation at the time of the disaster.

3.5 Consolidate Phase Tools

After the completion of the initial phase, it shall be necessary to conduct, a direct survey phase of the area as soon as possible to detect damage caused by the earthquake. In fact, the direct survey-based approach is a very detailed analysis that shows the real picture of the damage. As a result, decisions regarding Search and Rescue, medical emergency response, care and shelter for the injured and displaced people and other critical response needs must often be made while the amount of details grows.

The direct survey-based phase such as flight activities, on site assessment, satellite use and social media to some extent and so on, makes it possible to reach a level of definition not less than a 1:1000 scale. This means that data collected with a direct survey allow to go back to a map with a level of definition no less than a 1:1000 scale while the continuous availability of data guarantees that it is updated.

For example, onsite assessment can be used to achieve the highest possible level of detail. This assessment method is very laborious yet very accurate and is generally used when the damage is less visible or when a greater degree of confidence in the information is required (e.g. post-seismic viability). In addition, other information can be acquired through flight activities.

Typically, the consolidating phase is highly accurate yet it requires time and intense work.

Necessary information for this assessment phase shall be acquired through flight activities and methods are described in Annex 3.3 (Flight Activities Details) while the use of satellite and change detection techniques are described in Annex 3.4 (Field Assessment Details).

3.6 Media

Media throughout the world play a vital role in disaster management by educating the public about disasters; warning of hazards; gathering and transmitting information about affected areas; alerting government officials, relief organizations and the public about specific needs; and facilitating discussions about disaster preparedness and response.

In recent history, communication has increased our knowledge towards hazards' origins and behaviours. Media, in recent years, have helped raise people's awareness most effectively through live prompt reporting and giving information about hazards.

Modern activities in hazard mitigation and post disaster, focused on creating public awareness about risks and responses, are directly linked to the media. Such responses are based on various advanced means of communication that can be used to provide early warnings, evacuation plans and help post disaster activities.

When a disaster happens, it is important for first-responders to know what type of damage happened and where. So, TV, radio, printed and social media become a precious source of information.

TV and radio channels can play a primary role as they have an outreach to most remote areas as the information given in newspapers is perceived as reliable advice and people take it more seriously.

Media have the highest coverage: after a disaster they give people updates regarding warnings, alerts, evacuations and other details that disseminate the awareness regarding disaster among affected people and other public outside the affected areas.

Social media tools allow access to content published by citizens that use social networks to post situational updates in a variety of forms such as text messages, images, and videos. People write down what they see in places affected by disasters or report facts or rumours about a local or remote situation.

Some information can be interesting for emergency responders.

The key benefits are:

- **assessing disaster impacts**: early warning tools use models to predict the size of the impact, but models are never perfect. Social media content can be used to quickly assess if the impact is as expected.
- **assessing the effectiveness of response**: early response should address the most urgent needs of the affected population. Social media content should reflect this or can highlight changing needs.

However, social media often only reflect what has already been reported in the traditional media and shows the interest of well-connected citizens. For example, earthquakes in industrialized countries will produce a surge in social media content, even if they have only local consequences, while disastrous earthquakes in developing countries might only show a slight increase in social media content.

There are a lot of challenges to filter out irrelevant content and detect real signals from rumours, and social media.

The Joint Research Centre of the European Commission developed an approach to exploit Twitter data in earthquake disasters. For earthquakes, a lot of information is available through seismological measurements and models, including the time and location of an event. Impact models also do a good job estimating the severity of the disaster (i.e. GDACS alerts) up to estimates of casualties and financial impact (i.e. USGS PAGER).

There are also some Apps that can be considered as a voluntary alerting system, for instance “Did you feel the earthquake?” described in Annex 3.5.

3.7 Relationship Between Sectorisation And Active Sectors

An important feature of the affected area is access to the active sectors through the road network. Basic principles to take in to account are the following:

- each sector should be identified by the main road system;
- each sector should be accessible via a secondary road with a level of redundancy that depends on damage level.

The basic principles reported can be used as supplementary information for making the following decisions:

- resource sizing;
- initial deployment priorities and urgency.

3.8 Resources Management

As to the **composition of the assessment team**, detailed aspects related to professional figures are in Annex 3.6.

3.8.1 Resource sizing

Chapter 2, Paragraph 2.5, includes a general rule for sizing the sector taking into account the necessary resource to perform 50 buildings per USAR assessment sector. To assess 50 damaged buildings within 3 hours 5 USAR teams are needed, yet what is needed to assess fewer damaged buildings in an active sector?

If 5 assessment teams are needed to evaluate an active sector consisting of 50 damaged buildings, fewer teams can be involved to assess less damaged buildings in an active sector as the allocation of USAR resource must take into account the best condition in terms of coverage factor as to the damaged buildings per sector. Referring to the EMS-98 scale, damaged buildings are related to the macro seismic intensity that is correlated to the Peak Ground Acceleration (PGA).

Using the same symbology as in Paragraph 2.5, the coverage factor α_T is defined as

$$\alpha_T = \frac{A_{T,req}}{A_T} = \frac{N_{b,dam}}{N_{b,s}}$$

where

$A_{T,req}$ is the number of teams required as to the number of damaged buildings to be assessed;

$A_T = 5$ is the highest number of teams per sector;

$N_{b,dam}$ is the number of damaged buildings to be assessed;

$N_{b,s} = 50$ is the number of buildings per sector.

Basically, the coverage factor α_T is the fraction of damaged buildings to be assessed according to EMS-98, damage level 4 and 5, cases where the likelihood to have people that need to be rescued is greatest and it is the factor that multiplied by $A_T = 5$ gives the number of teams needed depending on the damage level.

The table 3.1 below shows the variability of the coverage factor α_T as the PGA (Peak Ground Acceleration) or the I (Macroseismic Intensity) according to EMS-98.

EN

Coverage factor per sector		
PGA [g]	I [EMS-98]	α_T
0.10-0.20	VII	0.2
0.20-0.30	VIII	0.4
0.30-0.60	IX	0.6
0.60-0.80	X	0.8
>0.80	XI	1.0
>0.80	XII	1.0

Table. 3.1 – Coverage factor per sector

For more detail regarding the methodology used to evaluate the coverage factor related to an event defined by his macroseismic intensity or PGA and some real case studies see the Annex 3.7.

3.9 Results Dissemination

3.9.1 Digital And Physical Methods

The results of the ASR1 phase, sectorisation and priorities, have to be shared and disseminated with all the relevant actors that need to use this data:

- USAR teams that are in the area through the UCC;
- LEMA is in charge of the management of the emergency at the local level.

These data can be disseminated in a physical or digital way and depend on the available resources after a catastrophic event, although digital methods, possibly, are preferable.

In fact, all the necessary documents and information should be kept in a public storage (which should be accessed even in case local network is down due to the emergency), so it would always be possible to have the initial information on the territory and the USAR teams and any other public entity dealing with the rescue could retrieve it independently.

An example of a data management system is Prometheus that stems from the experience of the Italian teams and acquires data from the sites and transmits organized information in a digital form. Such information is then analysed within a database and allow for prioritizing interventions and optimizing resources management on site.

The **Prometheus** system was created in order to digitally collect, transmit, manage and analyse data coming from emergency scenarios (earthquakes, collapsing buildings, attacks etc.).

The Prometheus platform is made of three areas:

- data acquisition,
- data transmission,
- information analysis and management. At present, Prometheus is implementing its system through a co-financed European Project (see **https://prometheusproject.eu**).

3.9.2 The Common Alerting Protocol (CAP)

The Common Alerting Protocol (CAP) provides for an open, non-proprietary digital message format for all types of alerts and notifications. It does not address any particular application or telecommunications method.

The primary use of the CAP Alert Message is to provide a single input to activate all kinds of alerting and public warning systems. This cuts down the workload resulting from using multiple warning systems while enhancing technical reliability and target-audience effectiveness. It also helps ensure consistency in the information transmitted over multiple delivery systems, another key to warning effectiveness.

Another application of CAP is to normalize warnings from various sources so they can be aggregated and compared in tabular or graphic form as an aid to situational awareness and pattern detection.

Although primarily designed as an interoperability standard for use among warning systems and other emergency information systems, the CAP Alert Message can be delivered directly to alert recipients over various networks, including data broadcasts. Location-aware receiving devices could use the information in a CAP Alert Message to determine, based on their current location, whether that particular message was relevant to their users.

The CAP Alert Message can also be used by sensor system as a format for reporting significant events to collection and analysis systems and centers.[23]

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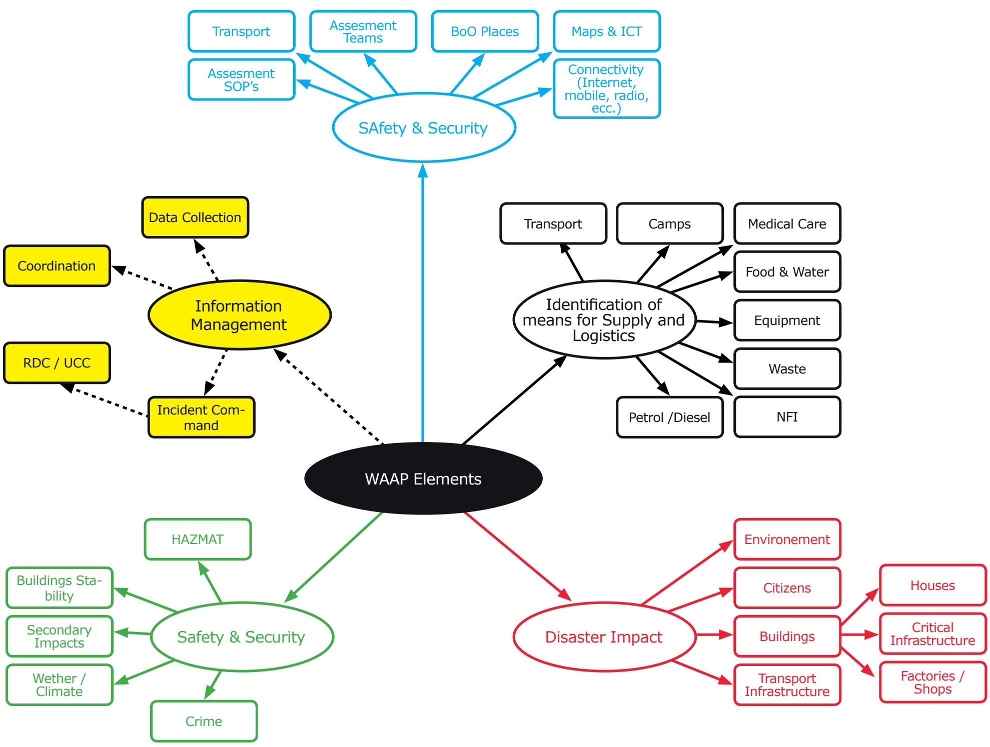
23 ITU – T (Telecommunication Standardization sector of ITU, Common alerting protocol (CAP 1.2) Recommendation ITU-T X.1303 bis, An international working group of more than 130 emergency managers and information technology and telecommunications experts convened in 2001 and adopted the specific recommendations of the National Science and Technology Council (NSTC) report as a point of departure for the design of a Common Alerting Protocol (CAP). Their draft went through several revisions and was tested in demonstrations and field trials in Virginia (supported by the ComCARE Alliance) and in California (in cooperation with the California Office of Emergency Services) during 2002 and 2003.

4 WIDE AREA ASSESMENT PROCESS - METHODOLOGY

4.1 Introduction

The ASR 1 inside the INSARAG Guidelines is described only in basic elements. It is quite obvious that the ASR 1 should be done usually by the LEMA within the shortest possible time i.e., before the local USAR teams and the later incoming assistance (intl. USAR teams) arrive on spot, being able to give them already a sector to assess (ASR 2) as well as to have identified those areas with priorities. This initial assessment thereof must content several tasks as a minimum:

(Some) Tasks for the initial assessment



Various international lessons learnt after major earthquakes identified the need for analyzing existing data prior to the ASR 1 for a quicker assessment process.

Especially the limited time for the ASR1 indicates that the needed work which usually must be done by the LEMA in the ASR 1 must include additional parts or "sub levels" of ASR as a work phase that is done before a real disaster happens: The prevention and preparedness phase that is well known from the disaster management cycle! The data collected will enhance the level of details and enable LEMA to have better Plans of Action as well as enough dedicated (skilled and trained) assessment teams.

Thereof the ASR Level 1 needs to be understood as a tripartite level that has two sub levels which are happening before the "real" ASR 1 starts. In this methodology the tripartite approach is used to define the WAAP as a coherent system using prevention and preparedness phase as resources for a quicker and more detailed assessment result:

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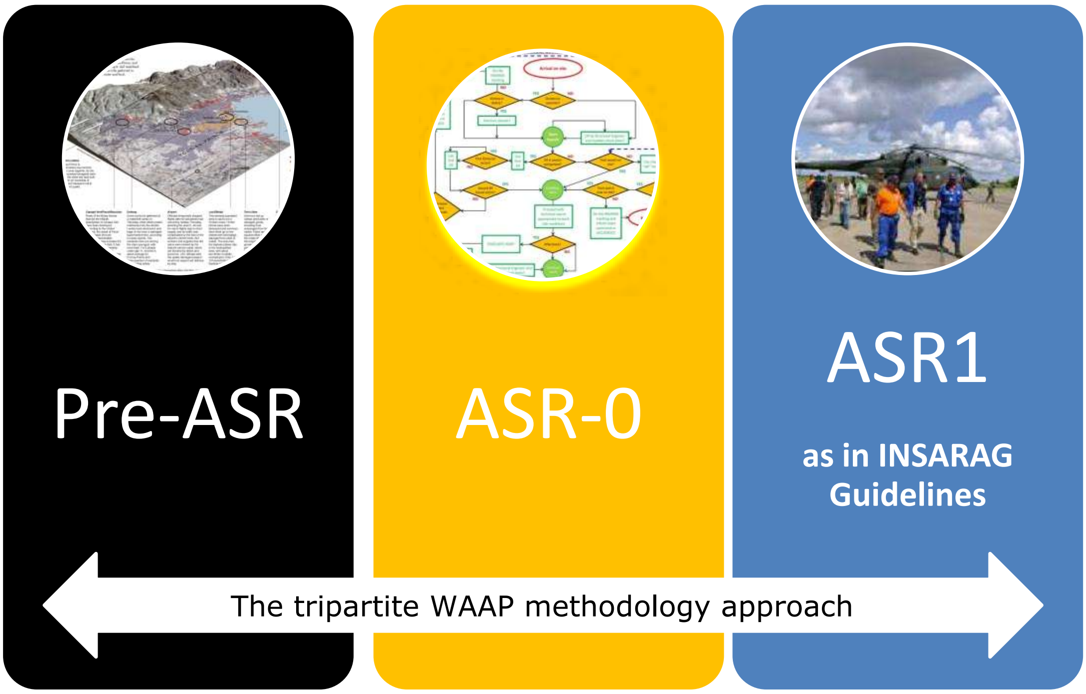


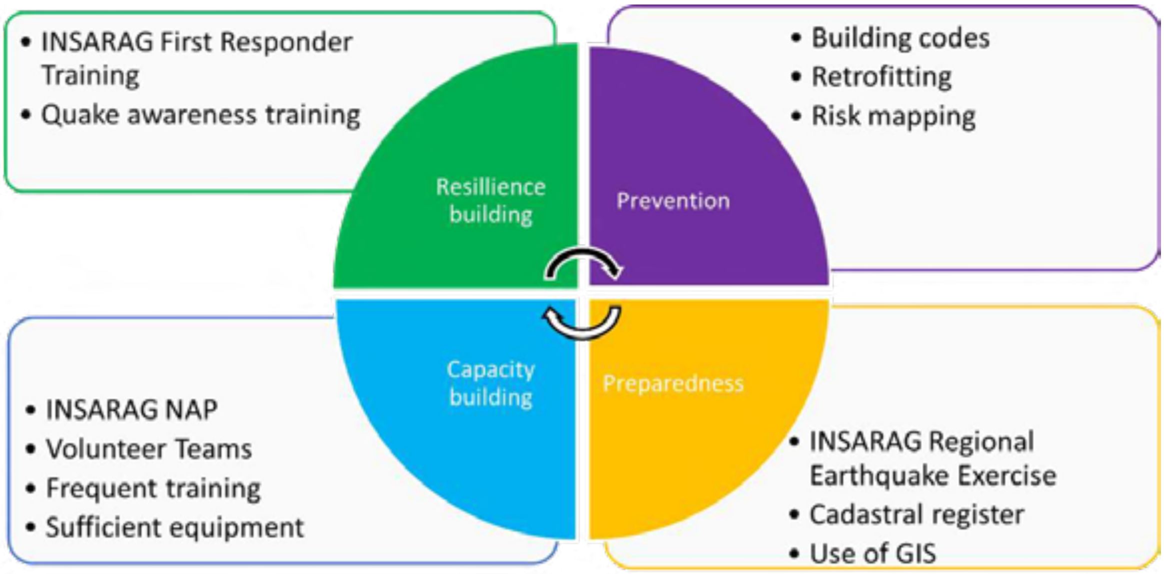
It is essential for the methodology that an ASR 1 must follow certain standards and their methodologies to be implemented correctly in the knowledge base of the LEMA, the USAR teams and other relief teams. Thereof the WAAP methodology is based on the INSARAG Guidelines, the EUCPM methodology and the international best practice and EU Member States experience. Even if the methodology uses the earthquake scenario throughout the WAAP manual and Trainers Handbook, it is understood that the methodology itself should be localized (if possible) and also could be used for similar disaster scenarios such as landslides, avalanches, heavy rock fall and the like.

As “the LEMA” is just a TOR (Term of Reference) that indicates the responsible authority on all country and administration levels, the methodology must accept that there are two different work levels with very diverse tasks and responsibilities. Thereof the WAAP methodology will address an operational level and a decision maker level in the training.

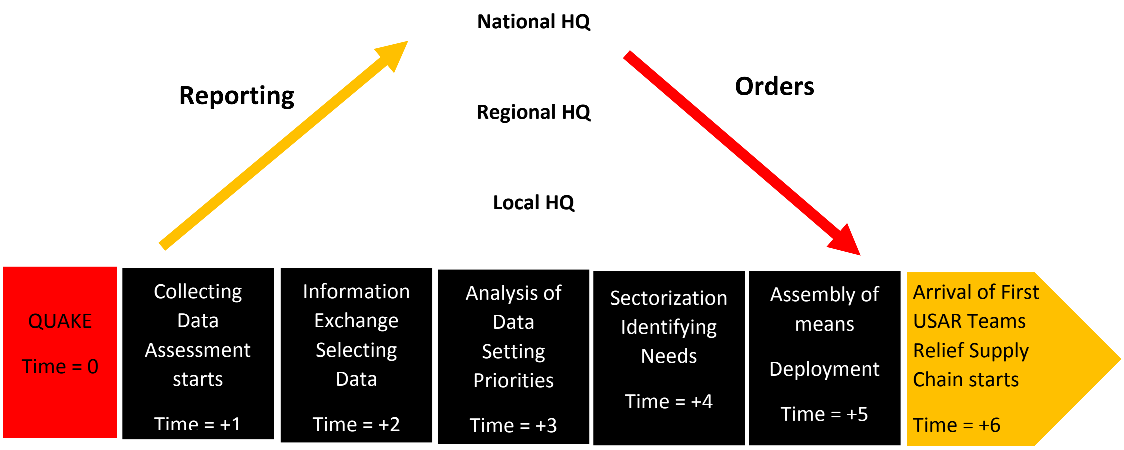
The manifold tasks of the initial assessment under extreme time constrains might always have the problem of possible mistakes, wrong conclusions in regard to means and needs, nonetheless this methodology will help (together with Lessons Learnt and Good Practice) to reduce these and enable the operational and decision maker level to optimize the crisis response.

4.2 The Assessment Process

As the time for the ASR 1 is extremely limited as quick crisis respond is needed, it is assumed that there is only a maximum of four, sometimes up to six hours for the work. The WAAP methodology has implanted the “Pre ASR” and the ASR 0 Levels that include many activities to bridge that gap between limited time and maximum of data for better decision making on needs and means. Some elements to consider from a coherent perspective are shown below:



The next (symbolic) chart shows why the data from pre-ASR and ASR 0 level of the WAAP is so important:



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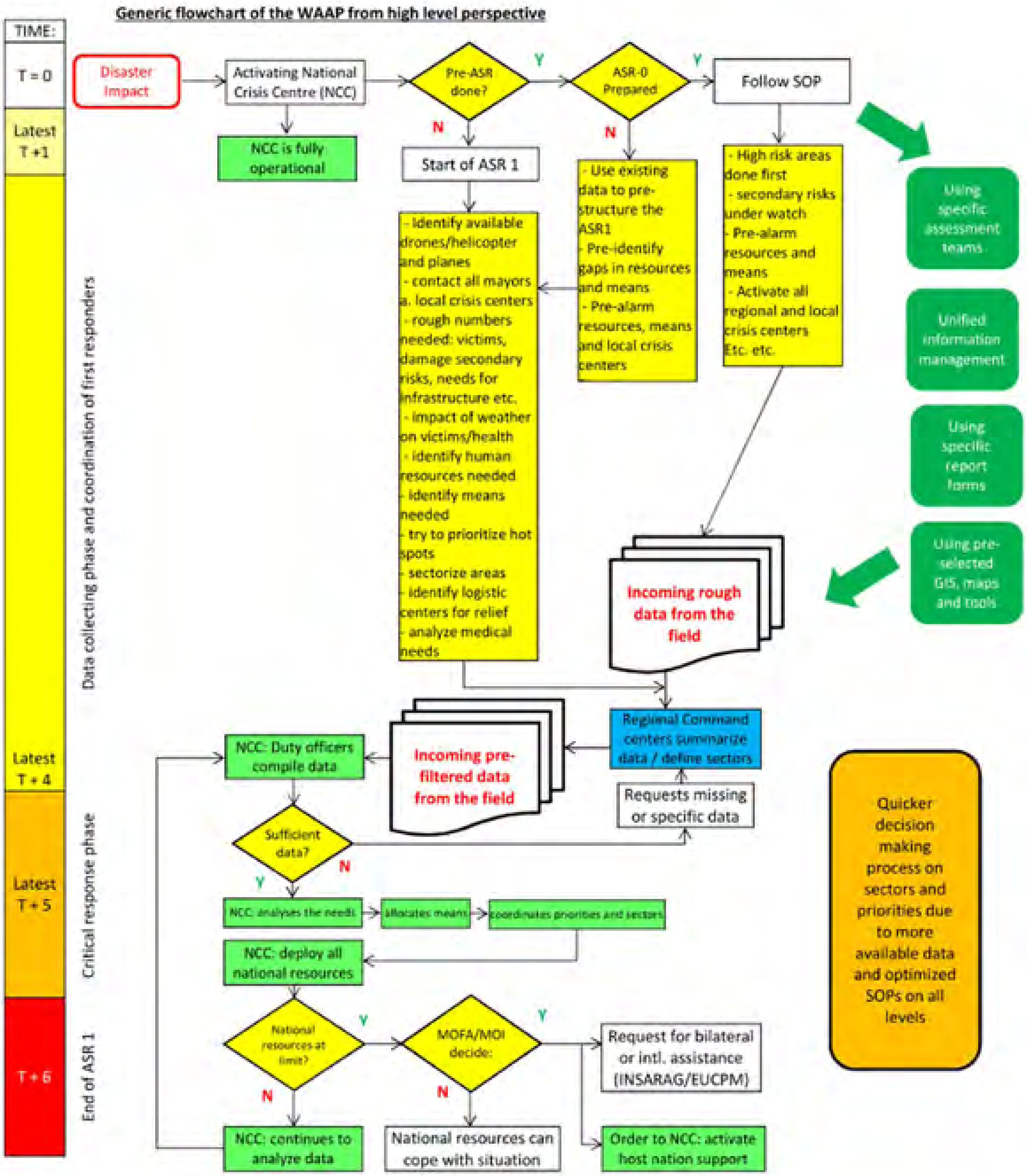
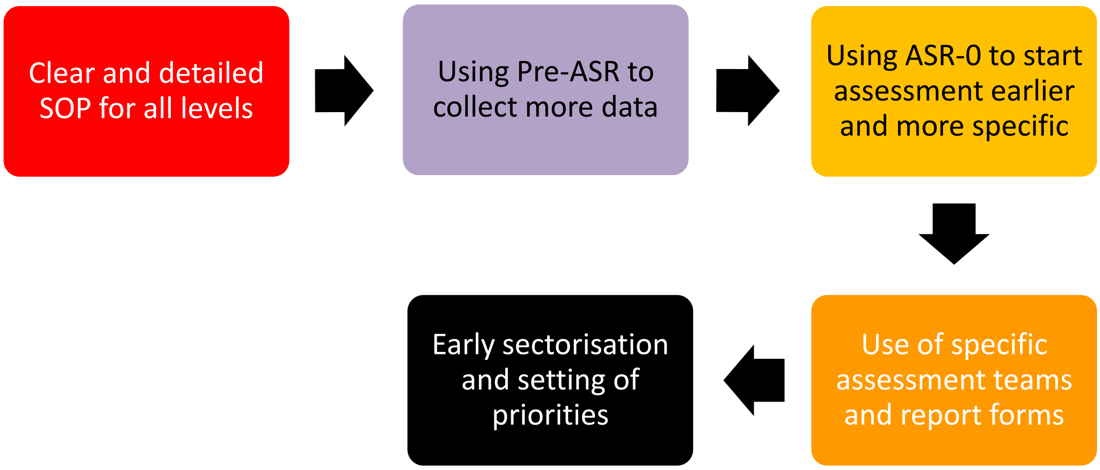
Having in mind that the time constraint is first “system immanent barrier effect” and that there is no way to have more time, it is quite clear how important the additional data from Pre-ASR and ASR 0 is. In an ideal way the WAAP would be like this flowchart:



The WAAP methodology as a whole follows the idea that most of the needed data is available and the only missing point is the awareness of this fact and thereof no use of this data. The new process is having five essential steps that enhance the assessment quality:



The benefits of the WAAP are not possible without a long period of implementation. Thereof the WAAP Manual tries to show all the potential aspects of this process.

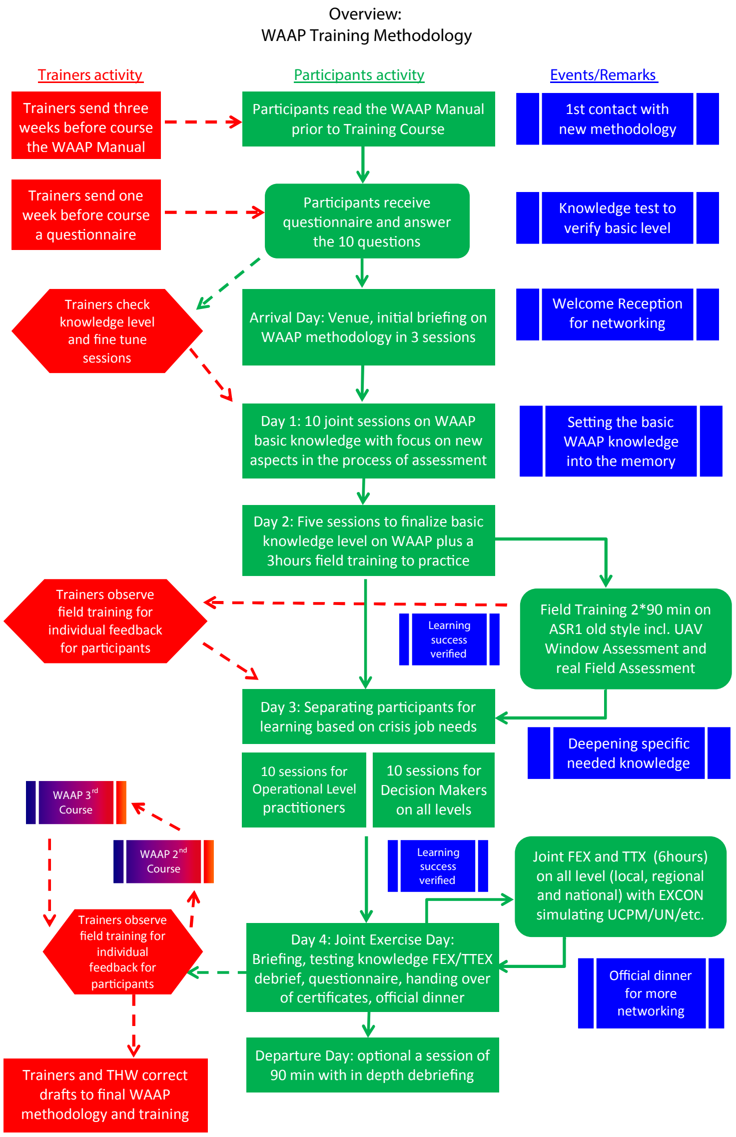
Nonetheless the new WAAP will be different from country to country as the localization is a core element of the methodology.

This WAAP will also be full of immanent barrier effects if the planning of the WAAP is not standardized. Thereof the development of SOP's for all level should be the first step. A national data base might be an option to speed up the data collection but there are also other possibilities to arrange the data availability in a crisis situation. The main task still is to speed up the process of decision making for the sectorisation and the priority setting. Based on these decisions the overall amount of means can be identified and thereof a quicker analysis is possible to find out if the local, regional and national capacities are sufficient or if the additional call for incoming assistance might be necessary.

4.3 Training Methodology Overview

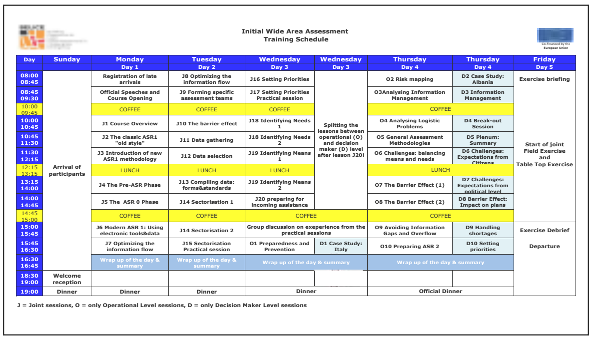
The development of the training methodology for the WAAP was influenced by the impact of the COVID-19 pandemic.

Thereof many parts of the originally planned training methodology could not be implemented such as the foreseen field training, and a completely different version had to be developed. While the original plan was to test the methodology in three training courses of five days, the final result was the outcome of a virtual three-day ToT Course without the foreseen field exercise. Further details can be found in the Trainers Handbook for reference.



The training methodology is based on the fact that it is not useful to have the complete content of the WAAP manual in the training. The manual should be the reference for the office, while the training is used to set the basic frame of knowledge on the WAAP. Instead of reproducing the manual content as a lecture the lectures will make the participants of the training aware of the details of the WAAP as well as they will recognize limits, but also benefits from the new WAAP methodology.

As the original planned verification of the methodology by the participants of the three courses was not possible, several (European) observers where used to evaluate the training. In addition, two members of the INSARAG Training Working Group were invited to observe and they were giving valuable feedback for the Trainers Handbook.



Initial Wide Area Assessment
Training Schedule

Day	Sunday	Monday	Tuesday	Wednesday	Wednesday	Thursday	Thursday	Friday
		Day 1	Day 2	Day 3	Day 3	Day 4	Day 4	Day 5
08:00 08:45		Registration of late arrivals	J8 Optimizing the information flow	J16 Setting Priorities		O2 Risk mapping	D2 Case Study: Albania	Exercise briefing
08:45 09:30		Official Speeches and Course Opening	J9 Forming specific assessment teams	J17 Setting Priorities Practical session		O3Analysing Information Management	D3 Information Management	
10:00 09:45		COFFEE	COFFEE	COFFEE		COFFEE		
10:00 10:45		J1 Course Overview	J10 The barrier effect	J18 Identifying Needs 1		O4 Analysing Logistic Problems	D4 Break-out Session	
10:45 11:30		J2 The classic ASR1 "old style"	J11 Data gathering	J18 Identifying Needs 2	Splitting the lessons between operational (O) and decision maker (D) level after lesson J20!	O5 General Assessment Methodologies	D5 Plenum: Summary	
11:30 12:15		J3 Introduction of new ASR1 methodology	J12 Data selection	J19 Identifying Means 1		O6 Challenges: balancing means and needs	D6 Challenges: Expectations from Citizens	Start of joint Field Exercise and Table Top Exercise
12:15 13:15	Arrival of participants	LUNCH	LUNCH	LUNCH		LUNCH		
13:15 14:00		J4 The Pre-ASR Phase	J13 Compiling data: forms&standards	J19 Identifying Means 2		O7 The Barrier Effect (1)	D7 Challenges: Expectations from political level	
14:00 14:45		J5 The ASR 0 Phase	J14 Sectorisation 1	J20 preparing for incoming assistance		O8 The Barrier Effect (2)	D8 Barrier Effect: Impact on plans	
14:45 15:00		COFFEE	COFFEE	COFFEE		COFFEE		
15:00 15:45		J6 Modern ASR 1: Using electronic tools&data	J14 Sectorisation 2	Group discussion on exeperience from the practical sessions		O9 Avoiding Information Gaps and Overflow	D9 Handling shortages	Exercise Debrief
15:45 16:30		J7 Optimizing the information flow	J15 Sectorisation Practical session	O1 Preparedness and Prevention	D1 Case Study: Italy	O10 Preparing ASR 2	D10 Setting priorities	Departure
16:30 16:45		Wrap up of the day & summary	Wrap up of the day & summary	Wrap up of the day & summary		Wrap up of the day & summary		
18:30 19:00	Welcome reception							
19:00	Dinner	Dinner	Dinner	Dinner		Official Dinner		

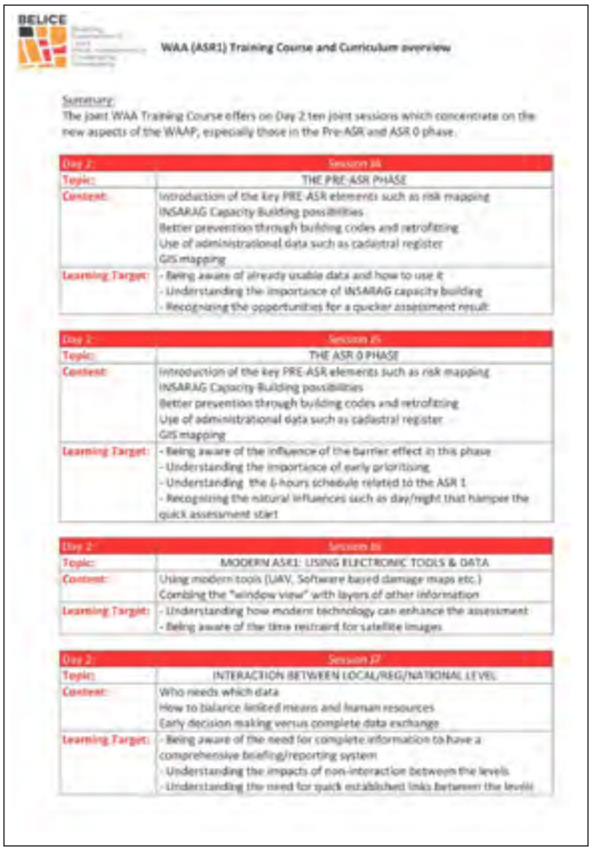
J = Joint sessions, O = only Operational Level sessions, D = only Decision Maker Level sessions

The Trainers Handbook was designed to enable Trainers of all EU Member States to develop their own training according to the needs of the participants. Thereof several time schedules were developed to suits various needs such as virtual training, different weekdays and the like.

The sessions are embedded in a curriculum that introduces all major aspects of the WAAP in a mix of joint lectures, specific lectures for operational and decision maker level and finally ends with a joint exercise in which via Table Top and Field Exercise the participants will proof that the methodology helps them through the challenges of the exercise.

The best learning outcome will happen when the lectures are slightly modified, i.e. have been localized by using own examples/maps etc.

Trainers will be free to decide if they want to stick to the "classic" model of a full week training (as



WAA (ASR1) Training Course and Curriculum overview

Summary:
The joint WAA Training Course offers on Day 2 ten joint sessions which concentrate on the new aspects of the WAAP, especially those in the Pre-ASR and ASR 0 phase.

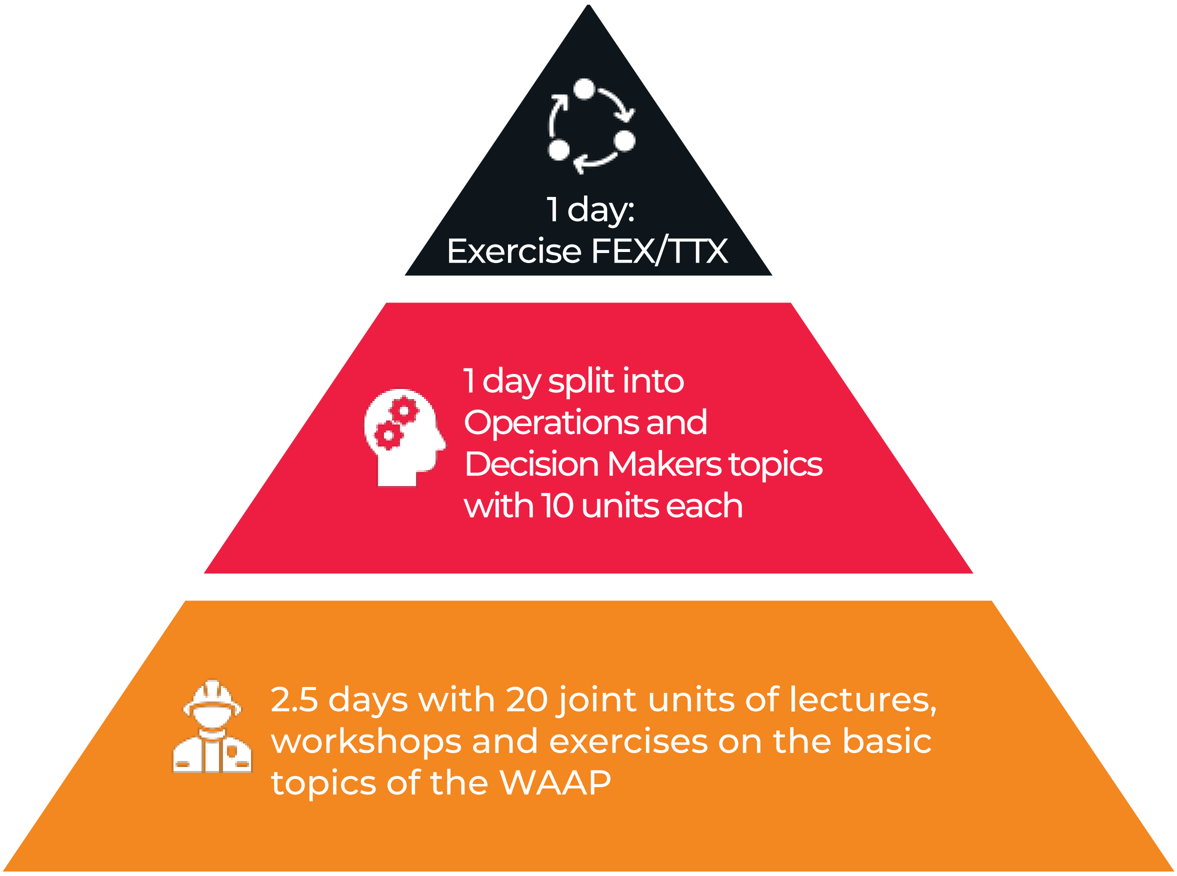
Day 2:	Session J4
Topic:	THE PRE-ASR PHASE
Content:	Introduction of the key PRE-ASR elements such as risk mapping INSARAG Capacity Building possibilities Better prevention through building codes and retrofitting Use of administrational data such as cadastral register GIS mapping
Learning Target:	- Being aware of already usable data and how to use it - Understanding the importance of INSARAG capacity building - Recognizing the opportunities for a quicker assessment result

Day 2:	Session J5
Topic:	THE ASR 0 PHASE
Content:	Introduction of the key PRE-ASR elements such as risk mapping INSARAG Capacity Building possibilities Better prevention through building codes and retrofitting Use of administrational data such as cadastral register GIS mapping
Learning Target:	- Being aware of the influence of the barrier effect in this phase - Understanding the importance of early prioritising - Understanding the 6-hours schedule related to the ASR 1 - Recognizing the natural influences such as day/night that hamper the quick assessment start

Day 2:	Session J6
Topic:	MODERN ASR1: USING ELECTRONIC TOOLS & DATA
Content:	Using modern tools (UAV, Software based damage maps etc.) Combing the "window view" with layers of other information
Learning Target:	- Understanding how modern technology can enhance the assessment - Being aware of the time restraint for satellite images

Day 2:	Session J7
Topic:	INTERACTION BETWEEN LOCAL/REG/NATIONAL LEVEL
Content:	Who needs which data How to balance limited means and human resources Early decision making versus complete data exchange
Learning Target:	- Being aware of the need for complete information to have a comprehensive briefing/reporting system - Understanding the impacts of non-interaction between the levels - Understanding the need for quick established links between the levels

shown on the end of the page) or if they want to customize according to specific reasons. It is possible to divide the training course into days or even into afternoon sessions for the refreshing of knowledge. The joint exercise should have a field element but if not possible, even this can be re-adjusted to an indoor training.



ABBREVIATIONS

ASR	Assessment Search and Rescue
ASR1	Wide Area Assessment
ASR2	Sector Assessment
ASR3	Rapid Search and Rescue
ASR4	Full Search and Rescue
ASR5	Total Coverage Search and Recovery
BoO	Base of Operation
ERCC	Emergency Response Coordination Centre
HAZ-MAT	Hazardous Material
ICS	Incident Command System
INSARAG	International Search And Rescue Advisory Group
LEMA	Local Emergency Management Authority
NEMA	National Emergency Management Authority
OSOCC	On-Site Operations Coordination Centre
PPE	Personal protective equipment
RDC	Reception Departure Centre
SAPR	Acronym for Drones
SAR	Search and Rescue
UCC	USAR Coordination Cell
UNDAC	United Nations Disaster Assessment and Coordination
UN OCHA	United Nations Office for the Coordination of Humanitarian Affairs
USAR	Urban Search and Rescue
VOSOCC	Virtual OSOCC
WAAP or WA2P	Wide Area Assessment Process

GLOSSARY

A

Assessment
The action of assessing someone or something

Assessment team
A group of people appointed with an assessment.

Authority
A person or organization having political or administrative power and control.

Approach
A way of dealing with a situation or problem.

Aggregate
A whole formed by combining several separate elements. Or Pieces of broken or crushed stone or gravel used to make concrete and in building.

Active sector
Sector in the affected area by the event where intervention is needed.

Affected area
Area or a region which is heavily damaged by either natural, technological or social events.

Access
The means or opportunity to approach or enter a place.

B

Barrier effect
Obstacles due to a wide range of environmental factors such as: heavy snow, traffic due to damage to the road system escaping in narrow/limited escape routes, road interruptions, non-coherent management of information flow (dissemination of false/fake information, correct information not taken into consideration, missing basic information). These factors can severely hamper the general assessment in SAR.

Building
A structure with a roof and walls, such as a house or factory.

C

CENSUS
An official count or survey, especially of a population.

CENSUS data related map
A graphic representation of census data.

Common Alerting Protocol

The Common Alerting Protocol (CAP) is a digital format for exchanging emergency alerts that allows a consistent alert message to be disseminated simultaneously over many different communications systems.

D

DATA

Facts and statistics collected together for reference or analysis.

Drone

A remote-controlled pilotless aircraft.

E

Emergency

A serious, unexpected, and often dangerous situation requiring immediate action.

Emergency plan

Written set of procedures and instructions for handling emergency situations.

EASeR

The EASeR (Enhancing Assessment in Search & Rescue) project targets a specific aspect of search and rescue (SAR) assessment called “barrier effect” during emergency interventions in response to catastrophes, especially earthquakes (https://www.easerproject.eu) .

EN

F

First responders

A person whose job entails being the first on the scene of an emergency, such as a firefighter or police officer.

G

GIS

Geographic information system, a system for storing and manipulating geographical information on computer.

Golden day

Generic reference to the survival period of victims after the collapse of the buildings, in fact, statistically in the first 24h after the event more than 80% of the victims found survive. This rate decreases to less than 10% after 24 hours.

I

INSARAG

The International Search and Rescue Advisory Group.

Information management

Concerns a cycle of organizational activity: the acquisition of information from one or more sources, the custodianship and the distribution of that information to those who need it and its ultimate disposition through archiving or deletion.

Infrastructure network

The network of basic physical and organizational structures and facilities (e.g. buildings, roads, power supplies) needed for the operation of a society or enterprise.

K

Key infrastructure

See infrastructure network.

M

Map

1) a diagrammatic representation of an area of land or sea showing physical features, cities, roads, etc

2) a visual representation of an area.

Mapping

The process of making maps.

Media

The main means of mass communication (broadcasting, publishing, and the Internet) regarding collectively.

P

Population

All the inhabitants of a particular place.

Preparedness

The state of being prepared for an emergency.

Process

A series of actions or operations conducing to an end.

Priorities

The fact or condition of being regarded or treated as more important than others.

R

Resource Management

The deployment of organizational resources when and where they are needed.

S

Sector

An area or portion that is distinct from others.

Sectorisation

division into sectors.

Seveso plants

It is a European Union Directive aimed at improving the safety of sites containing large quantities of hazardous substances. The name was taken by an industrial accident, that occurred in Seveso on July 10, 1976, in a small chemical manufacturing plant in the North of Milan in Lombardy, Italy. The accident has given rise to numerous scientific studies and standardized industrial safety regulations. The EU industrial safety regulations are known as the Seveso Directive.

Stressor

Something that causes a state of strain or tension.

Shakemap

A map showing ground movement and shaking intensity following major earthquakes.

Social Media

Websites and applications that enable users to create and share content or to participate in social networking.

EN

Survival Rate

The percentage of people still alive for a given period of time.

Satellite

An artificial body placed in orbit round the earth in order to collect information or for communication.

Size

The extent of something; a thing's overall dimensions of magnitude, how big something is.

Safety

The condition of being protected from something which can cause danger, risk, or injury.

Security

The state of being free from danger or threat. The term in this Manual is used to refer to acts and systems whose purpose may be to provide security.

T

Time management

The ability to use one's time effectively or productively.

V

Vulnerability

The quality or state of being exposed to the possibility of being attacked or harmed, either physically or emotionally.

EN

ANNEXES

ANNEXES LIST

CHAPTER 1

- ANNEX 1.1: TABLE OF HYPOTHESIS AND CASES DESCRIBED

CHAPTER 2

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- ANNEX 2.2: HOW TO ANALYSE EACH MAJOR RISKS
- ANNEX 2.3: SECTOR SIZE METHODOLOGY
- ANNEX 2.4: AUXILIARY PROCEDURES AND IDENTIFICATION FORMS FOR LOCAL AUTHORITIES
- ANNEX 2.5: SIMPLE PROCESS TO SECTORISE WITHOUT PREPAREDNESS
- ANNEX 2.6: LOCAL AUTHORITY DATA COLLECTION POSSIBILITIES
- ANNEX 2.7: NAMING OF SECTORS AND SIZE OF SECTORED AREA
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Annex 1.1 TABLE OF HYPOTHESIS AND CASES DESCRIBED

SUMMARY

The following annex is a table describing, per each phase, its aims and linking it with the hypothesis described in the Manual.

At the end of the table are also present some notes that will help in clarifying some particular aspects of the phases.

PHASE	AIMS	ACTIONS		
		No planning activity has been prepared	A planning activity has been prepared but it does not include some basic elements (cartography, information on population, vulnerability of buildings and viability) and/or the planning activity has not been prepared coherently with the aims – Only web data are available (OpenStreetMap, Worldpop, Shakemap, ...)	Planning activity has been completely prepared based on detailed information related to any possible scenario assessment, the information contained in column "Aims" is available Local Authority data is available
		Hypothesis 1	**Hypothesis 2**	**Hypothesis 3**
PREPARDNESS **In charge of Local Authority** The civil protection planning activity can be jointly realized by administrations at different territorial levels for preparedness and management of the emergency and for the management of consequences due to emergency of various nature and gravity. It is of fundamental importance, for an effective planning, the presence of strategic elements and operational procedures aimed at achieving an effective Wide Area Assessment.	The civil protection and emergency planning: - risks identification - buildings and viability identification - BoO identification - logistical area identification - landing area identification - identification of the gates of the road arteries, - identification of coordination centers - identification of accommodation facilities - identification of health facilities, etc.)	**Go to the next phase**	**The public data available on the web are used** to define the necessary elements: identification of risks, identification of buildings, roads, identification of BoOs, identification of logistic areas, identification of landing areas, etc. **_- pre-sectorization_**, before impact and therefore without references to the shakemap or pga; the sectors are defined with the data available to the LA or with public data and the tool (for example the "BELICE" plugin). The subsequent steps can start from this sectorization and develop it with data related to the impact. **_- Identification of coordination centers;_** This building will be identified starting from those available by the local authority. The actual use	**Planning activity prepared will be used**. The elements necessary for the management of the response should already be available (identification of risks, identification of buildings, roads, identification of BoOs, identification of logistic areas, identification of landing areas, etc.). **The scenarios and the magnitudes are identified,** in relation to the scenarios and the magnitudes the resources necessary for managing the response are also evaluated. **Pre-sectorizations of the affected areas are defined,** for example connected to different magnitudes of the event. The pre-sectorizations are extended to the whole territory with the criterion described in chapter 2 of the Manual. The event (magnitude / location) will only activate the sectors for which the damage exceeds a defined threshold or those with the presence of people in order to start Search and Rescue

PHASE	AIMS	ACTIONS		
		No planning activity has been prepared	A planning activity has been prepared but it does not include some basic elements (cartography, information on population, vulnerability of buildings and viability) and/or the planning activity has not been prepared coherently with the aims – Only web data are available (OpenStreetMap, Worldpop, Shakemap, ...)	Planning activity has been completely prepared based on detailed information related to any possible scenario assessment, the information contained in column "Aims" is available Local Authority data is available
		Hypothesis 1	**Hypothesis 2**	**Hypothesis 3**
			is to be evaluated and approved through a necessary reconnaissance on the spot. **- Identification of strategic buildings** (barracks, hospitals, etc.); **- Identification of BoOs;** **- Identification of landing areas,** **- Identification of temporary hospitalization areas;** These areas will be identified with the available map systems, to be evaluated and approved through a necessary on-site reconnaissance to confirm the effective use of the areas using the reconnaissance cards contained in Annex A.2.4.1 and A.2.4.2	operations. **The necessary resources are defined** on the basis of the scenarios used as a reference for planning. In principle, the necessary resources are defined on the basis of the magnitude, the affected area, the type of area or sector (eg historic, residential, commercial, industrial, rural, etc.).

PHASE	AIMS	ACTIONS		
		No planning activity has been prepared	A planning activity has been prepared but it does not include some basic elements (cartography, information on population, vulnerability of buildings and viability) and/or the planning activity has not been prepared coherently with the aims – Only web data are available (OpenStreetMap, Worldpop, Shakemap, ...)	Planning activity has been completely prepared based on detailed information related to any possible scenario assessment, the information contained in column "Aims" is available Local Authority data is available
		Hypothesis 1	**Hypothesis 2**	**Hypothesis 3**
ASR 0 **In charge of Local Authority** **or of External Support Units** First phase after the event;	-To assess the impact scenario[i] using the very first information from the affected area; - to define an initial assessment of the necessary resources;	**1 of 3 Impact** For a prior definition of the impact area, in the absence of any other information, it is possible to use the general scenarios with the data available on national and international platforms such as: -GDACS - Global Disaster Alerting Coordination System; -USGS; - etc To identify the area of impact in greater detail, it is possible to use the methodology proposed in *Hypothesis 2*	**1 of 3 Impact** (Identification of the impact area and first rough sectorization) Request input data from: - shakemap layer (vector) - Built area (raster) available from worldpop Returns: - impact area- a first rough sectorization	The Local Authority provides on the basis of real data referring to the event that occurred, the scenario closest to the event that occurred is selected as a starting point. The planned planning should allow, at least in the first instance, the estimation of the necessary resources with respect to what was planned and the definition of the initial response, the estimation of the event, the knowledge almost in real time of the evolution of the event.
		2 of 3 Sectorization to use the methodology proposed in *Hypothesis 2*	**2 of 3 Sectorization** (More detailed sectorization definition) Request input data from: - first rough sectorization obtained applying the methodologies of the	

PHASE	AIMS	ACTIONS		
		No planning activity has been prepared	A planning activity has been prepared but it does not include some basic elements (cartography, information on population, vulnerability of buildings and viability) and/or the planning activity has not been prepared coherently with the aims – Only web data are available (OpenStreetMap, Worldpop, Shakemap, ...)	Planning activity has been completely prepared based on detailed information related to any possible scenario assessment, the information contained in column "Aims" is available Local Authority data is available
		Hypothesis 1	**Hypothesis 2**	**Hypothesis 3**
			first module (vector - Built area (raster) available from worldpop (worldpop.org). To obtain the most detailed sectorization, the openstreetmap data relating to buildings (area data), roads, rivers, railways, etc. are used. (linear data); Sectors are created with buildings that may have been damaged and to which assessment, search and rescue teams will need to be sent. For each sector are defined: • unique id • surface • built surface • number of buildings • number of estimated people • population density • PGA value (maximum ground acceleration) • Number of teams to send	

PHASE	AIMS	ACTIONS		
		No planning activity has been prepared	A planning activity has been prepared but it does not include some basic elements (cartography, information on population, vulnerability of buildings and viability) and/or the planning activity has not been prepared coherently with the aims – Only web data are available (OpenStreetMap, Worldpop, Shakemap, ...)	Planning activity has been completely prepared based on detailed information related to any possible scenario assessment, the information contained in column "Aims" is available Local Authority data is available
		Hypothesis 1	**Hypothesis 2**	**Hypothesis 3**
			• Googlemaps link of the sector centroid	
		3 of 3 Resource definition (identification of the necessary resources) to use the methodology proposed in *Hypothesis 2*	**3 of 3 Resource definition** (identification of the necessary resources) On the basis of the number of buildings and the values of the PGA, the number of teams to be sent for each sector is identified and, therefore, the total number of teams needed.	
ASR 1 **In charge of Local Authority** **or of External Support Units** Resources activated and on the territory; direct verification of the event	Use of information from the territory to confirm the emergency scenario and quantify the necessary resources;	<u>- Identification of coordination centers;</u> This building will be identified from those available by the local authority. The actual use is to be evaluated and approved through a necessary reconnaissance on the spot. <u>- Identification of</u>	**The Units/Teams are on field.** The direct assessment of what was planned and subsequently verified on the basis of the data relating to the event (information, shakemap, etc.) is carried out: The situation of the buildings, the viability, the provisions foreseen for BoO, the landing areas, the logistic areas, the sectors to be activated with respect to those foreseen, the urgencies and priorities.	**The Units/Teams are on field.** Direct verification of what was planned and subsequently verified on the basis of the data relating to the event (information, shakemap, etc.) is carried out: The situation of the buildings, the viability, the provisions envisaged for BoO, the landing areas, the logistic areas, the sectors to be activated with respect to those foreseen, the urgencies and priorities. Two levels of in-depth analysis are identified in the manual, the first faster

PHASE	AIMS	ACTIONS		
		No planning activity has been prepared	A planning activity has been prepared but it does not include some basic elements (cartography, information on population, vulnerability of buildings and viability) and/or the planning activity has not been prepared coherently with the aims – Only web data are available (OpenStreetMap, Worldpop, Shakemap, ...)	Planning activity has been completely prepared based on detailed information related to any possible scenario assessment, the information contained in column "Aims" is available Local Authority data is available
		Hypothesis 1	**Hypothesis 2**	**Hypothesis 3**
		strategic buildings (barracks, hospitals, etc.); - Identification of BoOs; - identification of landing areas, - identification of temporary hospitalization areas; These areas will be identified with the available map systems, to be assessed and approved through a necessary on-site reconnaissance to confirm the effective use of the areas using the reconnaissance cards contained in Annex A.2.4.1 and A.2.4.2. **The Units/Teams are on field.** The direct assessment of what was		linked to easily available data (initial action, par. 3.4), the second more in-depth but expensive in terms of resources and time (consolidation phase, par. 3.5).

PHASE	AIMS	ACTIONS		
		No planning activity has been prepared	A planning activity has been prepared but it does not include some basic elements (cartography, information on population, vulnerability of buildings and viability) and/or the planning activity has not been prepared coherently with the aims – Only web data are available (OpenStreetMap, Worldpop, Shakemap, ...)	Planning activity has been completely prepared based on detailed information related to any possible scenario assessment, the information contained in column "Aims" is available Local Authority data is available
		Hypothesis 1	**Hypothesis 2**	**Hypothesis 3**
		planned and subsequently verified on the basis of the data relating to the event (information, shakemap, etc.) is carried out: The situation of the buildings, the viability, the provisions foreseen for BoO, the landing areas, the logistic areas, the sectors to be activated with respect to those foreseen, the urgencies and priorities.		

1 The impact scenario is the integrated product of a descriptive activity, deriving from the information that reaches the coordination center, accompanied by explanatory cartography, and of an evaluation of the effects that can be determined on man, on assets, on settlements, on animals and the environment, from the evolution in space and time of an event or a concomitance of events (induced landslides, volcanic events, overlapping risks such as pandemic) attributable to one or more of the types of risk. The primary objective of each impact scenario, as part of a civil protection plan, is to define and orient the decision-making activities aimed at implementing the strategic elements necessary for the execution of the plan itself (e.g. quantification of the necessary resources to be requested from the superordinate coordination centers, location of the coordination center, location of BoOs and road gates, hospitalization of the population in accommodation facilities outside the impact area, etc.). The contribution provided by the collection of direct evidence and the dynamic observation of the territory is of particular importance, thanks to which it is possible to reach a scale of detail and a wealth of information not comparable to the sole and exclusive use of thematic cartography, of hypothetical probabilistic calculations. In fact, even following these observations it will be possible to identify critical points or areas and report them to the coordination center, to make them become additional elements of knowledge shared with all the subjects involved and with the adoption of useful actions to improve the response to the emergency.

Note:

Preparation (pre-ASR) involves the commitment of all components (local authorities, rescuers, Union response mechanism) to understand the need to share basic knowledge in order to rescue effectively and to be rescued in the most efficient way possible.

The central purpose of preparedness (pre-ASR) is to develop community resilience against risk.

The answer is based on managing the consequences of the event through the acquisition of control over:

- the affected area (active sectors) - ASR 0;
- the resources (available and necessary) - ASR 0 & ASR 1;
- the scenario (probable effects of the event) - ASR 1.

Control over the area = understanding the spatiality of the problem.

- define the actual or probable extension of the affected area (damage to buildings, viability and emergency management areas);
- define the usability of the access and connection system and with which vehicles;
- identify the access routes, the areas necessary for the management of the crisis, the connecting roads;
- define the access system and the emergency roads in and out of the affected area.

Control over resources = understanding the size of the problem.

- identify which resources are present in the affected area;
- know which of these resources are committed or available;
- identify what additional resources may be needed;

Control over the scenario = understanding the nature of the problem.

- define the actual or probable scenario in terms of:
  - number of victims and deaths,
  - details of persons in need of search, rescue, evacuation, assistance,
  - the number and location of destroyed or damaged buildings,
  - actual or potential damage to essential infrastructure.
- determine how the nature of the problem can change with the progress of time;
- establish a priority system to respond to specific problems,
- establish a system for the allocation of personnel and resources to sectors;

The manual offers tools that allow you to obtain control in a time proportional to the desired detail, and this is the added value, because it allows

the event manager to always make informed decisions, what changes is the level of detail that derives from time available.

EN

Annex 2.1 BARRIER EFFECTS DETAILS

SUMMARY

The following annex includes a description of each barrier effect and the players that can have a critical role in facing them, such as:

- National Civil Protection authorities at EU and extra EU level,
- National Operations Centre,
- Local authorities (e.g. self-government, municipalities, public administration on different levels),
- First Responders,
- Assessment teams – all teams that carry out assessment activities in search and rescue (SAR) during emergency interventions in response to natural disasters and that face one or more “barrier effects”,
- Any other entities/teams involved in the assessment.

A 2.1.1 Access To The Area

As to the barrier effect called “access to the area”, the players that follow may play an important role in addressing and resolving it.

The national operations centres can collect and constantly update both ordinary and complex historical data in case of emergency, in order to build and progressively update the database with the history of the activities carried out, the resources employed and handled, the criticality faced and the chronological order, as well as the related documents drawn up or filed. Such data collection can be further refined thanks to sensitive parameters, i.e. relating to strategically relevant or critical elements, which is important to know in order to quickly face a disaster with the necessary operating resources, as well as the appropriate procedures for workers safety, in order to prevent probable barrier effects or mitigate environmental risks. On the basis of such data, it is possible to draw up maps correlating the data of the first and second group, according to the objectives pursued each time, such as for example:

- flight obstacle maps for air safety purposes
- asbestos risk maps, in post collapse scenarios, to protect rescuers;
- environmental risk indexes maps, to locate adequate and appropriate resources in the national territory;
- past stability verifications maps, to prepare useful monitoring of rescue daily activities.

In case of a disaster, the national operations centers may carry out analyses aimed at anticipating and limiting possible difficulties of access to the sites. If available, pre-and post-event aerial or other images and satellite data, can be analysed in order to immediately identify the location and extent of the emergency scenario, any critical issues, road network conditions and alternative routes, etc.. At the same time, using cadastral data, if available, it shall be possible to identify the type of building involved in the disaster, and the resulting possible vulnerability indexes.

Local authorities, on the other hand, with regard to any difficulties that an assessment team might encounter in reaching the emergency site, could provide useful information to address and, possibly, overcome them, about locations for landing aircraft near the areas affected by the disaster and the road network of access routes to the emergency site. Local authorities should therefore:

- map and periodically update the possible landing pitches or areas in their territory
- constantly update the various road plans and possible access routes to the areas of their territory.

EN

A 2.1.2 Time Pressure

The need for rapid assessment by the team is closely related to the certainty, on the part of the team itself and the operating teams, that as time goes by, it shall become increasingly difficult to perform rescue operations to save lives.

The national operations centres can assess the scenario in the short term and consequently the resources to be moved and where, through the following activities:

- drafting maps to give general information about the resources to be moved
- processing data and satellite images to assess the scenario in detail, thus allowing to optimize or integrate the resources sent immediately, verify intact and fast roads, as well as any environmental risks, etc..
- immediately collecting and processing data about the resources moved, the activities carried out, the areas of intervention, so as to provide immediately a common basis for monitoring the actions and planning the next steps.

A 2.1.3 Communications & IT

The flow and the channels of communications can be an important barrier effect in case of complex emergencies and the subjects interfacing within an emergency can contribute as follows:

The national operations centres can standardize information flows and dissemination at all central and local organizational levels, as well as staff training on information use. In fact, by collecting information from the commands of the affected areas on what needs to be found and distributed to the teams that are about to go to the emergency sites, they can usefully contribute to the resolution of barrier effects resulting from information flows and information technology. The national operations centres can in fact assess whether communication support shall be needed by the teams and what type they need (radio communications, field portal systems and IT personnel) which shall therefore be available while using such technologies.

Local authorities should identify ways and means to communicate with the population.

Local authorities should also assess the possible weaknesses of their communication networks and decide whether and how to strengthen them by saving data in a different storage.

In relation to the hours following a disaster, local authorities should, if possible, assess the stability and/or damage to their communications network and, taking them into account, identify how to communicate to provide information to the affected population and the various parties involved in the rescue.

The first responders, if able to keep on finding correct and timely information about the incident can be a real added value for the assessment team, as they are able to provide detailed and certain information.

- The assessment team shall update the means of communication provided, so as to ensure information flow even in difficult conditions such as:
- damaged and/or congested communication infrastructure
- excessively busy communication channels
- lack of reliable means of communication.

During preparedness, it shall be important to care for and maintain all the equipment, while in the mobilization phase it shall be important to verify proper operation of all electronic tools and to require information about the condition of the infrastructure and communications networks in the affected area and with their coverage so as to plan the operations to ensure communications with the USAR assessment team.

A 2.1.4 Incident and Whole Emergency Management

This possible barrier effect shall involve the whole management of the emergency and is therefore essential for the best possible result in terms of search and rescue of any victim.

The parties who can usefully contribute to deal with any barrier effects arising from incorrect incident or whole emergency management, shall be the following:

The national operations centers should identify in a standardized way their organizational responsibilities and roles in case of emergency and the local and regional players they shall interface with, monitoring and assisting, where necessary, the various persons that manage the emergency so that activation and mobilization shall be effective and timely.

The decision-making and communication flow between the national operations centers and those responsible at various levels for the emergency shall be supplemented by information on the teams being deployed, in particular on the assessment teams which are closely linked to the assessment of the emergency scale and extent. The interaction and passage of decisions must be clear and updated in order to allow for the correct flow of information.

Local authorities, in the event that a disaster of such a size that it requires the support of parties outside the local area, shall be familiar with and know how to fit properly into the information and management flow of those who manage the various levels of emergency. It is therefore extremely useful that the local structures and the parties that are part of them shall be properly trained and aware of the information flows that shall come from the local authority and go back to it.

The USAR assessment teams, in order to contribute usefully to deal with the barrier effects arising from incorrect incident or whole emergency management shall cooperate and, where necessary, set up the USAR Coordination Cell (UCC). The main task of the UCC shall be to channel all information from the affected territory.

A 2.1.5 New Technologies Dependency and Support

New technologies can constitute a barrier effect if in excessive large numbers and with different modes of operations which do not communicate with each other or are not useful within their limited time use. During preparedness, the technologies to be used, when and what type of support they need shall be decided.

EN

The USAR assessment teams shall use such technologies which include various possibilities such as SAPR (drones) and data management systems which are useful for USAR team's work.

More particularly, it is possible to use high endurance fixed wing drones able to embark multiple payloads (sensors), be conducted in bvlos operations (beyond the pilot's view) and to stream to remote operations rooms. Infrared sensors and streaming images to remote locations extends the use of drones.

For this reason, having a software platform that facilitates the collection and dissemination of such information, can play an essential supporting role in overcoming the barrier effect because it shall acquire data from sites and transmit digital and structured information. Such information stored in a database shall allow to prioritize interventions and to optimize on site resource management. These software platforms should aim at digitally collecting, transmitting, managing and analyzing data from disaster scenarios (earthquakes, building collapses, attacks, etc.).

Such platforms are made of three parts:

1) data acquisition
2) data transmission
3) information analysis and management.

A 2.1.6 Media Management

When speaking of media management, one thinks about activities related to acquiring every possible data and information related to the emergency, their analysis, the formulation of a communication message on the basis of the critical points identified and the directives received from the top management, the external dissemination of the official content, including any accompanying images.

Local authorities, should identify which media to use in the event of an emergency and how to manage information coming both from them and social media, deciding in particular not only which social media to monitor but also whether to do so in a one or two-way. Local authorities and rescuers should share information collected through local and social media, after verifying them as they are useful in understanding where it is most urgent to start assessing.

A 2.1.7 Use of Aircrafts / Helicopters And Generally Air, Land And Water Vehicles

If the work sites of both the assessment team and the people who shall then carry out the operations are difficult to reach, it is necessary to understand the most appropriate means of transportation to overcome such a barrier.

The national operations centres, intending to understand the means to be used according to the situation, can draft a series of documents including the characteristics of any means of transportation that can be used in case of complex disasters, on the basis of previous similar experiences. Such documents shall detail the procedures for using special means, such as aircrafts and drones while describing:

- the operating characteristics of each aircraft
- the potential and limits of use
- the loading plans divided by persons and instruments and an early analysis on the most suitable means depending on the activity to be carried out.

Local authorities, regarding the support they can provide as to such barrier effect, should:

- map and periodically update the possible pitches or landing spaces in their area;
- constantly update the various road networks plans and possible access routes to their own areas.

Upon identifying the specific transport needs of the assessment team, interaction with local authorities shall allow planning and selecting the most suitable vehicle for transport and subsequent movement from the landing pitch.

With regard to the assessment team, its equipment shall be modular according to the load capacity and the means of transportation considered as most appropriate, selected on the basis of the information found about the scenario's characteristics (ground vehicles, Fire-fighters helicopters, Canadair, outsourced aircraft...).

When mobilizing by land, therefore, light vehicles under 35 quintals with four-wheel drive shall be preferable and therefore appropriate for any type of terrain and climate.

It is important in some situations to have even lighter vehicles such as quads which are useful to overcome debris resulting from structural failure and can be used in particularly restricted environments.

The National Operations Centers can plan and arrange moving USAR resources by air, thus allowing for:

- early deployment of resources with consequent reduction of time pressure
- reaching environments that are difficult to access by land due to all those variables limiting access to the epicenter of the disaster as follows, particular weather conditions, impassable communication routes due to damaged infrastructure and surplus of requests for help from the involved populations in the suburbs.

A 2.1.8 Activities Outsourcing

In the course of a complex disaster, it may be necessary to resort to facilities and vehicles that are not in the possession of the bodies responsible for rescue activities, both for assessment and operational search and rescue. Some examples can be satellites not directly available to the rescuers or some military drones that can be operative in particularly challenging weather conditions.

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In such cases, the national operations centers themselves should identify, through their internal divisions, the needed means and equipment and who can provide them. During preparedness, it shall be possible to outline and plan the types of resources that can, as a rule, be useful to such purpose while implementing, if necessary, the necessary agreements. The armed forces, for example, are often indispensable either to provide specific means of transportations such as aircraft or to provide support in special cases and conditions to clear roads during natural or human disasters.

Fundamental support can come from local authorities who should have updated data about companies authorized to supply goods in case of need and possibly access appropriate websites to contact them.

In case the assessment team, during the USAR Assessment activities, shall need resources (tools, equipment, vehicles,...) that it does not have, it shall request them specifying in detail the characteristics of what it needs and why.

Annex 2.2 HOW TO ANALYSE EACH MAJOR RISKS

SUMMARY

The following annex includes a description on how Local Authorities can analyse the major risks of their territory and which procedures can be helpful in making correct decisions.

Although sectorisation, in the first phase of the emergency, is an indispensable activity for coordinating relief on site, it was not yet regulated in every country. The few general indications from the INSARAG guidelines define the fundamental elements to be followed, leaving ample scope for defining procedures. In other words, nowadays there is no shared procedure to follow for the sectorisation at a national and international level. On the other hand, it should be pointed out that sectorisation is a complex activity involving many aspects and knowledge, including: data about the territory in terms of orography, urbanisation, natural risks, data about building's construction technologies, of course also data about the activities of the rescuers, with particular reference to the timing for conducting the activities also as to the operational capacity planned for deployment in the field. According to INSARAG guidelines, this activity is initially attributed to the local Authority which, thanks to the knowledge of its territory and before the event, can perform sectorisation. If this activity has not been carried out by Local Authorities, during an emergency it can also be carried out by the first emergency teams with their support.

Anyway, the first emergency response, whatever is the nature and the extension of the event that generates it, if well planned, could limit the extent of human and economic losses. Emergency planning, to be done in peacetime, must consider a reliable risk analysis and an adequate intervention model, on whose basis the capacity for a first emergency response of the local authority shall be necessary for coordinating relief and assistance activities to the people involved.

In addition to the important procedural aspects, it shall be necessary to consider the preventive identification of the coordination centers, the emergency areas and all the structures aimed at managing emergencies in relation to the territorial context and the road network.

To better optimize the intervention model, and therefore, the emergency response, it is important that local authorities acquire useful information on the territory, for such purposes and the elements useful in general for emergency management are included herein.

A 2.2.1 Territorial Framework

Defining the territorial framework is useful to make the intervention of local resources and, in any case, the intervention of external resources possible to support local ones. It can be done describing the cognitive elements of the territory such as territorial references, orography, possible information on hydrography and meteorological and climatic context.

It would be helpful to describe information related to the urban settlement and demographic aspects (number of residents, with particular reference to vulnerable persons, properly surveyed) as well as, a summary of data on the strategic and relevant building and infrastructural heritage.

Finally, it is always desirable to collect demographic information related to the city centre and any hamlet.

Thematic maps could be used for representing all the information starting from those relating to the territorial context. It would also be advisable to provide a shareable digital vector support possibly saved on accessible web servers.

The cartography at the basis of a general overview could range in scale between the two following limits [1:15.000-1:25.000]. In the absence of an adequate technical cartography, a different cartographic base could be used such as specific aerial photogrammetry. It is always useful to integrate information with existing information systems (google, open street map, etc.).

A 2.2.2 Risks Identification

The intervention model will be planned considering the dangerous and risk conditions of the municipal area. The knowledge of the types of risks to which the municipal territory is subject and their location, allows the definition of reliable event scenarios.

The risks to consider are generally:

- Weather, hydrogeological, hydraulic risk;
- Forest fire interface risk;
- Seismic risk;
- Industrial, anthropic, railway risk;
- Snow, ice, avalanche risk;
- Tsunami risk;
- Other specific local risks;

For each type of risk, the best intervention model could be defined according to the event scenarios. The intervention model includes operational procedures for mobilising the first-emergency response and could be very useful to define correctly the capability. It would be also convenient to identify and define the most vulnerable areas for each type of risk and the number of people exposed in these areas.

Thematic risk maps should highlight the risks present in the municipal area at the specific operational scale with appropriate symbols. For example, the areas subject to flooding, or areas at risk of landslide and areas affected by environmental problems.

For each thematic map, the relationship between the area at risk and the state of danger for people, things and services could be underlined, in order to be able to identify the best strategies of active and preventive defence.

A 2.2.3 Emergency management centres

For a proper emergency management, it could be appropriate to identify all the buildings potentially usable, such as strategic infrastructures and strategic operating offices located in the municipal area whose functionality during earthquakes is key for civil protection purposes including:

- Operational offices for activities coordination (OSOC, LEMA buildings, etc.);
- Locations of Operating Structures such as Fire Brigades, Armed Forces, Police, headquarters of the local Voluntary Organization;
- Hospitals, health facilities;

Is important to recognize all relevant buildings, relevant structures and infrastructures in relation to the consequences of a possible collapse such as:

- crowded buildings such as schools, retirement homes, churches, temples, stadiums, cinemas, theatres, shopping centres, etc.;
- production sites and industries at risk of major accidents;
- landfills sites, waste plants, all other plants;
- Heritage Buildings;

It is desirable to define the overall accommodation capacity of the tourist facilities such as hotels, campsites, healthcare facilities, etc. located within the municipal territory or in the neighbouring areas and useful for ensuring shelter and assistance to the population.

In seismic areas, the choice of the building as the seat of strategic functions is subject to a careful assessment of the structural features, in order to assess seismic vulnerability, through simplified procedures. In general, it is important to acquire information on the project design, construction age, static testing and any structural changes made subsequently. The general maintenance status of both the structural parts and the finishes and installations must also be carefully assessed.

In order to choose the right facilities to host a coordination center, it is advisable to consider not only the building's own structural elements, but also the functional facilities (IT, road access, parking areas, etc.) and surrounding geo-morphological characteristics such as hydrogeological suitability, site amplification conditions, dangerous conditions deriving from landslides / instability of slopes, soil liquefaction and hydraulic hazard, as well as the elements deriving from anthropic risks. Further details in the definition of the elements for the assessment of such buildings as Coordination centres can be found in the forms included in Annex 2.4.

For identifying the elements of the emergency management system (strategic buildings, emergency areas, access and connection infrastructures) and of the interfering elements (structural aggregates, structural units), a scale ratio ranging between the following limits [1:10.000 – 1:2000] is recommended. It is extremely useful to depict the addresses and telephone emergency numbers and centres' location with appropriate symbols and dedicated information.

A 2.2.4 Emergency Areas

Emergency areas are places intended for civil protection activities and must be previously identified in emergency planning. It is useful that local authorities, during preparedness, identify the emergency areas as follows:

- *Population waiting areas*, in which to accommodate the population before the event or in the immediate post-event.

These Areas are places where the population shall gather first, usually squares, parking lots, public or private spaces deemed as suitable and not subject to risk, reachable through a safe pedestrian and with a highlight path. The population can be surveyed in such areas and will be able to receive information on the event and the first aids, pending the preparation of the Hospitalisation Areas. Population Waiting Areas are generally used for a few hours.

The number and size of such areas vary in relation to the demographic dislocation and must follow criteria of homogeneous coverage of the population residing in a municipality.

- Areas and centres of assistance of the population, in which to set up the structures for the assistance of the population affected by an emergency event.

These Areas are safe places where the first housing settlements shall be installed: they must be adequately sized and be already equipped with a minimum set of technological infrastructures (electricity, water, sewage, etc). Usually, they are sports fields, large parking lots, exhibition centres, gyms, sports facilities, state-owned areas of other types. The population assistance areas shall be used for short, medium and long periods, depending also on the type of emergency to be faced and the type of housing facilities that will be set up.

- Areas for gathering rescuers (BoO) and resources, in which to convey the rescuers, the resources and the means necessary for the rescuing the population.

The gathering areas and rescuers ensure a rational use of rescuers and resources in the intervention areas: they must have sufficiently sized to accommodate logistic structures and store the means and materials needed for rescue operations.

They must be located in open safe areas, with easy access through the main road network and, as far as possible, distinct from the population shelter areas, in order to avoid barrier effects. The Rescue Collecting Areas shall be used for the entire period necessary to complete the rescue operations. It is important that local authorities identify such areas in an adequate number as to the needs identified during the risk analysis phase.

Further details about what is needed for assessing such Areas can be found in the forms included in Annex A.2.4.1.

- Emergency landing areas, for reaching difficult to reach areas, where landing of rotary-wing vehicles is envisaged.

Emergency landing zones (Z.A.E.) allow to reach areas that are difficult to access by using rotary-wing aircrafts and can also allow emergency-technical and health rescue activities. Possible pitches registered by Aviation Services and for which routine maintenance is required must be preferred. When identifying specific areas, the following general issues shall be taken into account:

- presence of fixed and / or mobile obstacles in the vicinity of the site;
- availability of adequate spaces for landing / boarding of men and materials;
- presence of grassy surface and substantial round/solid grounds, such as to be able to guarantee the operation of at least helicopters with trolley with pads without mass limitations, i.e., medium-light helicopters with wheeled carts without load distributors;
- roads with the centres of the coordination centres/leading to the coordination centres and other strategic buildings.

Further details for assessing such Areas can be found in the forms included in Annex A.2.4.2.

Annex 2.3 SECTOR SIZE METHODOLOGY

SUMMARY

The following annex includes details related to sector sizing methodology and some examples addressed to Local Authorities or Rescuers that are interested in conducting sectorisation both during the pre- assessment phase or after an event.

A 2.3.1 Rural Areas and Scarce Density of Buildings

In a rural area it is possible to find residential buildings inhabited by those mainly devoting to farming activities and holiday homes, which are inhabited only at certain times of the year, and agricultural buildings such as farmsteads, stables, livestock farms, etc... In these sectors the presence of an industrial fabric is however very scarce and shall not be included in the following analysis.

The nature of this type of territory, consisting of areas with low population density and with few scattered buildings in mountain areas, could influence the factors analysed for sector sizing. In fact, the time taken by the assessment teams to verify a building (about 15 minutes) could vary a lot as the presence of several isolated rural buildings increases the time the teams need to reach such buildings scattered in the sector.

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In order to size the sector, several criteria are reviewed below to define which of them allow for assessing each sector in the shortest possible time.

A 2.3.2 Local Authority's Predefined Territorial Extension

Territorial extension predefined by the local authority: e.g. territorial boundaries of a settlement. For example, the town of Amatrice, in Italy, affected by an earthquake in 2016, includes 69 hamlets with most buildings packed along the main road crossing them. In similar cases, the assessment teams, as soon as reaching the site immediately after the earthquake, shall work at very short distances because the buildings are very close to each other and, upon completing the assessment of the damaged buildings, they shall necessarily move by car to check the remaining isolated rural buildings which, being few and mainly for agricultural use such as farmhouses, livestock farms, etc., shall be checked rather quickly.

In fact, the teams shall take longer to reach the isolated buildings rather than probably assessing them. In this case the size of the sector could coincide with the administrative territorial boundaries provided by the local authority such as the red lines in Figure 2.2.1, for example in case of CASALE, a hamlet of Amatrice. As it is easy to guess, **in this case the practical usefulness of sectorisation vanishes because the territorial limits are**

irregular and difficult to represent in a map of the scenario even during the division of the affected territory by the personnel in charge of mapping.

0.25 km2 Surface Area Made Of 500 By 500 m Squared Sector

Alternatively, the area shall be divided into regularly square-shaped polygons, of practical use not only for local authorities, but also for mapping staff and, above all, for rescuers who are not familiar with the area.

In order to limit the time needed for assessment and depending on the amount of buildings present (datum known to the local authority on the basis of cadastral maps), it is possible to choose a 500 m by 500 m squared sector so that the area is 0.25 km2, regardless of the number of buildings included, which however, taking into account the rural area, will be very limited and with very low population density (Figure 2.2.2).

Figure 2.2.1 – Farm home, hamlet near Amatrice

Figure 2.2.2 - 500 by 500 m sector with a 0.25 km^2 surface area

700 by 700 m Sector and 0.5 km2 Surface Area

By increasing the size and selecting a 700 by 700 m sector with an area 0.5 km2 other factors influencing the assessment arise.

In the case of the Amatrice area, as shown in Figure 2.2.3, two different hamlets located on different hills and separated by a valley fall in the same sector. In this case the teams, to complete assessing the sector, should check the buildings closely located along the road, the isolated buildings of each hamlet and also reach the other promontory by crossing the valley separating the two villages.

For these reasons such an approach is of little use because it does not allow, unlike the previous case, to close the sector in the shortest possible time.

Figure 2.2.3 - 700 by 700 m sector with a 0.5 km² surface area

It is therefore clear from the analysis, that using squared polygons with a surface area of 0.25 km2 facilitates the assessment and makes it possible to close the "active" sectors as quickly as possible.

Other considerations could be done for a rural and peripheral wide area involved into the scenario: the buildings could be also disseminated in the area, so the likelihood that their rubble could cover the road among two buildings is very low, thus making road access almost always possible and rescue teams can optimize the time they spend to move between buildings by car (Fig. 2.2.4).

Fig. 2.2.4 – Ischia Island, Italy – Rural affected buildings in the 2017 earthquake – moderate damage degree

Below are two examples of sectorisations carried out by rescuers according to Local Authorities in the case of Amatrice, Central Italy, affected by an earthquake in 2016 (Figure 2.2.5) and the area of Durres, Albania affected by an earthquake in 2019 (Figure 2.2.6).

Fig.2.2.5 – Amatrice, Italy, 2016 - Sectorisation

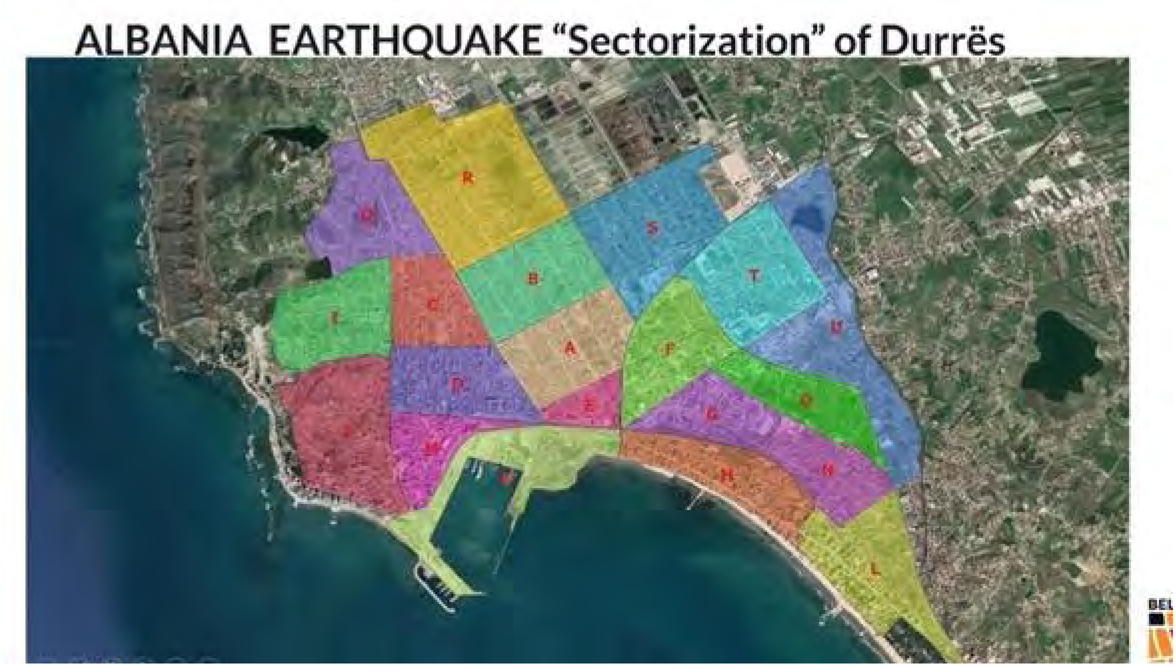

Fig.2.2.6 – Durrës, Albania, 2019 - Sectorisation

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Annex 2.4 AUXILIARY PROCEDURES AND IDENTIFICATION FORMS FOR LOCAL AUTHORITIES

SUMMARY

The following annexes include forms that could be used by Local Authorities to identify useful information that can help carrying on carry the following activities: pre-assessment, assessment, pre-sectorisation and sectorisation.

The annex herein includes all the forms for collecting useful information for managing the emergency.

A 2.4.1 BASE OF OPERATION FORM (BELICE BoO FORM)

A 2.4.2 EMERGENCY LANDING AREAS FORM (BELICE HELIPORT FORM)

A.2.4.1 BELICE - BASE OF OPERATION FORM

MUNICIPALITY ______________________ C.C.. ______________________

PROVINCE ______________________ N. FORM __________

REGION ______________________ DATE ___/___/_____

STATE ______________________

PROPERTY		CITY-AREA ______________________	AVERAGE ELEVATION (S.L.M.) m ______
PUBLIC	PRIVATE	ADDRESS AND/OR NAME AREA - OWNER ______________________ ______________________	
		Lat./N __________ Long./E __________ SYSTEM (__________)	
⊠	⊠	USE ______________________	
SITE AREA m² __________			

EVALUATION INDICATORS

A : IS THE AREA ALREADY PAVED?		***MULTIPLY COEFFICIENT***
❑ Yes **(COEFF. A=1)**	❑ NO **(COEFF. A=0,8)**	❑ A=0,8 ❑ A=1 TIPO PAVIMENTAZIONE ______________

A – NOTE : ______________________

B : IS THE AREA SITUATED ON A SLOPE AND/OR ROUGH TERRAIN?			***MULTIPLY COEFFICIENT***
❑ Yes **(COEFF. B=0)**	❑ Yes BUT IT WOULD BE ENOUGH WORKS OF MODEST AUTHORITY TO MAKE IT FLAT **(COEFF. B=0,9)**	❑ NO IT'S FLAT **(COEFF. B=1)**	❑ B=0 ❑ B=0,9 ❑ B=1

B – NOTE : ______________________

C : DOES THE AREA FALL INTO FLOOD ZONES?		***MULTIPLY COEFFICIENT***
❑ Yes **(COEFF. C=0)**	❑ NO **(COEFF. C=1)**	❑ C=0 ⊠ C=1

C – NOTE : ______________________

Q: DOES THE AREA BELONG TO A LANDSLIDE SECTOR?		***MULTIPLY COEFFICIENT***
❑ Yes **(COEFF. D=0)**	❑ NO **(COEFF. D=1)**	❑ D=0 ⊠ D=1

D – NOTE : ______________________

E : IS THE AREA BELOW ROCKY CLUSTERS OR LANDSLIDES?		***MULTIPLY COEFFICIENT***
❑ Yes **(COEFF. E=0)**	❑ NO **(COEFF. E=1)**	❑ E=0 ⊠ E=1

E – NOTE : ______________________

F : IS THE AREA FAR FROM THE COMMUNICATION ROUTES?			***MULTIPLY COEFFICIENT***
❑ Yes CLOSER DISTANCE TO ROAD EQUAL TO 1000 m **(COEFF. F=0)**	❑ Yes CLOSER DISTANCE TO ROAD BETWEEN 200 m E 1000 m **(COEFF. F=0,8)**	❑ NO CLOSER DISTANCE TO ROAD LESS THAN 200 m **(COEFF. F=1)**	❑ F=0 ❑ F=0,8 ❑ F=1

F – NOTE : ______________________

G : IS THE AREA PLACED IN PROXIMITY OF THE DRINKING WATER NETWORK?			***MULTIPLY COEFFICIENT***
❑ Yes INTERNAL NETWORK **(COEFF. G=1,05)**	❑ Yes LESS THAN 200 m **(COEFF. G=1)**	❑ NO UPPER THAN 200 m **(COEFF. G=0,9)**	**❑ G=0,9 ❑ G=1 ❑ G=1,05**

G – NOTE : ______________________

H : IS THE AREA PLACED IN PROXIMITY OF THE GRID OR ELECTRIC CAB?				***MULTIPLY COEFFICIENT***
❑ Yes INTERNAL NETWORK **(COEFF. H=1,05)**	❑ Yes LESS THAN A 200 m **(COEFF. H =1)**	❑ NO UPPER THAN 200 m **(COEFF. H =0,9)**		❑ **H=0,9** ❑ **H=1** ❑ **H=1,05**
H – NOTE :				
I: IS THE AREA PLACED IN PROXIMITY OF THE SEWERAGE SYSTEM?				***MULTIPLY COEFFICIENT***
❑ Yes INTERNAL NETWORK **(COEFF. I=1,05)**	❑ Yes LESS THAN A 200 m **(COEFF. I=1)**	❑ NO UPPER THAN 200 m **(COEFF. I=0,8)**		❑ **I=0,9** ❑ **I=1** ❑ **I=1,05**
I – NOTE :				
L : IS THE AREA PLACED IN PROXIMITY OF THE GAS NETWORK?				***MULTIPLY COEFFICIENT***
❑ Yes INTERNAL NETWORK **(COEFF. L=1,05)**	❑ Yes LESS THAN A 300 m **(COEFF. L=1)**	❑ NO UPPER THAN 300 m **(COEFF. L=0,95)**		❑ **L=0,95** ❑ **L=1** ❑ **L=1,05**
L – NOTE :				
M : IS THE AREA ALREADY EQUIPPED WITH COVERED SURFACES THAT CAN BE USED IMMEDIATELY?				***MULTIPLY COEFFICIENT***
❑ Yes **(COEFF. M=1,05)**	❑ NO **(COEFF. M=1)**			❑ M=1 ❑ M=1,05
M – DESCRIPTION :				
N. FLOOR	AVGARAGE FLOOR AREA m²	N. WC		
M – NOTE:				

WARNING - If these boxes are grey back coloured, means that the site is unsuitable, so the evaluation operation can be stopped, unless further sites can be examined, in which case the comparative evaluation will take place on the basis of the sensitivity and experience of the examiners, assigning new values to the indicators on the reported.

FINAL JUDGMENT

$\mathbf{I_{id}}$ = = **A** × **B** × **C** × **D** × **E** × **F** × **G** × **H** × **I** × **L** × **M** × **N** = ⌴,⌴⌴⌴

- ❑ $\mathbf{I_{id}} \geq 1$ — The area is fully suitable for settlement.
- ❑ $0,475 \leq \mathbf{I_{id}} < 1$ — The area is only eligible for settlement after small measures.
- ❑ $0 < \mathbf{I_{id}} < 0,475$ — The area is suitable for settlement only after substantial and onerous interventions.
- ❑ $\mathbf{I_{id}} = 0$ — The area is certainly unsuitable for settlement.

Note - It is advisable to avoid the choice of areas located in proximity of industrial plants and cemetery facilities, or communication routes with high vulnerability elements, which can be severely damaged by seismic events. The notes should be filled only if they provide useful information about the indicator under consideration.

A.2.4.2 BELICE – HELIPORT FORM

MUNICIPALITY ⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴ C.C.. ⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴
PROVINCE ⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴ N. FORM ⌴⌴⌴⌴⌴⌴⌴⌴
REGION ⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴ DATE ⌴⌴/⌴⌴/⌴⌴⌴⌴
STATE ⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴

PROPERTY		CITY-AREA	AVERAGE ELEVATION (S.L.M.) m
PUBLIC	PRIVATE	ADDRESS AND/OR NAME AREA - OWNER	
		Lat./N ⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴ Long./E ⌴⌴⌴⌴⌴⌴⌴⌴⌴⌴ SYSTEM (__________)	
❑	❑	USE	

CERTIFIED	☐	temporary	☐	Lighting yes ☐ - no ☐	Size (m²) ⌴⌴⌴⌴⌴	Presence of obstacles ☐
not reported	☐	fixed	☐			

Auxiliary area	☐	Lighting yes ☐ - no ☐	Size (m²) ⌴⌴⌴⌴⌴	Presence of obstacles ☐

N	ID-NAME	lanes	Minimum width (m)	Minimum height (m)	obstacles

Annex 2.5 SIMPLE PROCESS TO SECTORIZE WITHOUT PREPAREDNESS

SUMMARY

The following annex includes the description of how to draft a pre-sectorisation or a sectorisation plan if not previously done before the event.

The following steps were identified having in mind rescuers' needs in the hours immediately after the event.

After having determined the impact area, it shall be possible to superimpose the preventive sectorisation on the map.

Such sectorisation shall be carried out based on:

- Census areas
- OpenStreetMap

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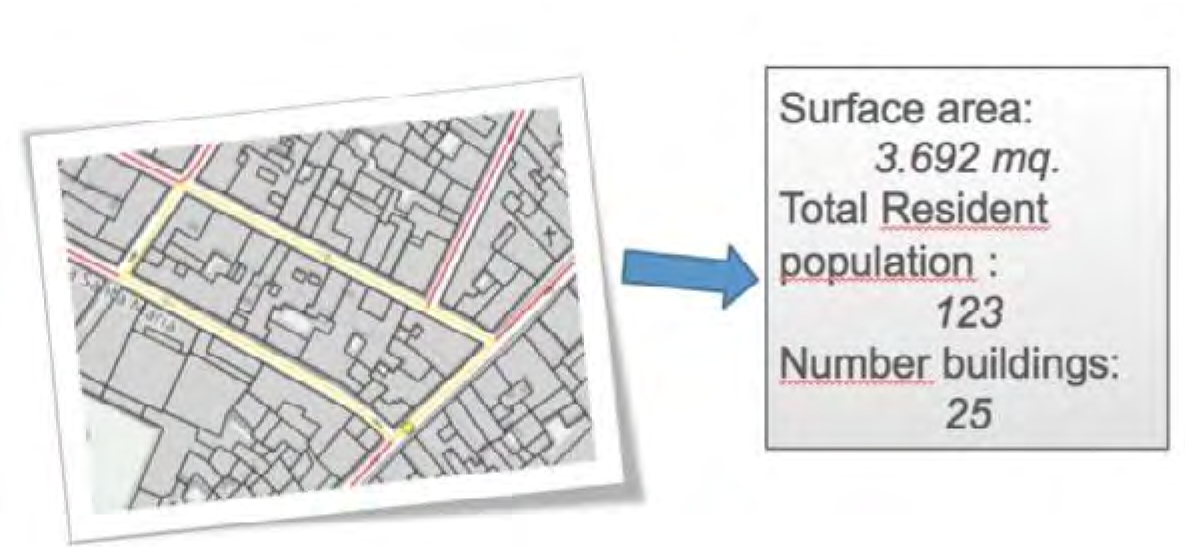
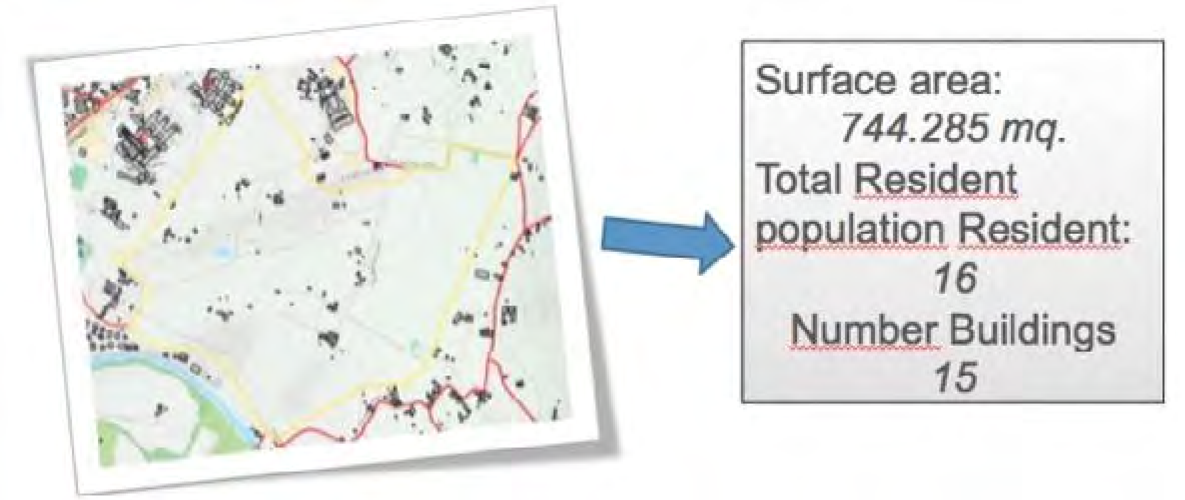
A 2.5.1 Census Areas

Census areas are used for statistical purposes. They contain a great deal of data on population and buildings.

These areas are determined according to population density. The higher the population density is, the smaller the census area is and vice versa. And they have rivers, roads, lakes as boundaries.





The areas include a series of information that are useful for prioritising interventions:

1 NUMBER OF INHABITANTS

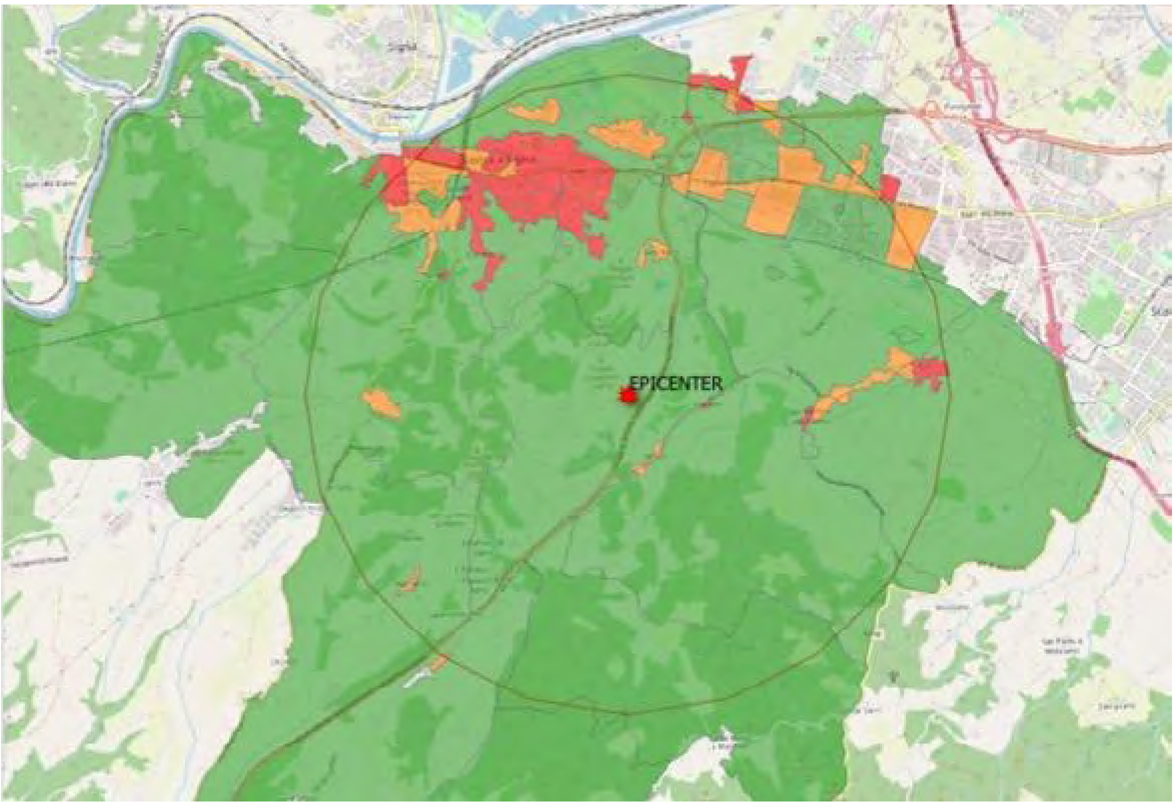
2 NUMBER OF BUILDINGS

3 NUMBER OF BUILDINGS ACCORDING TO TYPE OF CONSTRUCTION (REINFORCED CONCRETE, MASONRY, OTHER)

4 NUMBER OF BUILDINGS BY YEAR OF CONSTRUCTION

5 NUMBER OF BUILDINGS BY NUMBER OF FLOORS.

On the basis of such elements, it is possible to set a priority algorithm.



The red sections highlight areas where priority action is needed.

A 2.5.2 Sectorising With Openstreetmap

When census data are missing, it is possible to sectorise the areas on the basis of the free downloadable data of ‘openstreetmaps’.

A 2.5.3 Openstreetmap

OpenStreetMap is a freely modifiable map (previously controlled) of the whole world, basically built from scratch and issued with a free license.

The OpenStreetMap license allows free access and use of the images and of the data used to create it, thus promoting their smart use. Collaborators and volunteers of the project not only map before a pc but also move in the streets and the countryside with GPS to create the Map and this means that the map grows all the time, any minute, thus becoming more complete and better.

A 2.5.4 How To Sectorise with Openstreetmap

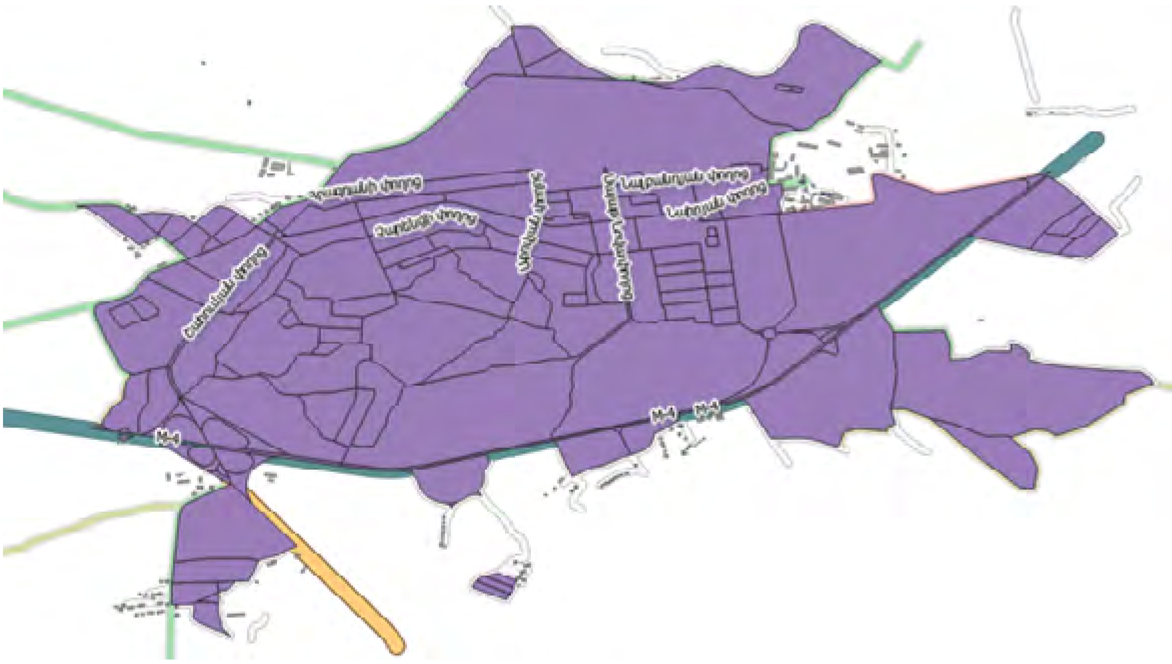
With any GIS software it is possible to download the vector data of the OSM divided by streets (lines) and buildings (areas) Alternatively it is possible to get them from the site in shapefile format.

https://www.geofabrik.de/data/download.html

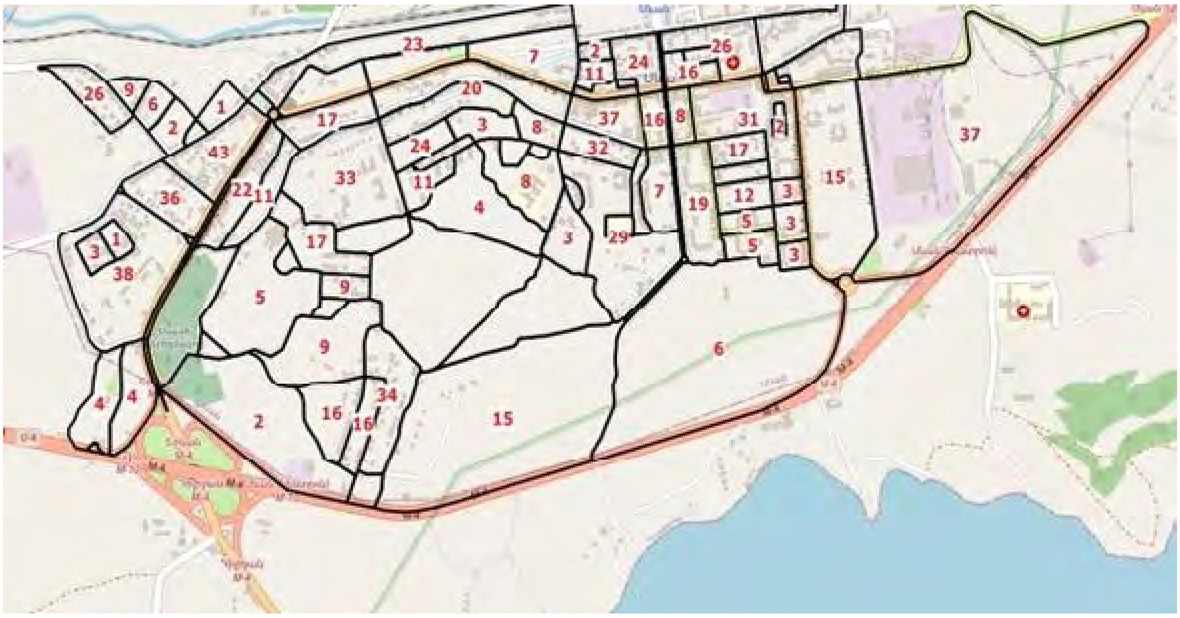
Let’s take the example of Sevan a city in Armenia.

Data relating to roads and buildings of the osm are downloaded or imported in vector format.

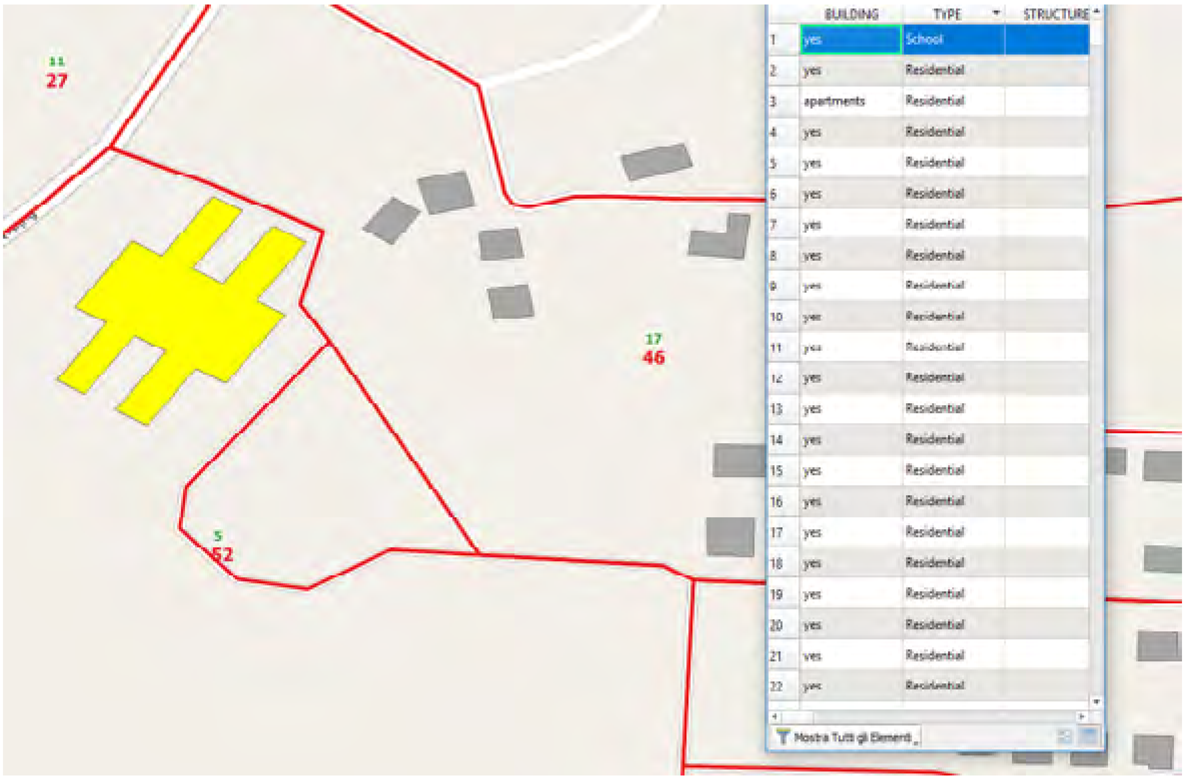
The GIS software was asked to create areas based on road junctions and rivers. This is the result.



The GIS software generates a field with either numeric or alphanumeric id of created areas and to include a field with the number of buildings enclosed in each polygon. And then it is cleaned up the result where the red number identifies the number of buildings included in the area.



The osm attributes also include the type of building, In the example below the yellow one is a school.



	BUILDING	TYPE	STRUCTURE
1	yes	School	
2	yes	Residential	
3	apartments	Residential	
4	yes	Residential	
5	yes	Residential	
6	yes	Residential	
7	yes	Residential	
8	yes	Residential	
9	yes	Residential	
10	yes	Residential	
11	yes	Residential	
12	yes	Residential	
13	yes	Residential	
14	yes	Residential	
15	yes	Residential	
16	yes	Residential	
17	yes	Residential	
18	yes	Residential	
19	yes	Residential	
20	yes	Residential	
21	yes	Residential	
22	yes	Residential	

These automatic (computer created) sectorisations can be joined or possibly divided in a simple way, thus obtaining a maximum 60 buildings encoded and close, one to the other, per area.

It is also possible to consult the population density in this link of the area concerned.

https://ghsl.jrc.ec.europa.eu/ucdb2018Overview.php

In practice, a cartographic operator needs to have:

- a pc with gis software (also open source)
- data that can be freely retrieved from OpenStreatMaps
- an orthophoto map of the area
- census data where available or alternatively density of population data.

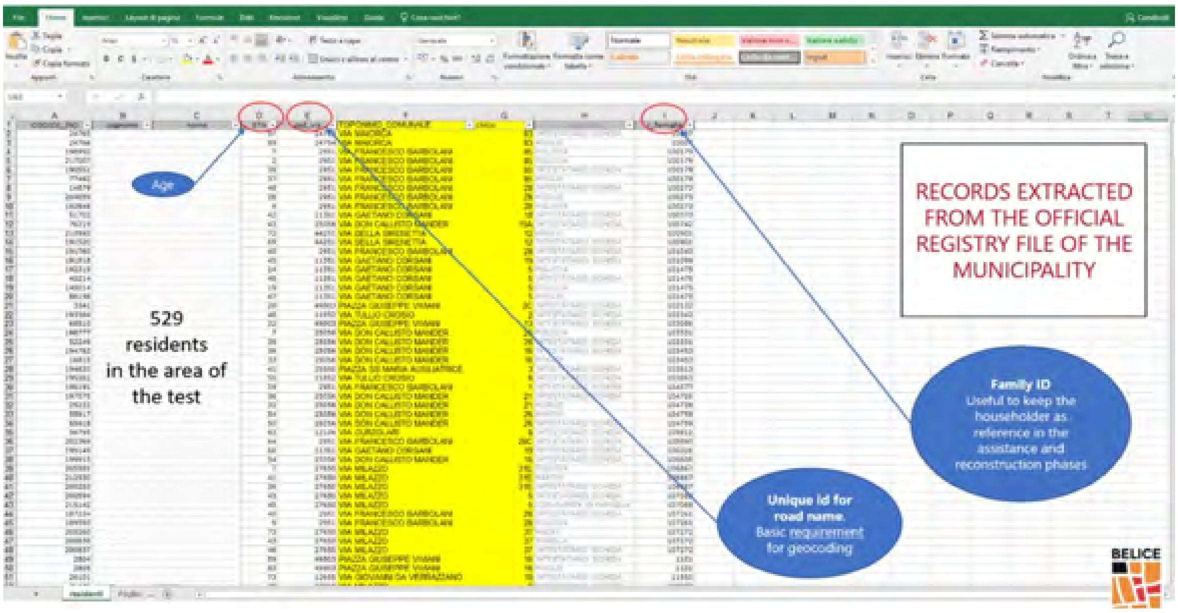
EN

Annex 2.6 LOCAL AUTHORITY DATA COLLECTION POSSIBILITIES

SUMMARY

The following annex includes a detailed description on how Local Authorities can collect data and information useful for pre-sectorisation or sectorisation and between which tools and possibilities they can choose.

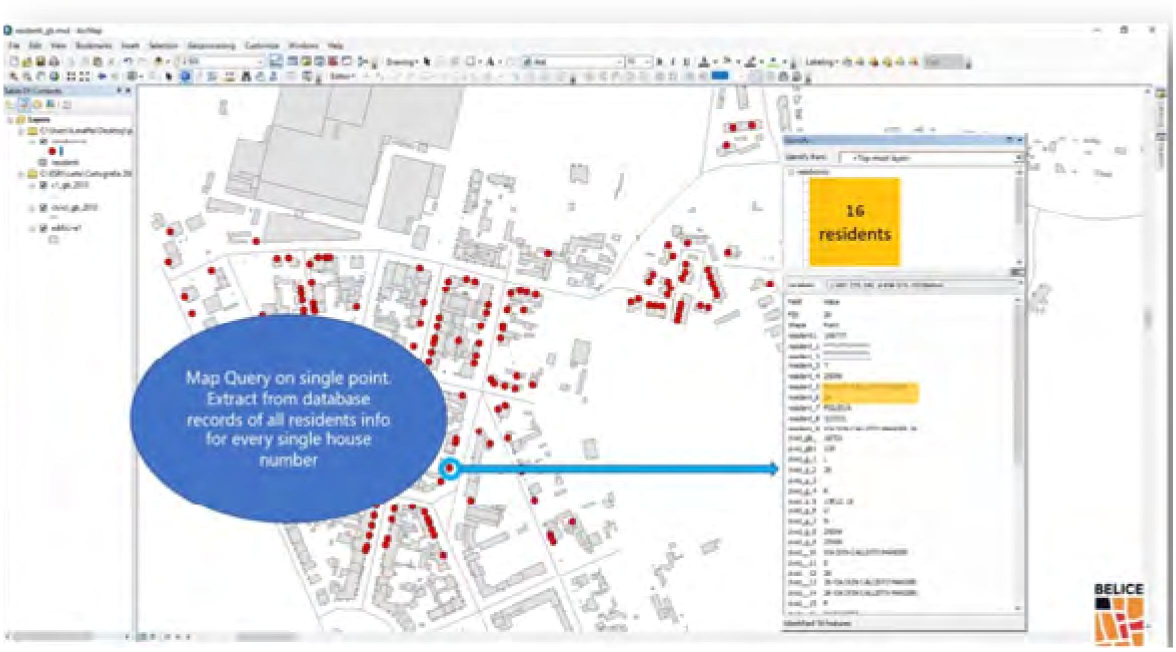
Local authority can quickly assess the vulnerability based on data already available in the Municipal database. Such assessment, although performed quickly can be very important if done before the event so as to provide info to the rescue community storing and indexing the results on a cloud platform that can be used even if the local data infrastructure is damaged.



The official registry file of the Municipality contains important information like the Family ID, the age of residents and the ID road name.

The ID road name must be unique and is a basic requirement for geocoding, what is important is to have a good street index so to avoid records with name of the same road written in different way. In this case even if the resident's info is not already geocoded can be processed with some basic steps provided below.

The Family ID is also useful to keep the householder as reference in the assistance and reconstruction phases having one single person for each family group; also, the age of residents could allow to better know the needs of the population.



With a GIS software, using the geocoding tool, based on the “ID road name” table field, is possible to project the resident’s information on a map: every dot represents the total of residents for every single house number representing the population distribution in the affected area. For every point corresponding to single house number is possible to have the info of all residents directly from the map.

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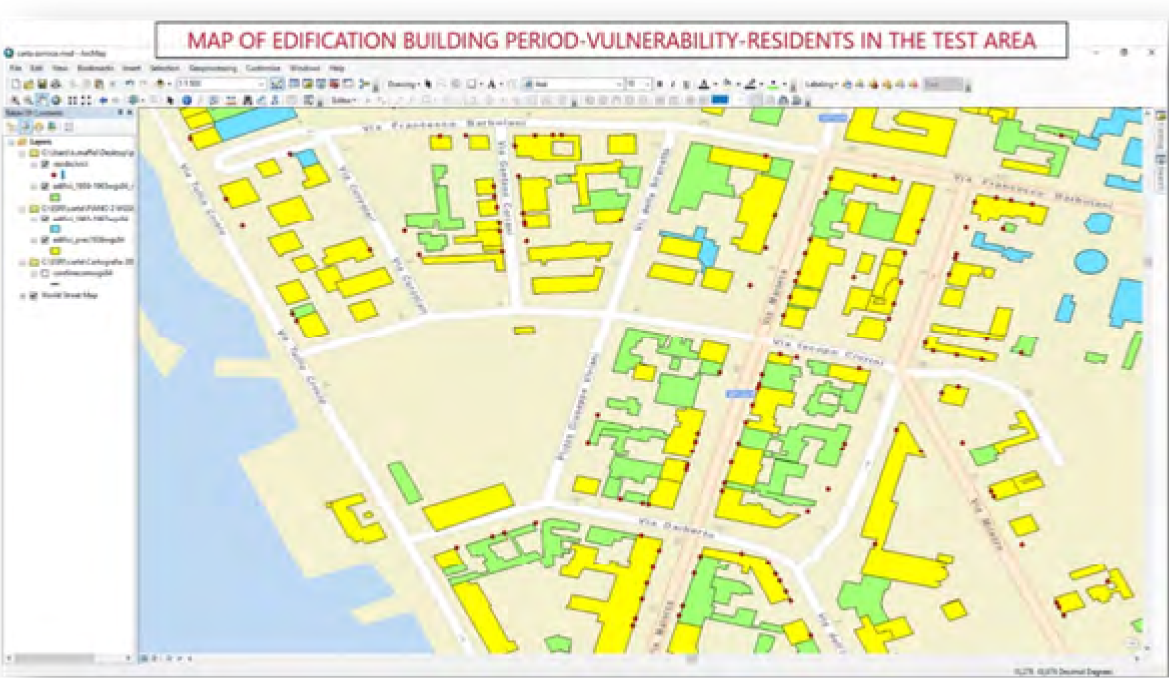
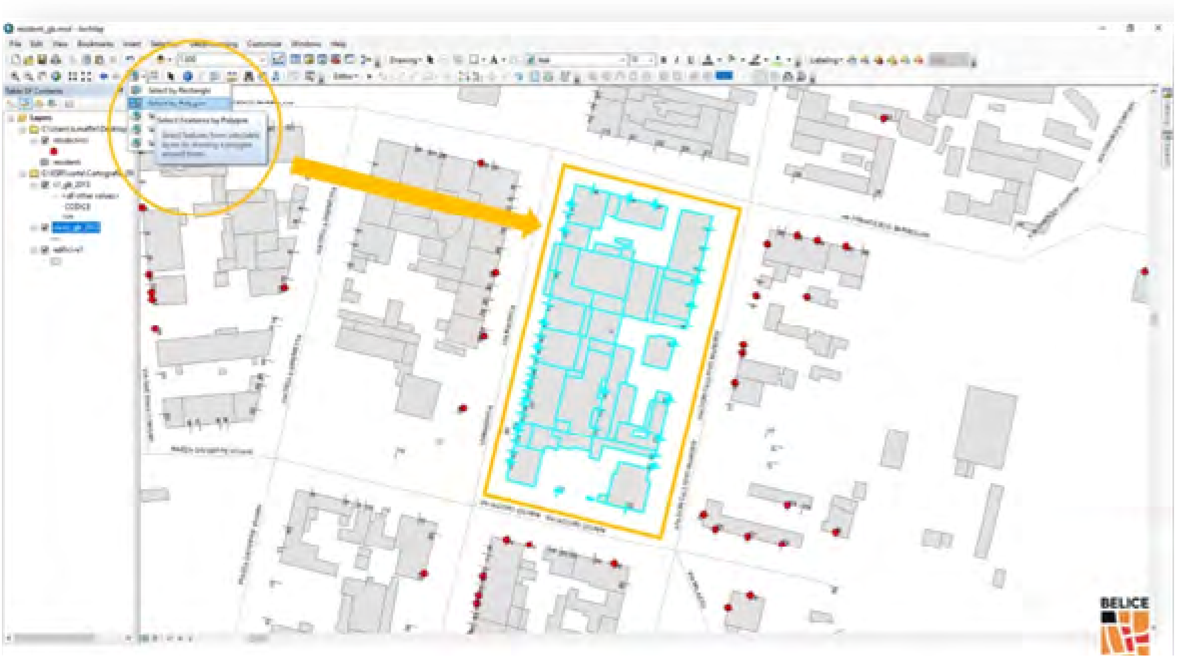
In case the Municipality has a GIS layer of the edification building period, is possible to add this information on the resident’s map.

The concept for the expedite assessment is that older buildings are more vulnerable.

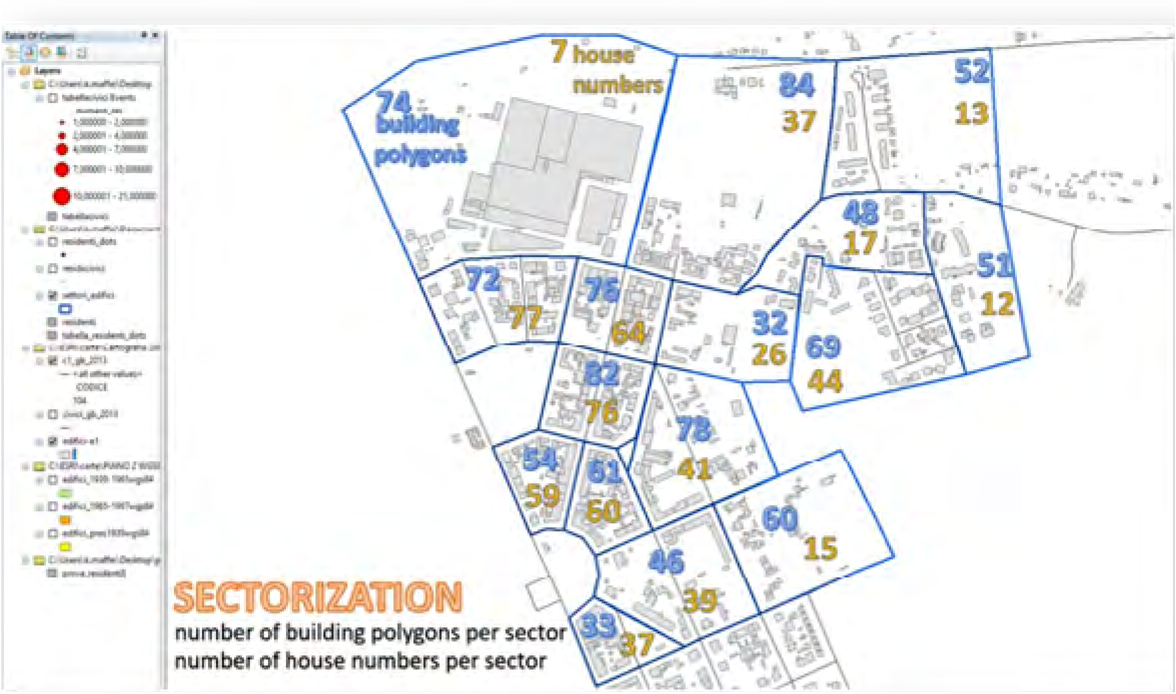
Adding the period of construction layer to the GIS map allows the first responders to better assess the characteristics of the affected area.



Using the “select by polygon” tool on a GIS map it is also possible to extract how many residents live in the area of interest. The selection produces a table providing for the information about the residents (name/surname, address, age and if householder).



The Municipality using the extracted info above can proceed to define the polygons, part of the pre sectorisation, so to try having around 50 buildings per sector. The sector is manually defined keeping physical elements as part of the perimeter (sea, river, big road...). For each sector using the GIS is possible to immediately known how many polygons or house numbers are present. In this case it is evident that building polygons (similar to census data) overestimate the number of buildings because also small building annexes are independent polygons. On the other hand, house numbers probably underestimate a bit the building numbers.



In order to add an additional info to the sectors it is possible to also add the building period layer so to have an additional info about vulnerability for proper assessment, an info that can be useful to define the sector priority during assessment.

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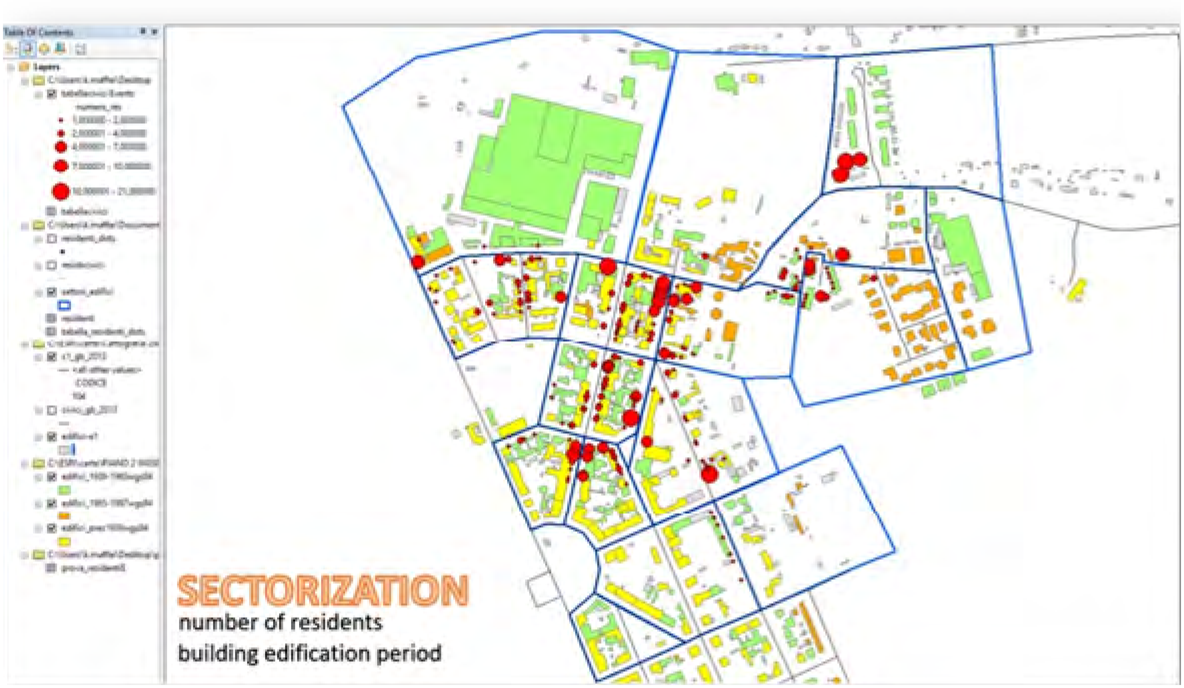
Another info that can be included in the sectors map is the resident's layer. In this case, resident's info was aggregated for each single house number providing a visual representation divided by category. That type of view can provide an immediate feedback on the type of building; the top left area is for example an industrial area while the central one has no residents because buildings are used only during summer vacations.

The two additional info layers can be merged together so to have a unique map with sector, period of construction and resident's info. The map in this case shows the sector size so to allow for sector assessment using the planned amount of prioritize the sectors if the assessment team are numerically less than the sector in the area affected by the event.



An important aspect is to use geographic info in geographic coordinates with wgs 84 datum so as to have data ready to be exchanged without no need for complex conversion during emergency phases. Thus, data can be acquired also on the go, ready to be used on standard viewing platform (google earth, gis).

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Annex 2.7 NAMING OF SECTORS AND SIZE OF SECTORED AREA

SUMMARY

The annex as follows includes information about how to name sectors in line with the proposed methodology of this Manual. It can be a very useful tool for managing sectors and operational sites.

The “span of coordination” concept involves a flexible number of teams and is based on the concept of “span of control”. Once the number of teams to manage becomes too large (generally 3-7 entities to manage is average, while 5 teams is the best compromise) their activities become more difficult to coordinate.

In general, when the optimal span of coordination will be exceeded, sector coordination should be considered. When this occurs, it is necessary a control structure that involves teams, sector coordination, and USAR Coordination headquarter.

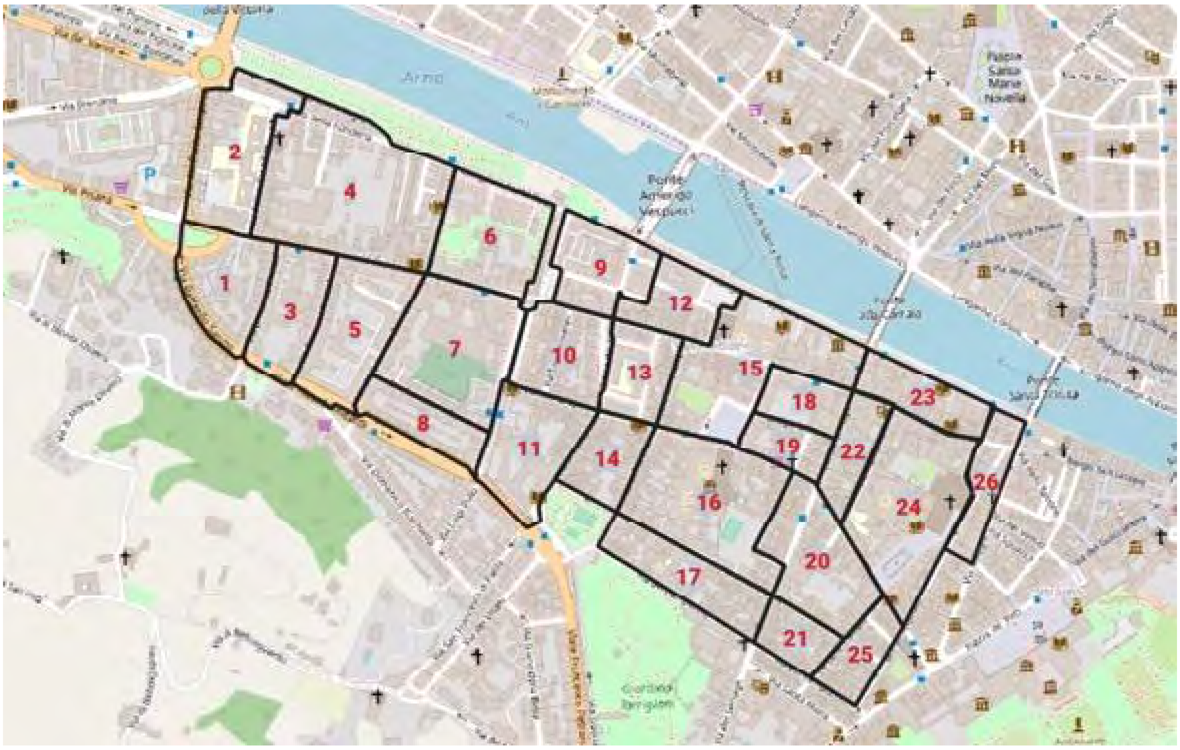
However, due to the limited time to start the assessment operations, the Emergency Manager, by evaluating the size of the affected area, can foresee the quickly use of locally placed advanced command posts, defining the territorial competence boundaries, to manage the assessment teams within the assigned area.

The use of information technologies platforms fits in this activity and is recommended, IT is extremely useful to manage a large amount of data directly from and to the assessment teams, allowing for cutting down information management time.

Due to a large number of sectors which may need to be assessed, the use of plain numerals is recommended to name the sectors.

The image below shows numbered sectors identified in a highly urbanised area of Florence, whose boundaries run along streets.

Such sectors were named with numbers, have an extensive surface and a large number of buildings.



Thus, it shall be necessary to divide the sectors in numbers, having the following characteristics:

- About 50 buildings each.
- The boundaries shall run along streets/roads, rivers, railroad, lakes etc.
- They shall be identified clockwise.

Each Assessment Team shall be given the following:

- A technical sheet including the map of the sector.
- The information to reach it.
- Any additional note.
- 20 progressive numbers to name unmistakably the identified sites.

The sector code must be separated from the worksite number by a hyphen to prevent any misunderstanding 1-1, 1-2, 1-3 ...

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Annex 2.8 ASR1-BELICE PLUG-IN

SUMMARY

The following annex includes a detailed description of a tool to quickly start a first plan for the estimation of damages (WAAP - Wide Area Assessment Process) and for the first assessment of the number of teams necessary to start Search and Rescue (SAR) operations using data available on the web before and immediately after an earthquake.

ASR1-BELICE Plug-in aims to create a primary sectorization of a territory following a seismic event, through automatic routing and using only data available and freely usable on the web in every part of the world.

The division into sectors allows you to define the number of areas to which to send the first assessment and rescue teams and, consequently, to have the first rough indication of the number of teams needed to deal with the post-earthquake emergency very quickly.

The tool is to be used where a sectorization carried out in the emergency planning and/or civil protection phase is not already available. In fact, local authorities generally have more up-to-date and qualitatively better data.

The plug-in was developed in python language to be used both on free software such as QGIS, and on commercial software such as ARCGIS.

The data used are extracted from freely accessible sources on the web such as:

Openstreetmap which is the largest free cartographic database available on the web. With a continuous and widespread update by its Contributors.

Worldpop which represents one of the most important raster databases globally, from which it is possible to download many information levels of each country ranging from the estimated population on 100mtx100mt grids to urbanized areas, etc .. These data are used, as reported on the site World Pop, from many international organizations, foundations, and agencies such as: Mapaction, UNOCHA, International Red Cross, USGS, FAO and many more

Shakemap represents the only necessary post-event data that is fundamental to determine the impact area and the sectorization within it.

This data is available about 20 minutes after the event and is freely put online by geophysics and volcanology institutes around the world. The shakemap is a vector data that provides an immediate display of the level of shaking of an area hit or affected by an earthquake.

The procedure is divided into two parts:

- Impact
- Sectorization

A 2.8.1 Impact

This procedure requires 2 input data:

- Shakemap layer (vector)
- Built area (raster) available from worldpop.

The form returns:

- impact area
- a first rough sectorization.

The image below is the shakemap layer taken by Ingv relating to the Amatrice earthquake.

The following images show the result obtained with the application of the first module: identification of the impact area and first rough sectorization.

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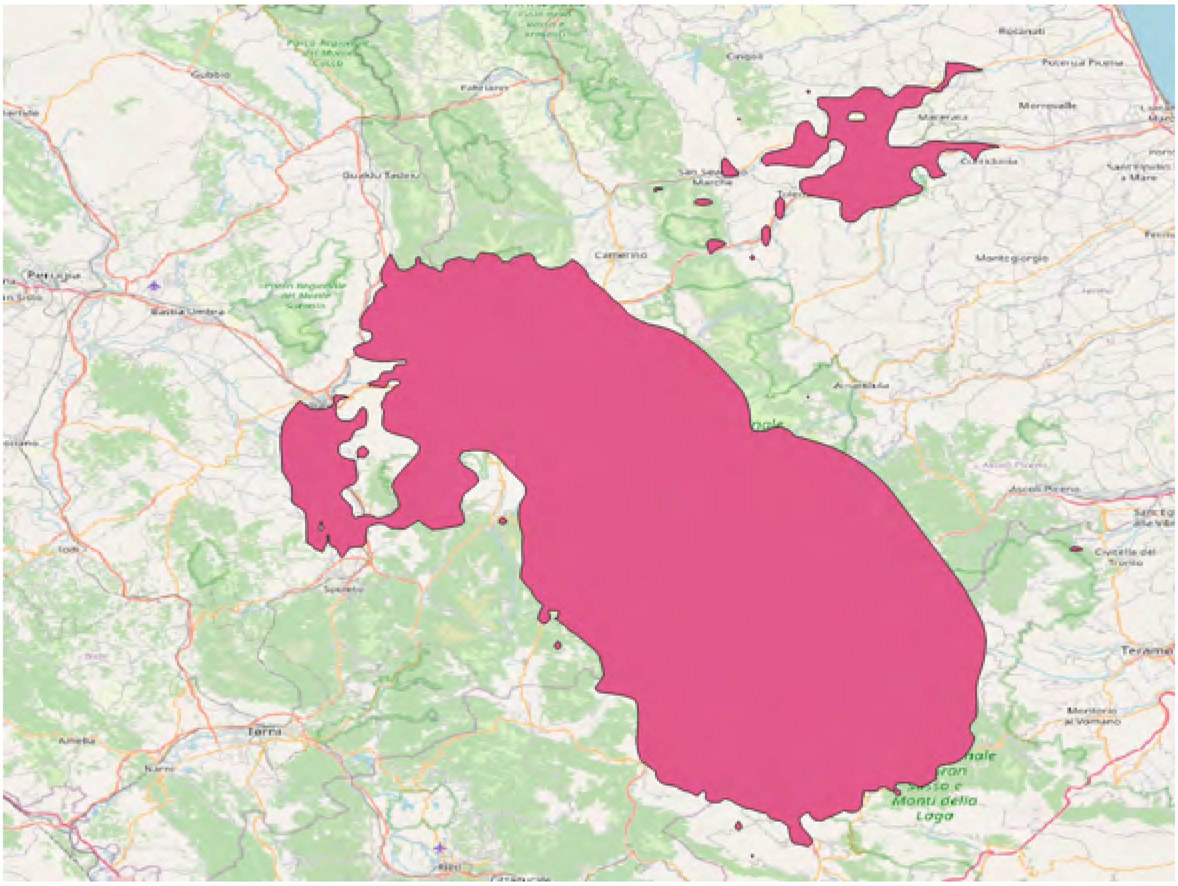
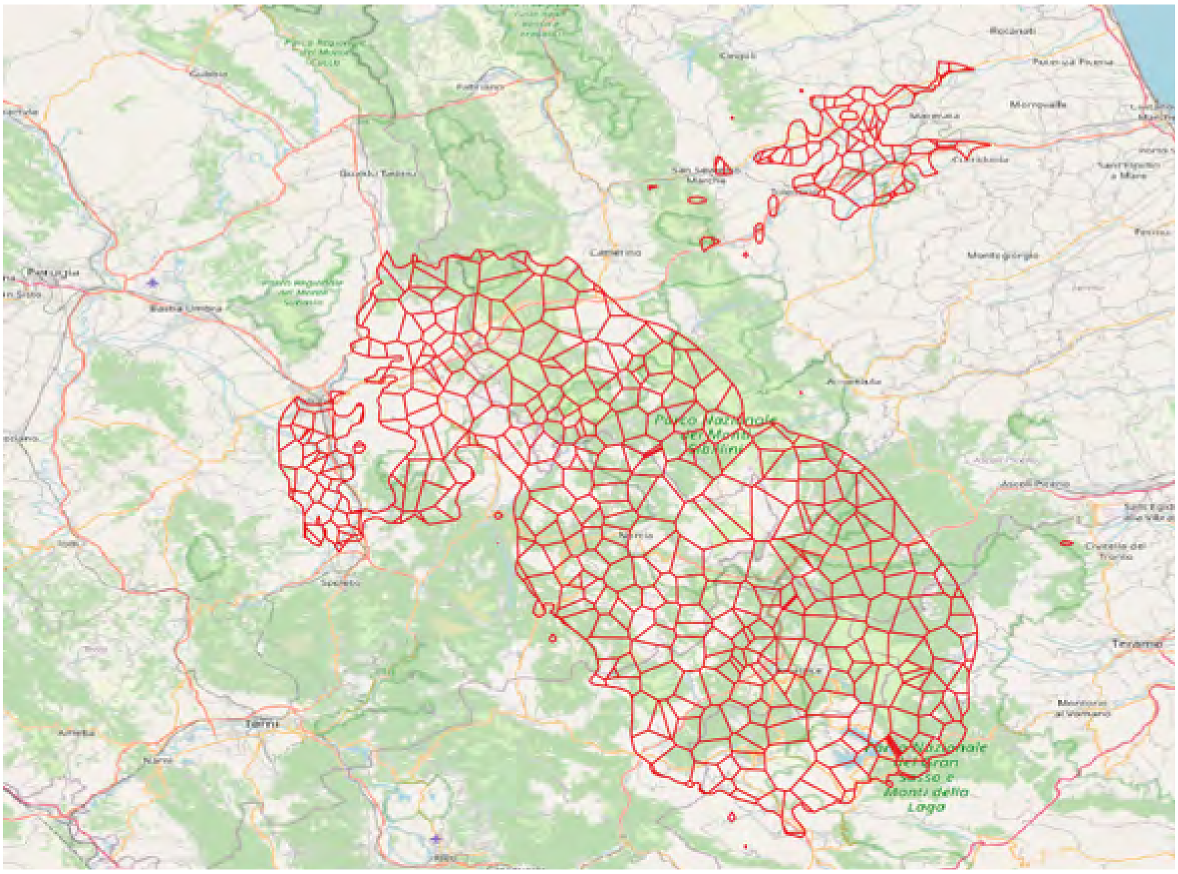


The image shows the impacted area in which the sectorization proceeds.



First rough sectorization

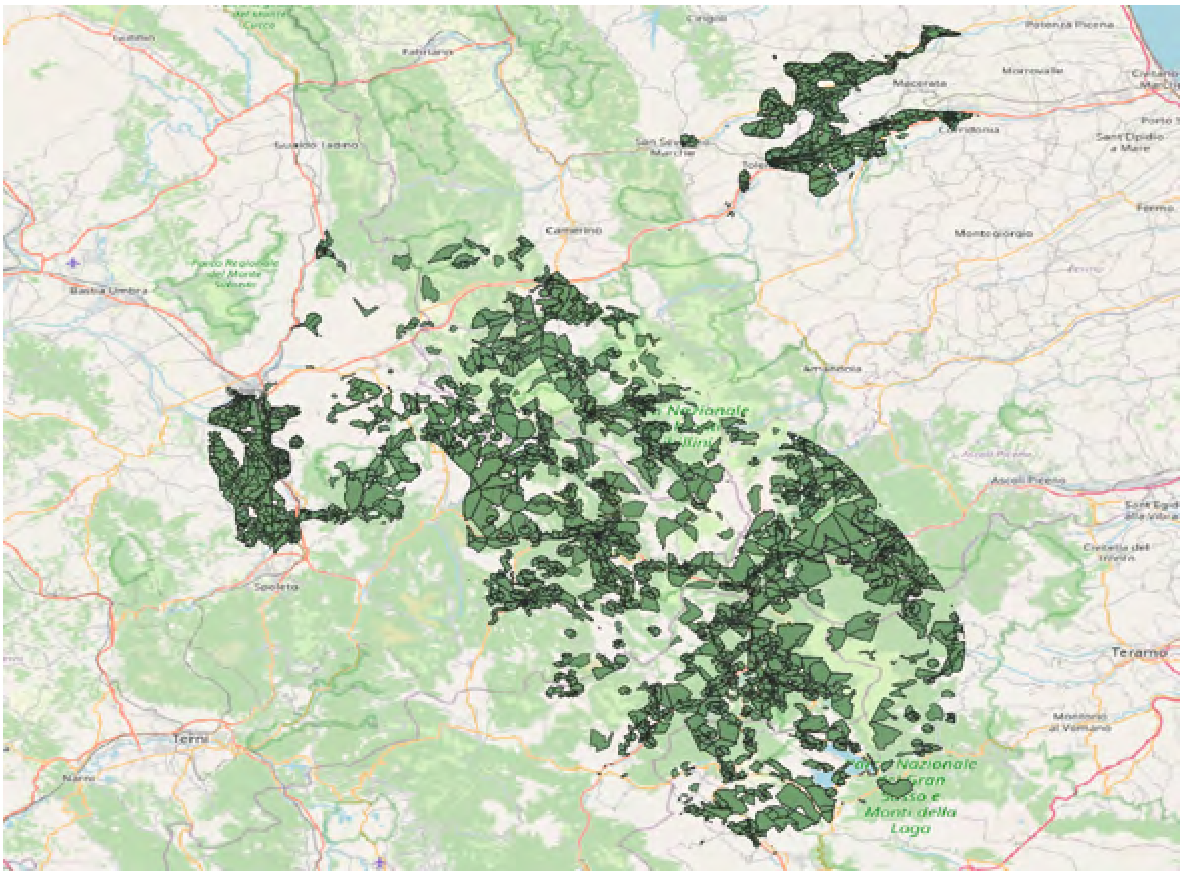
A 2.8.2 Sectorization

This procedure requires 2 input data:

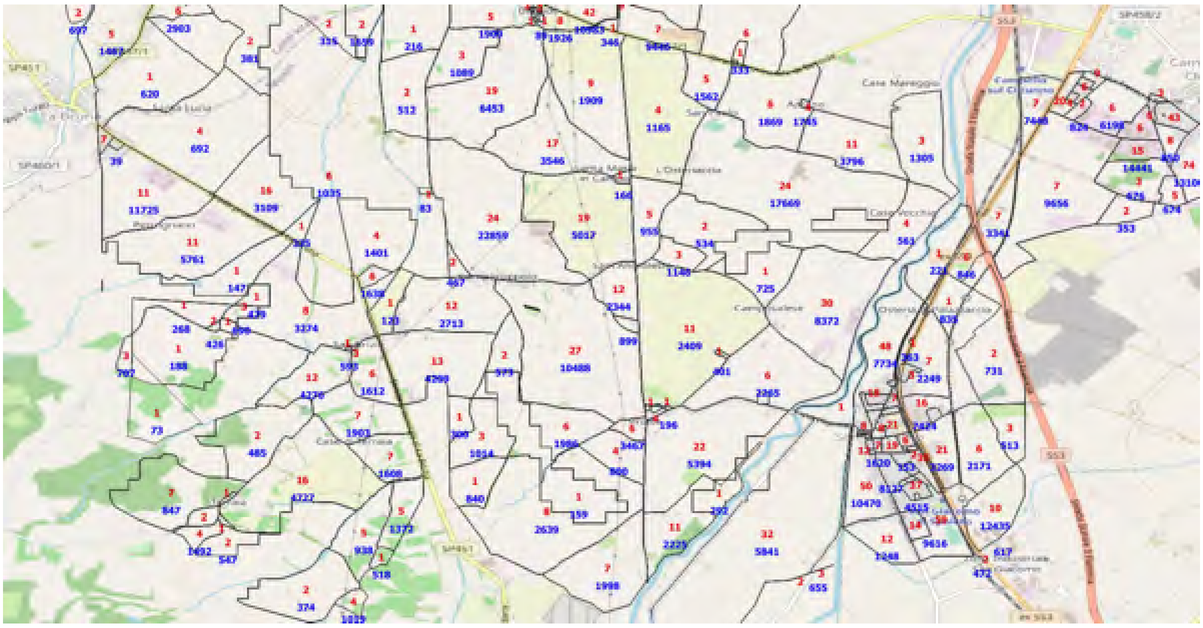
- the data obtained with the application of the first impact module (vector)
- population layer (raster) available from the worldpop.org site.

The module returns a more detailed sectorization.

To obtain the most detailed sectorization, it automatically draws on openstreetmap data relating to buildings (area data), roads, rivers, railways, etc. (linear data); it creates polygons, which are defined sectors, whose sides correspond to the loaded linear data which, crossing each other, delimit an area. If there are no buildings within the sectors, the module will automatically delete them, in this way only the polygons in which there are buildings are defined that may have been damaged and to which it will be necessary to send the assessment, search and rescue teams.



In the previous image many sectors have disappeared because there are no buildings inside.



This image shows the sectors in detail: The red number is the number of buildings there; the blue number indicates the square meters of the area of the sector.

The greatest value of this sectorization, with reference to the need for assessing the damage and sending the SAR teams, are the attributes present in each sector:

- Id unique numeric value of the sector
- sector area expressed in square meters
- built area expressed in square meters
- number of buildings in the sector
- number of estimated people in each sector
- population density expressed in P/Square kilometers
- pga value in the center of the sector
- number of teams to send in the sector
- Googlemaps[1] link of the sector center.

The list of sectors, with their respective attributes, can be downloaded to a spreadsheet and automatically set up to classify the areas according to the priority of intervention in order to quickly send targeted resources.

The processing time of the two modules on a territorial extension as in the examples shown, with a PC of average characteristics, is about 30 minutes.

The BELICE plug-in it can be run on the web and can be loaded to make it executable according to certain access and use criteria.

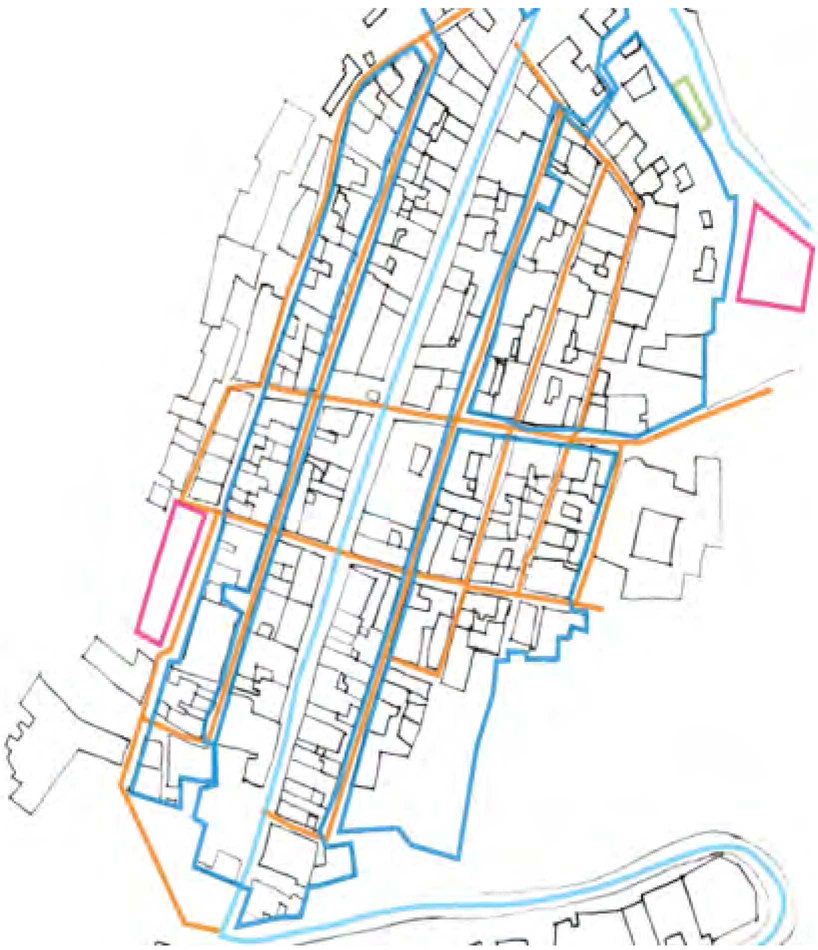
1 The googlemap link allows once launched via smartphone or tablet to view the point (target) on the device and using the navigation function allows you to reach the goal quickly, managing to avoid delays or road blocks.

Annex 3.1 ACCESS INFRASTRUCTURE NETWORK DETAILS

SUMMARY

The following annex includes a detailed description of the access infrastructure network elements that need to be considered when identifying a sector. This annex can be useful to all the readers that want to draw up a sectorisation plan including those necessary elements that have to be taken into account.

The following figure shows the access network and the first basic elements that have to be managed. Every intersection between the roads, primary and secondary access, should be considered such a "node" of the network. Each node is connected by straight line segments more or less located in the centre of the roads.



Access infrastructures network and basic elements

Roads belonging to primary and secondary access infrastructures network are generally chosen on the basis of:

- roadworthiness in the emergency phase;
- speed of connection according to their characteristics;
- minimum length of the route;
- fewer sections of the route.

Moreover, the **secondary** access infrastructure network is completed with any additional connection paths required to ensure a minimum level of redundancy to guarantee other connections between them. This completion is assessed on a case-by-case basis in relation to the extent of the impacted area, the natural elements (hills, mountains, rivers and so on) and the general level of damage.

Primary Access infrastructure interconnects the first basic elements of the emergency with the outside world and should be sized to allow emergency vehicles to travel. A primary access infrastructure starts from a node of the secondary access infrastructure and arrives at a higher-level infrastructure that passes through the territory of the municipality (e.g. a motorway, a main suburban road or a suburban road) or arrives at the municipal administrative limit. In any case, the primary access infrastructure must, at least, reach the limit of the urban settlement or area affected by the crisis.

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The access infrastructure network considered for ASR1 analysis should be identified taking into account also the need to ensure the viability of the system as a whole, even in the event of a single section crisis. For this reason, redundant infrastructure can also be considered in addition to those strictly necessary for accessing from the outside and the mutual connection between basic elements, identifying route alternatives. The identification of the number and location of redundant infrastructure depends on;

- specific characteristics of the individual territory and moving difficulty;
- distance and location of the BoO in relation to the affected area;
- the number of involved teams and resources.

Annex 3.2 ANALYTICAL APPROACH DETAILS

SUMMARY

The following annex includes all the necessary information to understand which are the tools and possibilities that can be used immediately after the event on the basis of the analytical approach.

A 3.2.1 Defining The Impact Area By Using Alert Systems Such As GDACS

The objective of GDACS is to assess the overall impact of earthquakes (and eventually associated tsunamis) on affected countries. GDACS alert levels aim at drawing attention to an event that might turn out to be serious enough to require international intervention, or, that could overwhelm national authorities' response capacity.

JRC has established partnerships with seismological organizations around the world that provide real-time data on earthquakes parameters (magnitude, depth and location). As of September 2017, GDACS included the earthquake intensity calculations (USGS shakemaps in the alerting algorithm). Such parameters are used to establish the affected area and calculate the population nearby. A country-wide vulnerability indicator moderates the alert level to take into account the country-specific vulnerability.

GDACS alert levels aim at classifying earthquakes according to the likelihood that the affected societies can no longer cope at a national level and will require humanitarian intervention. The final score then considers the level of coping capacity of the affected country or countries. The coping capacity dimension measures the ability of a country to cope with disasters in terms of formal, organized activities and the effort of the country's government as well as the existing infrastructure, which contributes to the reduction of disaster risk.

The "Shakemap" Alerting Model

The GDACS "Shakemap" alerts are based on the geographical distribution of the earthquake's Modified Mercalli scale intensity (MMI) - what is known as "shakemaps". A rough map of the intensity of earthquakes stronger than about Mw 5.5 is made available a few minutes after the event, mainly by the United States Geological Survey (USGS) but also by other institutes around the world that use the Shakemap USGS software, e.g., the National Institution of Geophysics and Volcanology (INGV) of Italy.

The GDACS shakemap-based alert relies on a score, derived by the number of people exposed in each MMI grade, from VII (Very Strong Shaking) upwards, calibrated by the casualties recorded for all seismic events since 2006 (source: DG ECHO daily flash[1], EM-DAT[2]). In some countries with more than 3 or 4 earthquakes being recorded, more detailed Country-specific coefficients are used. This score has been then re-calibrated separately for each country to obtain country-specific correction from the global trend ("country seismic vulnerability").

Finally, the alert score is transformed into an alert level according to the following thresholds:

GDACS Alert Level	GDACS score (Shakemap)
RED	≥2
ORANGE	≥1 - 2
GREEN	0 - 1

In case the event involves 2 or more countries, the highest coefficients within MMI>=7 are considered.

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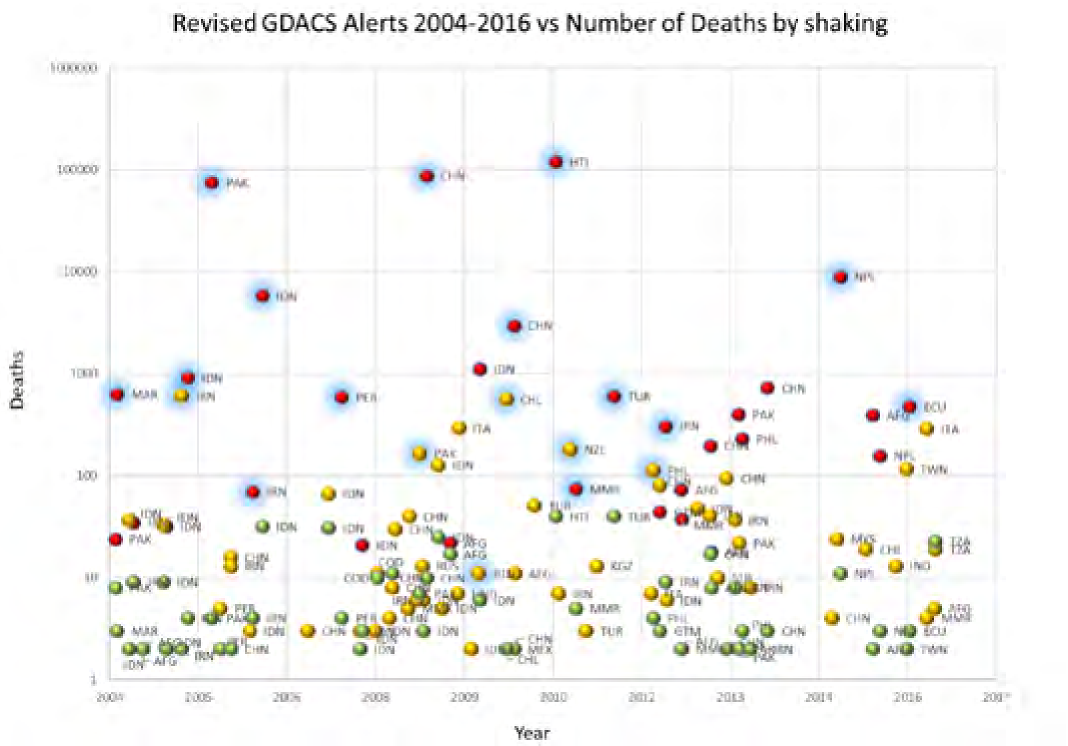
At this step, the score lower than 1, corresponds roughly to a number of casualties less than 10, according to the calibration, A score between 1 and 2 corresponds to casualties between 10 and 100. A score higher than 2 corresponds to more than 100 casualties.

It is worth mentioning that such alerts do not take into account possible tsunamis.

A graph of the "Shakemap" Alerts after all corrections versus the number of people killed for the calibration sample of earthquakes (events between 2006 and 2016 with more than 2 people killed and with shakemap available) is shown below.



https://www.gdacs.org/Knowledge/models_EQ.aspx

The GDACS alerts have been re-calculated using the "Shakemap" Model. The events that required an international humanitarian intervention are highlighted. (N.B. Number of deaths for tsunamis are not included).

To define the predefined and pre sectorized areas that fall into the impact zone, it is useful to overlap the impact areal map (GDACS) with previously prepared maps (from LEMA or the Fire Department) processed with cadastral data or UTM grid plus EU portal with housing density.

It is recommended to do so during mobilisation, before arriving in the area affected by the earthquake, in order to save time. For this reason, the means of transport of the USAR assessment teams must have web connection even during their journey.

Details about shakemaps and damage maps follow below.

A 3.2.2 Shakemaps and Alert Systems

In case of an earthquake, a shakemap shows the distribution of ground shaking in the affected area (local severity of shaking) that provides useful pieces of information about areas prone to damage. This approach is useful in a large-scale context and it must be integrated by direct knowledge of the criticalities.

A shakemap representing the expected impact on the structure in a macroseismic scale (e.g., MCS scale or EMS scale), is a critical information for emergency management decision-making and aid to answer the following important questions such as: which areas were most seriously damaged? Which areas were less damaged?

The shakemap is a scientific datum that must be verified on the territory (see the direct-survey phase) because the correlations used are statistical. Therefore, the shakemap must not be interpreted by local authorities as an exact data but must guide the choices on a large scale until more accurate data are available updating the picture.

In a shakemap, ground motions are converted to color-coded seismic intensity to show potential damage and perceived shaking level at all locations. These are useful for estimating which areas are most likely to have damaged buildings and utility and transportation lifelines. All the maps are refined and updated as more data become available.

Typically, a shakemap is available within 30 minutes after an event (generally within 10-15 minutes) so an emergency service may be deployed to those areas where the damage is heavy.

A shakemap makes it possible to displace the emergency responders in the areas of heavy damage soon and provides opportunities to enhance post-disaster response by integrating technologies like Geographic Information Systems (GIS). It is possible to obtain shakemap “shapefiles” for use as overlays with GIS, providing a more detailed understanding of potential damage to local infrastructure and facilitating a more effective response (technical map with a level of definition not less than 1:10.000 scale ratio).

Using shakemap it is possible to prioritise sectors and process them: in a nutshell it allows for identifying the areas of impact and determining the level or priority of each one of them.

In this context, a good level of pre-sectorisation makes it possible to identify also the location of strategic buildings and their access, emergency areas with their road network access and the location of BoO.

The uncertainties of this phase must be compensated by relevant direct knowledge of the expected damage and typically are relating to situations known directly to local authorities or reported to them by citizens who attended the event and were saved.

The considerations made should lead local authorities to increase their knowledge of the territory and to adapt planning tools with damage scenarios that derive directly from experience. Similarly, local authorities should develop methodologies for dialogue between authorities and citizens in order to have a known and routinely used channel of communication available.

Such methods can be an extremely efficient way to collect information on initial damage from survivors and potential claimants when the damage is not easily visible or when it is extremely widespread.

Information on initial damage collected through self-assessment methods should be verified by the assessment teams.

This evaluation method requires effective communication and development of systems for obtaining information, and can drastically reduce the time needed to carry out the first wide evaluations.

Detail in order to how to define the area of impact using alert systems like GDACS is described in Annex 3.1.

A 3.2.3 Damage maps

To assist disaster response efforts, many agencies make damage maps available to discriminate areas of damage resulting from an event.

Different types of damage maps can be used.

Shakemap based: the damage is related to ground motion and shaking intensity;

Geospatial based: the damage is related to detected changes of the ground surface.

Below are examples of the first type of damage maps, which can be used in the initial action phase.

Figure A 3.1 provides near-real-time maps of ground motion and shaking intensity in terms of macroseismic intensity.

Figure A 3.2 below provides for near-real time maps of ground motion and shaking intensity superimposing macroseismic intensity and damage information from the alert system did you feel it?"

This approach can be defined as damage map shakemap based.

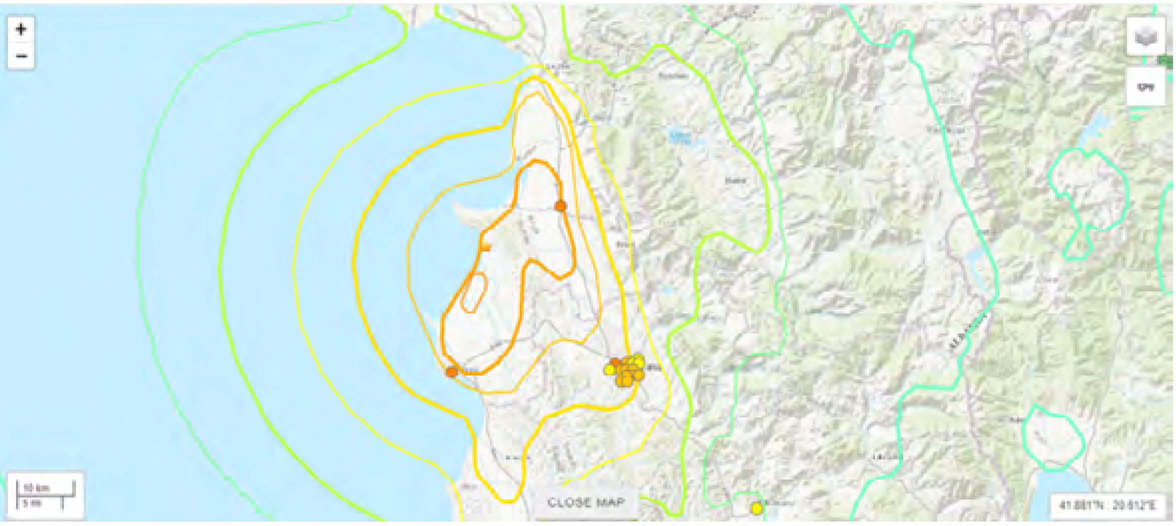


Fig. A 3.1 – M 6.4 - 15km WSW of Mamurras, Albania – Shakemap MMI, USGR, Interactive map

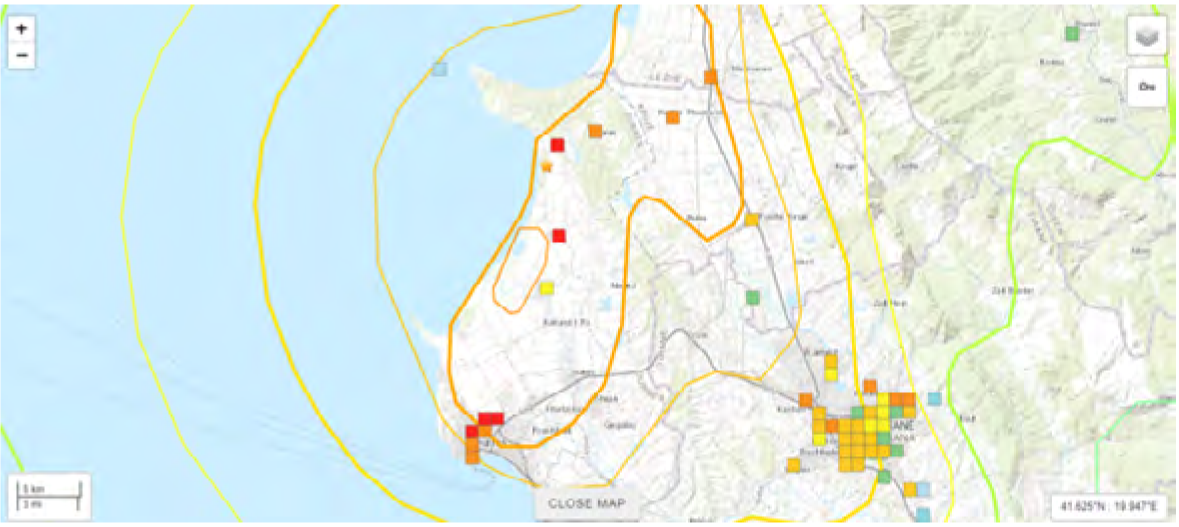


Fig. A 3.2 – M 6.4 - 15km WSW of Mamurras, Albania – Shakemap MMI plus DYFI 1 km, USGR, Interactive map

All reports concerning an earthquake that are available during a seismic crisis must be carefully evaluated to determine their validity, the urgency of the action and the extent of the operation required.

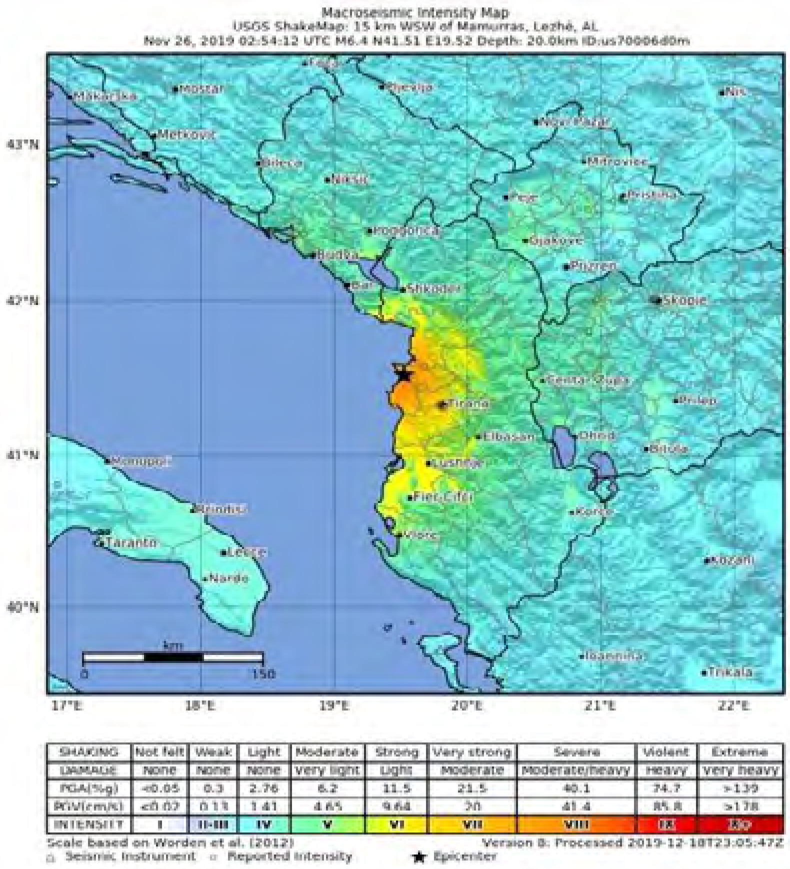


Fig. A 3.3 – M 6.4 - 15km WSW of Mamurras, Albania – Shakemap MMI, USGR, Map and relationship between MMI intensity and PGA (Peak Ground Acceleration)/PGV (Peak Ground Velocity)

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Figure A 3.3 represent, on a wide scale, shaking intensity in terms of macroseismic intensity and the relationship between macroseismic scale (MMI intensity) and dynamic shaking parameters: Peak Ground Acceleration (PGA) and Peak Ground Velocity (PGV), parameters recorded by seismic monitoring network.

Annex 3.3 FLIGHT ACTIVITIES DETAILS

SUMMARY

The annex that follows includes a detailed description on flight activities that can be conducted immediately after an event in order to start collecting useful details on a wide assessment area and both rescuers and local authorities can be interested in them.

In the first few moments after the disaster, overflight investigations, by helicopters or drones, can be an efficient way to assess damaged areas and are customarily used to collect information when damage is visible from above when rapid assessments is needed and/or when damage is remote or not easily accessible. It is generally associated with disasters where the damage is evident and for early assessment of the wide area.

This method allows for rapid damage assessment but the damage must be easily observable from above and the quality of the information may not be enough to carry out damage assessments without field verification. By using drones, it is also possible to use change detection techniques.

Most commonly, top-down information developed by overflights is combined with site-level information.

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A 3.3.1 HELICOPTERS USE

By using helicopters, it will be possible to survey the wide area. However, helicopters shall be affected by weather conditions and need to promptly communicate the collected data.

An indicative and non-exhaustive list of some emergency scenarios shall follow, according to the order of priority, assessed in the absence of specific factors and at the same feasibility conditions:

1. rescue of persons;
2. urgent transport to places where people is seriously injured and/or in life-threatened conditions, with the connected medical team and/or organs for transplantation, including any necessary medical personnel;
3. search for missing persons;
4. support activities for teams that are involved in rescue operations including the transport of human and instrumental resources;
5. aerial survey of emergency scenarios;
6. extinction intervention by hook equipment;
7. transportation of personnel for the repair and/or implementation of infrastructure and equipment aimed at rescue;
8. animal recovery;

9 aerial footage, video documentation.

The priority list helps to understand how busy the rescue helicopters are during a disaster. There is also flight limitation at night. For these reasons, it would be important to make agreements for external resources skilled at night flight, such as the air forces.

A 3.3.2 DRONES USE, available as rotary and/or fixed-wing.

An event management and planning can be integrated with images and data coming from drones which can map the affected areas and the state they are in, checking road conditions and safe access, thus creating 3D models for estimates of the volumes involved and monitoring the developments of the scenario.

The Remote Piloted Aircraft, RPA, commonly known as drones or with acronyms such as UAV, Unmanned Aerial Vehicle or RPV, Remote Piloted Vehicle, are very different aircrafts in terms of size, weight, technological and functional characteristics, sharing the lack of a pilot on board. They are remotely controllable devices that can perform a series of tasks during the flight in a semi-autonomous way such as assessing immediately at close range damaged structures, or providing a first check searching inside unsafe structures in order to finalize the rescue activities.

The use of drones in situations of particular access, for monitoring and detecting damages, is key as drones can be integrated into the emergency event management procedures.

During the post-event phase, mapping the area will guarantee a basis of information to monitor the progress of the interventions available to the other bodies responsible for reconstruction, as well as to monitor the containment, shoring and, in general, protection and safety works, to verify the efficiency and durability of temporary works over time.

The sensors with which drones can be equipped, allow to obtain any type of data and information relevant for a greater understanding of the event in the hours immediately after it.

Some equipment is briefly described below:

a rotary-wing drone, influenced by weather conditions, flight autonomy 45’ (it is necessary to consider response time, kind of response and elaboration response time);

b eBee fixed-wing drone, flight autonomy 15-30’ (it is necessary to consider response time, kind of response and elaboration response time);

c Predator, supplied to the army / armed forces, unaffected by weather conditions.

d supplied to the army / armed forces, unaffected by weather conditions. It is necessary to consider the possibility of use, type of data supplied, data reading times (possibilities, times, data, etc.).

Typically, a technical map with the maximum level of detail is available within 3 hours after the flight activities.

A 3.3.3 MORE DETAILS ON DRONES

Both types of drones use software that is planned and preloaded before the flight, allowing for programming the characteristics of the flight plan based primarily on the required data and other variables such as wind, sun exposure, flight over areas, or no use in case of rain.

The specific use of drones during the assessment of the area immediately following a major disaster (wide area assessment), can be of help to the USAR teams, to obtain the largest amount of information in the shortest possible time, providing immediately photos and videos and an expeditious photogrammetry of the territory only after processing the data.

The aerial reconnaissance is intended to collect information through photos and videos so as to allow the applicant to set a particular action, through the direct observation of the images and / or video or streaming video on the ground.

Drone photogrammetry allows access to hard-to-reach or inaccessible areas, providing detailed images faster than standard methods.

Moreover, it shall be possible to obtain from the rescue operations, with appropriate IBM (Image-Based Modelling) processing:

- DIFFERENTIATED ORTHOMOSAICS, i.e. geo TIFF images (TIFF containing geospatial information).
- POINT CLOUDS, useful for obtaining detailed information on the soil without vegetation (DTM, Digital Terrain Model). These are three-dimensional point clouds that associate location and colour information to each point to view three-dimensional objects and raised surfaces.

3D MODELS from unstructured data such as a point cloud. They can generate virtual graphics projects, 3D reconstructions, augmented reality, etc..

The 2D maps are normally urgent for the requesting Fire Department (VVF), although it is necessary to implement some measures in order to raise the level of security, to draw them up. The flight planning for the creation of the 2D model of the territory is done with an appropriate software supplied on the G.C.S. using the sensor settings according to the procedure. Depending on the characteristics and equipment of the SAPR system, different payloads operating in different spectra can be used.

As to data processing timing, according to current knowledge and conditions of use, high resolution shall involve a 3 or 4 hours processing delay before the results shall be provided to the assessment team, whereas with medium resolutions, the time is significantly cut down to 30 minutes. Such processing times shall depend on the characteristics of the PC processing the data and the number of shots.

The return of the data acquired and / or subsequently processed is not bound to the presence of the data network (internet).

Annex 3.4 FIELD ASSESSMENT DETAILS

SUMMARY

The annex as follows includes information on the tools and information that can be used during a field assessment that can be conducted after an emergency and both rescuers and local authorities can be interested in such details.

A 3.4.1 Satellite use

The European Space Agency has launched the Copernicus program, which through data satellite provides a range of products and services to support scientific studies and emergency management.

This program includes such projects as EMS (Emergency Management Service) which consists of three modules: mapping, EFAS (European Flood Awareness System) and EFFIS (European Forest Fire Information System).

ESA is currently an international organization made of 22 member states and is responsible for coordinating the financial and intellectual resources of the member countries in order to produce programs and activities that reflect and unite the intentions of each European country as to space policy. The mission of ESA is to shape the development of European space capabilities and ensure that investment in space continues to create benefits for European and world citizens.

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The member states are Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Luxembourg, Netherlands, Norway, Poland, Portugal, Romania, Spain, Sweden, Switzerland and the United Kingdom. Canada also participates in any projects through a cooperation agreement.

In addition to these programs, particular attention should be paid to the Copernicus program designed for the study and observation of the Earth, which includes the Sentinel mission.

Copernicus is currently the most ambitious Earth observation program in the world and is made up of different systems (satellites, ground stations, aerial and marine sensors) that acquire data on Earth, as reported on the ESA website, and (**http://www.esa.int/Our_Activities/Observing_the_Earth/Copernicus/Overview3**).

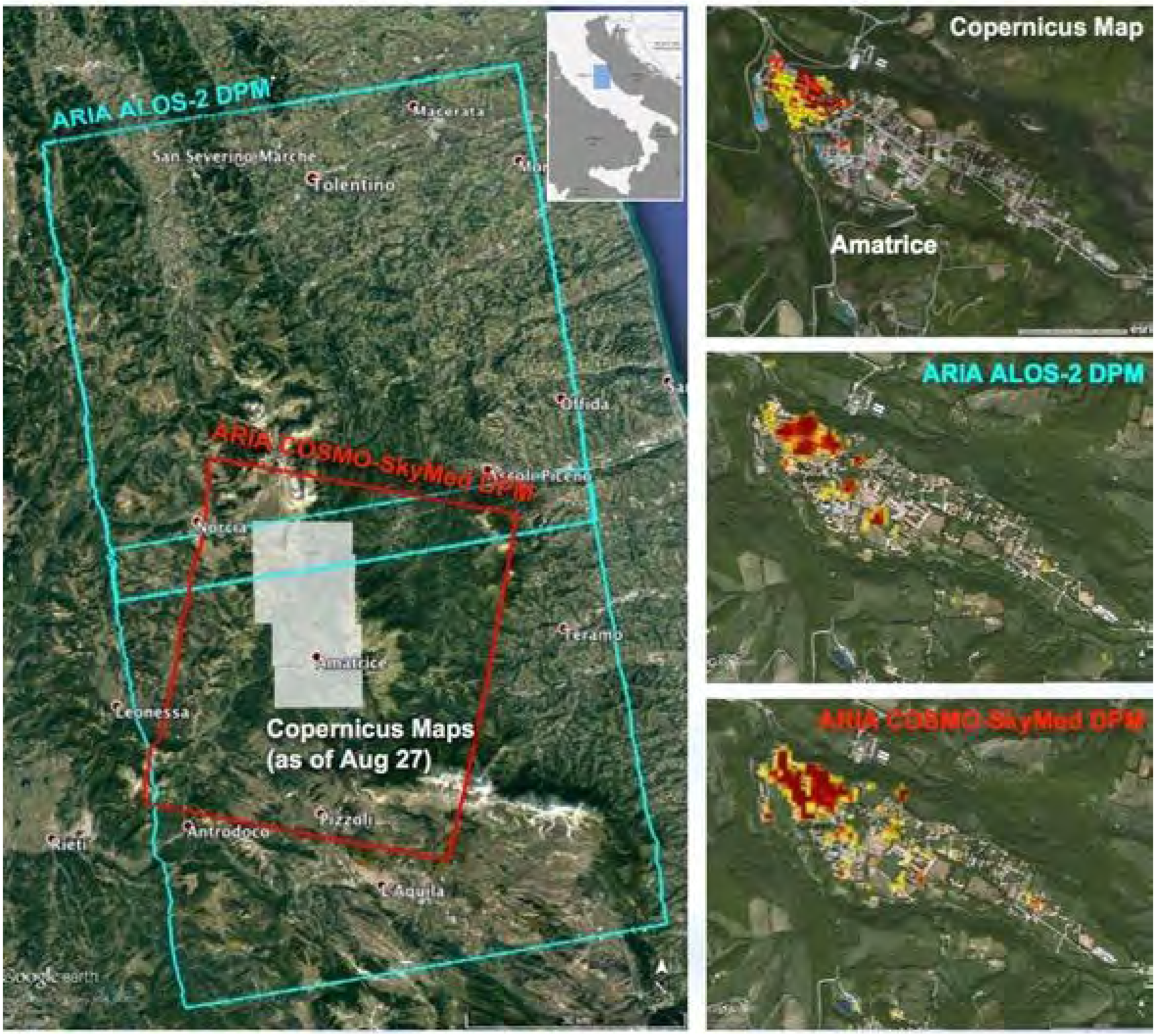
This program provides accurate, timely and easily accessible information to improve environmental management, understand and mitigate the effects of climate change and ensure civil security.

The program is coordinated and managed by the European Commission, while the development of infrastructure is under the control of ESA with regard to space components.

A 3.4.2 Damage map

To shows the real picture of the damage, it is possible to use geospatial based damage maps that estimate damages by comparing satellite/radar images of the affected area. In case of earthquakes, for example, the damage maps describe the extent of the geophysical impact and damage to structures. Generally, maps are presented with different shades of colours, with darker colours for greater damage.

Examples of damage detection for the Amatrice earthquake (Italy, 2016) are shown in the following figure.



M 6.2 - Amatrice, Italy – Areas of damage, NASA, the colour variations from yellow to red indicate increasingly significant ground surface change

Data products derived from satellite radar datasets are not affected by cloud cover and can be acquired during the day or night. Maps are available between a day or several days after the earthquake, depending on the availability of the first post-earthquake radar observations. In fact, the availability of maps based only on satellite visions depends on limitations greatly impacting their use in the analysis. When the following limitations exist, the timeliness of geospatial analysis can be affected.

- *Weather*: Cloud cover can often obstruct views for collection of damage in both satellite and airborne imagery. In addition, dangerous weather conditions can prevent planes from flying to collect airborne imagery.
- *Flight Prohibition*: Airborne imagery collection may be temporarily prohibited in areas with ongoing Search and Rescue Operations.
- *Poor Data Environments*: In some areas, detailed parcel and population data are not available. This creates a challenge during analysis and may affect the ability to provide the information required to support processing.
- *Contract Acquisition Timeline*: The acquisition process to obtain needed airborne imagery and/or analytic support can be delayed.
- *Impacted Area*: In urban areas with more residential buildings, a geospatial analysis may not be able to further refine the damage level by apartment unit. In rural areas steep terrain, heavy tree canopies or a lack of parcel data can be a limitation. These kinds of instances require additional analytical time and can prevent the analysis for certain properties.

Maps are available between a day or several days after the event, depending on the availability of the first post-event radar observation: for this reason, the information can only be used to verify the assumptions made.

A 3.4.3 The Sentinel Satellites

Sentinel-1, which provides radar images day and night in all weather conditions. This mission is organized with two Sentinel 1A and Sentinel 1B satellites which have a fixed orbit along the meridians.

Data coming from such satellites require lengthy post-processing to obtain a usable image and generally this work is done by ESA which makes them available online once the processing is concluded.

With both satellites (Sentinel 1A- Sentinel 1B) in orbit, a satellite passes over the same point every three days at the equator and less than one day over the Arctic.

Resolution ranges between 5 and 40 meters per pixel.

Sentinel-2, which produces high-resolution optical images.

These satellites (Sentinel 2A- Sentinel 2B) have MSI (Multispectral Instrument) sensors mounted on the platform, work passively as the incident light rays are divided and filtered on separate focal planes, one for the visible bands (VIS), one for the near-infrared band (Near-InfraredNIR) and one for the Short Wave Infrared (SWIR).

These images do not require any post processing and can be used immediately after acquisition. The resolution on the ground is about 10 meters per pixel. These satellites are designed so that the revisiting frequency is 5 days at the equator (2-3 days at medium latitudes).

Sentinel-3, The main objective of the Sentinel-3 mission is to measure the topography of the sea surface, the temperature of the sea and land surface and the colour of the ocean and land surface with high accuracy and reliability to support ocean forecasting systems, environmental and climate monitoring.

A 3.4.4 Copernicus

The European programme Copernicus provides the Civil Protection of the Member States with a rapid mapping service (Rush Mode) for the production of assessment maps of damage caused by natural or man-made disasters.

The service offers a contact point 24h/7 days for the reception of activation requests, previously authorized by the European Commission through the Emergency Response and Coordination Centre (ERCC) at DG ECHO, and takes care of the entire service chain up to the delivery of finished cartographic products through a public portal (http://emergency.copernicus.eu). The service is operated by an industrial consortium led by e-GEOS, an Italian company, under the technical supervision of the Joint Research Centre (JRC). This service shall be activated in case of emergency. The JRS Operations Centre acquires all available post-event satellite images not only from both European satellites (Sentinels) and Pleiades, GeoEye-1 and Digital Globe American Commercial satellites (satellites used by google maps) which have a very high resolution such as 0.6 m/pixel optics. The maps that are created in a very short time can be used to manage and plan emergencies.

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Annex 3.5 DID YOU FEEL THE EARTHQUAKE APP

SUMMARY

The following annex includes a useful app able for collecting information on the real effect of an earthquake directly from population present in the involved area.

In large emergencies the speed of resources allocation during the ASR phases is linked with a timely alert and mobilisation that should occur, since the very first minutes after the event, with a consolidated and immediately activated and applicable mechanism.

If such a system is operating and working effectively, the “adequate quality and quantity” of resources is mobilised with no further delay in few minutes from the beginning of the event. Then, the arrival on site will depend on the distance and transportation but at least alert and mobilisation time is compressed and reduced as much as possible.

If the “picture” of the event is clarified quickly enough, it shall be possible to define a size-up that will lead very early to determine that “this emergency” will require (almost for sure) “responding resources in a certain number and of a certain type”.

In order to understand as soon as possible what has really happened, two interesting examples are already available in US* and in Italy**. In these two Countries when an earthquake happen the Citizens can fill an online questionnaire where they describe the EFFECTS of the earthquake where they are in the moment of the shake.

Every earthquake in the world is immediately detected by seismic network that in few seconds give a first estimate of the energy released by the earthquake, where is the epicenter and at what depth is the “origin”. But the REAL EFFECTS of that release of energy on the buildings can only be measured and assessed by someone who is observing such effects directly. The inhabitants living in the affected areas, possibly, can immediately contribute to the questionnaire with valuable information thus gathering hundreds (and thousands) of questionnaires that are filled up and collected in the platform by the minute.

The results of these input are collected and portrayed on a geographical map. If the map depicts only a small portion of the territory, that means that the EFFECTS of the earthquake are limited. If the earthquake was felt and damages were reported from locations very far away from the epicenter, that will mean that the effects will surely be devastating in large portion of the territory and consequently a large response shall be needed. And this information even if “broad” can help in the quick decision making about “what type of- and how many- resources” shall be necessary to cope with that emergency and then with quick alert and mobilisation.

This is a first part of what can be called “pre-assessment” where a mechanism is set up to quickly detect the EFFECTS of an earthquake and the “response” needed.

A couple of examples are included in the annexes. It is easy to understand that each one portrays a different level of real damage and real effects detected by the citizens. Each image clearly helps to identify a significant difference in effects detected and consequently a different need in terms of “quantity of resources to be immediately mobilized”.

1 – effects detected in small area: LOCAL alert and mobilization

2 – effects detected in large area NATIONAL alert and mobilization

Examples of maps showing different distribution of responses from citizens on EFFECTS and damages directly detected immediately after an earthquake. In case 1 a local response has consequently been activated in case 2 a National response has been activated

This “pre assessment” becomes very helpful also for the following standard phases ASR-1 and ASR-2. During the time needed for implementing such phases while defining the sectors and the number of resources that can be allocated in the sectors, resources are alerted and mobilised in order to have them already as close as possible when the ASR-1 and ASR2 phase will produce “the list” of sectors and working sites.

The basic idea of the pre-assessment (and early alert and mobilisation) is that if most of the resources needed are already alerted and mobilised, their availability can affect the way sectors and priorities will be defined during the ASR-1 and ASR-2 phases.

* US:	«Did You Feel It»	https://earthquake.usgs.gov/data/dyfi/
** Italy:	«Hai sentito il terremoto»	http://www.haisentitoilterremoto.it/

Annex 3.6 ASSESSMENT TEAM DETAILS

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SUMMARY

The annex as follows includes how to find information on the minimum skills and composition of an assessment team, as well as how to find more information about the skills of an Assessment Team following INSARAG Guidelines.

According to the INSARAG guidelines, the USAR activity is divided into operational levels called Assessment Search and Rescue level (ASR).

There are five ASR operational levels and those where assessment activities are mainly carried out are 2: ASR1 and ASR2.

As already written in the manual, the ASR1 is the “wide area assessment”, while the ASR2 is the activity of the assessment teams on the field, searching work sites where the presence of people still alive is possible.

The main activity of the assessment team described in this annex is ASR2.

The USAR assessment team is however able, if necessary, to carry out ASR1 activities as well.

Post- emergency assessment, which is closely linked to the need of saving lives, can be performed by different actors.

This difference may depend on the location, the availability or unavailability of specialised resources (USAR Assessment Team), the extent of the territory affected, all of which may require a larger number of specific resources than those available.

In any case and in order to perform this kind of assessment activities, some minimum professional requirements are needed:

A technician qualified to perform structural assessment and safety who during the reconnaissance/assessment for the purpose of identifying operational priorities shall carry out the following tasks:

- getting information on and assessing the sites, identifying any safety interventions (e.g. Shoring);
- proceeding to an initial voice and visual search to detect survivors;
- establishing priorities in search and rescue operations, on the basis of the ascertained or presumed presence of survivors.

A technician qualified to identify the presence of hazardous substances and plants who during the reconnaissance/assessment for identifying operational priorities shall carry out the following tasks:

- getting information about the presence of hazardous substances and plants, identifying any precautions and operations of securing the shipment;
- collaborating in an early voice and visual search to detect survivors;
- collaborating in an expeditious triage aimed at ascertaining the presence of hazardous substances and systems;
- suggesting the use of "specific" PPE as well as any additional safety measures as to the presence of hazardous substances.

In any case, the knowledge of the cartography and the communication systems must be ensured[2].

In case an USAR Assessment Team is available, this could be made as follows:

Structural Engineer

During the reconnaissance/assessment for identifying operational priorities, such an officer shall carry out the following tasks:

- getting information on and assessing the sites, identifying any safety interventions (e.g., Shoring);
- proceeding to an initial voice and visual search (call-out) to detect survivors;
- establishing priorities in search and rescue operations, on the basis of the ascertained or presumed presence of survivors;
- providing for marking the site, according to the provisions of the INSARAG guidelines.

CBRN officer

During the reconnaissance/assessment for identifying operational priorities, such an officer shall carry out the following tasks:

- getting information about the presence of hazardous substances and plants, identifying any precautionary and shipment securing operation;
- collaborating in an early voice and visual search (call-out) to detect survivors;
- collaborating in an expeditious triage aimed at ascertaining the presence of hazardous substances and systems;
- suggesting the use of "specific" PPE as well as any additional safety measures as to the presence of hazardous substances.

A proper execution of such operations (ASR2) shall allow for quickly organising the rescue activities through effective planning and proper management of resources.

The **Management and Staff functional unit** shall include the following professionals:

2 More information is available in INSARAG Guidelines

Team Leader

He or she shall coordinate the activities of the assessment and planning unit team in synergy with the other locally activated Fire-fighters' coordination facilities.

Liaison Officer

Such an officer shall liaise with the members of the Civil Protection system on site (representatives of the local Civil Protection system, Healthcare Rescue, Police Forces, etc.) and:

- shall get information about the state of the sites before the disaster and the presumed number of victims involved;
- shall keep in touch with the communication bodies in the vicinity of the operational area, keeping the Module Manager (Team Leader) informed in accordance with the Department's institutional communication policies.

Staff Officers

They cooperate with the other members of the Reconnaissance and Assessment Team in developing the initial planning phase, more specifically:

- setting up the USAR Coordination Structure (UCC);
- dividing the assigned disaster area into sectors, if not previously done (ASR1);
- processing data received from the USAR assessment teams on site, through a specific software also used for Planning;
- drafting the necessary maps for the assessment teams and for the subsequent rescue teams,
- entering all data/information (information from local people, local rescue system, assessment teams, etc.). related to the defined sectors in specific digital forms.

Annex 3.7 ASSESSMENT PLANNING AND EVALUATION CONCEPTS

SUMMARY

The annex as follows includes information about how the sector sizing methodology was built and the bases of its scientific parameters.

A 3.7.1 The methodology

Based on the assessment included in Chapter 2, paragraph 2.5, the sector is sized on the basis of the following relation

$$N_b = A_T\, N_b\, t_{max} = 60 \text{ buildings}$$

where

$A_T = 5$ is the maximum number of teams per sector;

$N_b = 4$ is the capability of each team (4 buildings per hour and per teams);

$t_{max} = 3$ is the maximum time within the assessment shall be carried out in hours.

The value thus obtained, $N_b = 60$ *buildings*, is corrected by the factor δ and applied to $N_{(b,s)} = N_b\, \delta = 50$ buildings.

The formula tells us that to evaluate 50 damaged buildings included in one sector$A_t = 5$ assessment teams are needed. But if the buildings to be assessed in a sector are less than 50, for the same time $t_{max} = 3$ hours, less than 5 teams will be needed.

The coverage factor α_T is defined as

$$\alpha_T = \frac{A_{T,req}}{A_T} = \frac{N_{b,dam}}{N_{b,s}}$$

where

$A_{T,req}$ is the number of teams required in relation to the number of damaged buildings to be assessed;

$A_T = 5$ is the largest number of teams per sector;

$N_{b,dam}$ is the number of damaged buildings to be assessed;

$N_{b,s} = 50$ is the number of buildings per sector.

Basically, the coverage factor α_T is the fraction of damaged buildings to be assessed

(EMS-98 damage level 4 and 5) and is the factor that multiplied by A_T=5 gives the number of teams needed depending on the damage level.

The table below shows the variability of the coverage factor $\alpha_T$as the PGA (Peak Ground Acceleration) or the I (Macroseismic Intensity according to EMS-98).

Coverage factor per sector		
PGA [g]	I [EMS-98]	α_T
0.10-0.20	VII	0.2
0.20-0.30	VIII	0.4
0.30-0.60	IX	0.6
0.60-0.80	X	0.8
>0.80	XI	1.0
>0.80	XII	1.0

It is possible to express the coverage factor α_T only as a function of PGA or I (EMS-98) and, as it is shown, that is a parameter that varies very little with the assortment of vulnerabilities of the buildings included in the sector. The calculation therefore, allow us to define, as a general rule, that the number of assessment teams mainly depends on the severity of the earthquake. As a consequence, in the absence of more in-depth analysis, the number of teams increases linearly from grade VII macroseismic to reach the maximum for the XI.

Below, using the tables drawn from the theoretical analysis in paragraph 2., examples of assortments valid for residential sectors are proposed with an indication of the number of teams required, based on the number of damaged buildings to be assessed.

Assortment of vulnerability A=80% – B=20% – C=0%			
PGA [g]	I [EMS-98]	D4+D5 [%]	Teams [#]
0.10-0.15	VII	7.2	1
0.15-0.25	VIII	37	2
0.25-0.45	IX	64.8	3-4
0.45-0.75	X	89.8	5
>0.75	XI	99.7	5
>0.75	XII	100	5
Assortment of vulnerability A=70% – B=20% – C=10%			
PGA [g]	I [EMS-98]	D4+D5 [%]	Teams [#]
0.10-0.15	VII	6.3	1
0.15-0.25	VIII	32.6	2
0.25-0.45	IX	58.7	3
0.45-0.75	X	84.9	4
>0.75	XI	98.5	5

>0.75	XII	100	5

Assortment of vulnerability A=60% – B=30% – C=10%			
PGA [g]	I [EMS-98]	D4+D5 [%]	Teams [#]
0.10-0.15	VII	5.4	1
0.15-0.25	VIII	29.1	2
0.25-0.45	IX	56.1	3
0.45-0.75	X	83.6	4
>0.75	XI	98.3	5
>0.75	XII	100	5
Assortment of vulnerability A=50% – B=30% – C=20%			
PGA [g]	I [EMS-98]	D4+D5 [%]	Teams [#]
0.10-0.15	VII	4.5	1
0.15-0.25	VIII	24.7	2
0.25-0.45	IX	50	3
0.45-0.75	X	78.7	4
>0.75	XI	97.1	5
>0.75	XII	100	5

The examples show how the coverage factor α_T depends, to a large extent, on the severity of the earthquake.

For a more detailed analysis see paragraph 2. of this annex.

A 3.7.2 The theoretical basis of the proposed methodology

As a general concept, the assumption is made that it is accepted as inevitable that

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constructions, with their vulnerability, are damaged by seismic actions and that the concept of security does not necessarily imply a loss (risk).

The approach, therefore, requires the use of a macroseismic model for risk assessment based on:

- Hazard Parameters (PGA);
- Characterization of constructive vulnerability (vulnerability according to EMS-98);
- Estimates of expected losses in terms of damaged buildings and human lives (EMS-98, ATC-13).

A 3.7.2.1 Hazard Parameter (PGA)

Seismic hazard is assumed as a function of PGA or Peak Ground Acceleration.

The parameter can be obtained in the pre-event phase using the seismic classification of the territory (standards for buildings in seismic zones). In the post-event phase, the PGA can be read directly on a shakemap (available 15-30 minutes after an event) or an estimate of the macroseismic intensity is indirectly known.

In literature, there are many formulations and most of them can be traced back to a single form (Lagomarsino and Giovinazzi, 2006)

$$PGA = c_1 c_2^{(I-5)}$$

where PGA is expressed in units of g, I represent the macroseismic intensity measured on the conventional EMS-98 scale.

Law of correlations	c_1	c_2
Guarenti-Petrini	0.03	2.05
Margottini	0.04	1.65
Murphy O'Brien	0.03	1.75

The report gives the macroseismic intensity from the PGA data.

Also, you have that $I_{MKS} = 0.85 I_{MCS}$.

A 3.7.2.2 Vulnerability according to EMS-98

Below is the subdivision of the structures (buildings) into classes of vulnerability called vulnerability table (the table shows the most likely vulnerability class with a circle together with its statistical dispersion).

Note that the attribution of the most probable vulnerability class is immediate starting from cognitive elements related to the observation of the constructed.

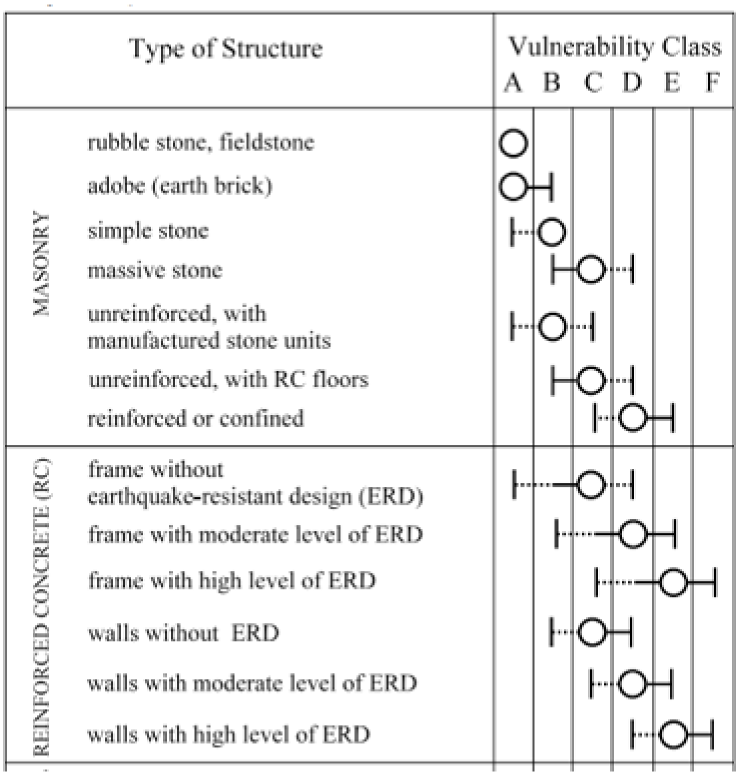

Figure 2.1 – Differentiation of structures (buildings) into vulnerability classes (Vulnerability Table)

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A 3.7.2.3 Expected losses in terms of damaged buildings

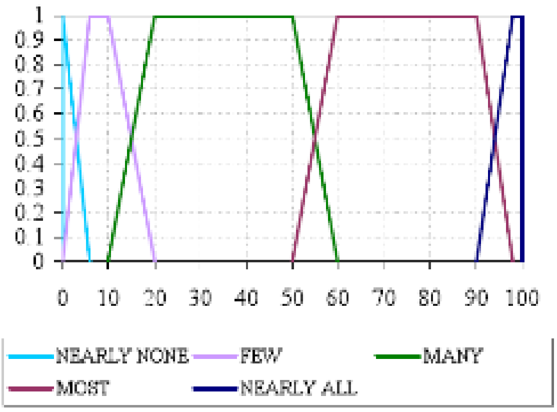
To obtain an estimation/prediction of the damage distribution, concerning the reference earthquake and the vulnerability of the built up environment, the damage probability matrices implicit in the EMS-98 scale shall be used.

The damage probability matrices provide, for a seismic input described in terms of macroseismic intensity and for different classes of constructs with homogeneous behaviour (seismic vulnerability classes), the likely occurrence of different degrees of damage (defined based on the observed consequences).

The linguistic information provided by the EMS-98 scale is summarized in the table below showing on the basis of the macroseismic intensity and level of damage (D0=no damage, D5= collapse), the number of buildings and the type of vulnerability they suffer at certain level of damage.

	Level of damage					
Macroseismic Intensity	D0	D1	D2	D3	D4	D5
I=V		Few A or B				
I=VI		Many A or B Few C	Few A or B			
I=VII			Many B Few C	Many A Few B	Few A	
I=VIII			Many C Few D	Many B Few C	Many A Few B	Few A
I=IX			Many D Few E	Many C Few D	Many B Few C	Many A Few B
I=X			Many E Few F	Many D Few E	Many C Few D	Most A Many B Few C
I=XI			Many F	Many E Few F	Most C Many D Few E	Most B Many C Few D
I=XII						All A or B Nearly all C Most D or E or F

It is, therefore, a question of assuming numerical values that can be associated to the three key adjectives used in the EMS-98 scale (Few, Many, Most) and to the two other two employees for its completion (Nearly none, Nearly all). To achieve this aim, the numerical interpretation deriving from a “Fuzzy pseudo-partition” (Klir and Yuan, 1995, Lagomarsino and Giovinazzi, 2001, Bernardini and Giovinazzi and Lagomarsino and Parodi, 2008) of the interval [0-100] of the percentages through 5 appropriate fuzzy sets are used.



For the linguistic completion of the scale, the determinations reported in the following tables (Bernardini and Giovinazzi and Lagomarsino and Parodi, 2008) are assumed where the numerical values refer to the expected values of the "white" probability.

A 3.7.2.3.1 Vulnerability Matrices In Terms of Macroseismic Intensity

For completeness, all the vulnerabilities of buildings are reported even if the most representative classes of the vulnerability of the Italian historical building are the first three (A, B and C). The numbers reported in the table represent the percentage of buildings that suffer a certain level of damage EMS-98 (from D0 to D5) concerning the macroseismic intensity EMS-98 (IEMS from grade V to grade XII).

Vulnerability Class A						
I_{EMS}	D0	D1	D2	D3	D4	D5
V	91	9				
VI	56	35	9			
VII	3	18	35	35	9	
VIII		3	18	35	35	9
IX			3	27	35	35
X				7.5	18	74.5
XI					7.5	92.5
XII						100

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Vulnerability Class B						
I_{EMS}	D0	D1	D2	D3	D4	D5
V	91	9				
VI	56	35	9			
VII	21	35	35	9		
VIII	3	18	35	35	9	
IX		9	18	35	35	9
X			3	18	44	35
XI				1.5	24	74.5
XII						100

Vulnerability Class C						
I_{EMS}	D0	D1	D2	D3	D4	D5
V	100					
VI	91	9				
VII	56	35	9			
VIII	21	35	35	9		
IX	3	18	35	35	9	
X		3	18	35	35	9
XI				12	53	35
XII					3	97

Vulnerability Class D						
I_{EMS}	D0	D1	D2	D3	D4	D5
V	100					
VI	100					
VII	91	9				
VIII	56	35	9			
IX	21	35	35	9		
X	3	18	35	35	9	
XI		3	18	35	35	9
XII			3	4.5	18	74.5

Vulnerability Class E						
I_{EMS}	D0	D1	D2	D3	D4	D5
V	100					
VI	100					
VII	100					
VIII	91	9				
IX	56	35	9			
X	21	35	35	9		
XI	3	18	35	35	9	
XII		1.5	6	9	18	65.5

Vulnerability Class F						
I_{EMS}	D0	D1	D2	D3	D4	D5
V	100					
VI	100					
VII	100					
VIII	100					
IX	91	9				
X	56	35	9			
XI	21	35	35	9		
XII		3	9	9	35	44

Example

Determine the damage distribution for a sector of 50 buildings consisting of buildings with vulnerability class B.

Taking the appropriate vulnerability matrix (the second one, Class B) and calculating the percentages for 50 buildings, it is immediately known how many buildings will have, in a probabilistic sense, a certain level of damage.

Vulnerability Class B – Damaged buildings per sector						
I_{EMS}	D0	D1	D2	D3	D4	D5
V	45	5				
VI	28	17	5			
VII	10	17	18	5		
VIII	2	9	17	18	4	
IX		2	9	17	18	4
X			2	9	22	17
XI				1	12	37
XII						50

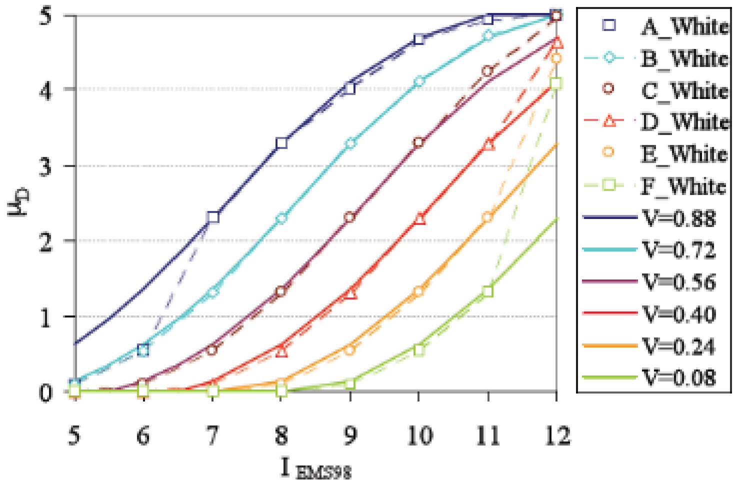
A 3.7.2.3.2 Vulnerability Curves In Terms of Macroseismic intensity

The vulnerability matrices can be parameterized and expressed in analytical terms through the following report (Bernardini e Giovinazzi e Lagomarsino e Parodi, 2008) which expresses the value assumed by the averages of the damage distributions as the macroseismic intensity varies μ_D.

$$\mu_D = 2.5 + 3tanh\left(\frac{I + 6.25V - 12.7}{3}\right)$$

where $0 \le \mu_D \le 5$ $0 \le \mu_D \le 5$ while the parameter V depends on the vulnerability class according to the values shown in the table.

V_A	V_B	V_C	V_D	V_E	V_F
0.88	0.72	0.56	0.40	0.24	0.08



A 3.7.2.3.3 PGA Vulnerability Curves

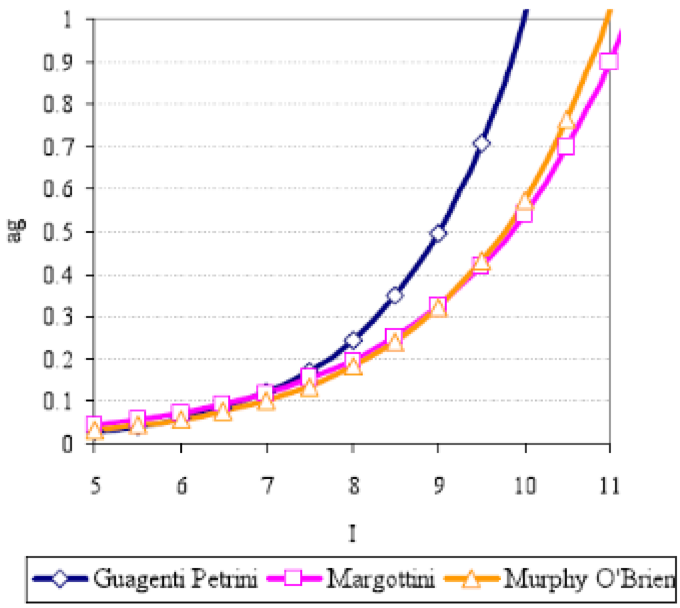
An equally useful representation of vulnerability curves can be obtained by transforming intensity values into corresponding PGA (Peak Ground Acceleration) values.

Using the formulation reported at the beginning (Lagomarsino and Giovinazzi, 2006)

$$PGA = c_1 c_2^{(I-5)}$$

where PGA is expressed in units of g, I represent the macroseismic intensity measured in the conventional EMS-98 scale.

Thus, the figure below shows the trend for the three proposed correlation laws.



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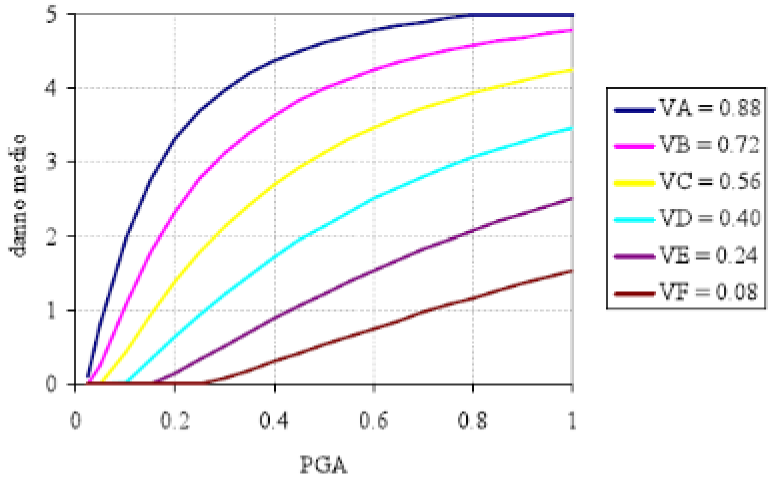
Using the correlation law proposed by Margottini, the trends of the vulnerability curves in terms of PGA for each EMS-98 vulnerability class are reported below.



A 3.7.2.4 Expected Losses In Terms Of Human Lives

The estimate of the loss of life is made using data derived from the ATC-13 standard "Earthquake Damage Evaluation Data for California" as a benchmark. This evaluation is useful to manage priority and urgency for each sector.

Level of damage	Average percentage of damage	Fraction of injured occupants		Fraction of dead occupants
EMS-98	[%]	Slightly	Severely	Deaths
D0	0.5%	3/100 000	1/250 000	1/1 000 000
D1	5%	3/10 000	1/25 000	1/100 000
D2	20%	3/1 000	1/2 000	1/10 000
D3	45%	3/100	1/250	1/1000
D4	80%	3/10	1/25	1/100
D5	100%	2/5	2/5	1/5

The application of a schematization of this type does not disregard the need to know population density. Since 2011, Eurostat has classified municipalities according to three degrees of urbanisation - high, medium and low - using a new tool based on population density and the number of inhabitants assessed within regular grids with cells of one square kilometre. The data for Italy, as an example, are summarized in the table below (ISTAT, Yearbook 2019). Densities are given per inhabitants/sq km.

ANNI REGIONI	Basso Comuni (%)	Basso Superficie (%)	Basso Popolazione (%)	Basso Densità (a)	Medio Comuni (%)	Medio Superficie (%)	Medio Popolazione (%)	Medio Densità (a)	Alto Comuni (%)	Alto Superficie (%)	Alto Popolazione (%)	Alto Densità (a)
2014	67,9	72,5	24,2	67	28,7	22,7	42,4	377	3,4	4,8	33,3	1.391
2015	67,9	72,5	24,2	67	28,7	22,7	42,5	376	3,4	4,8	33,4	1.389
2016	67,8	72,5	24,1	67	28,8	22,7	42,5	376	3,4	4,8	33,4	1.389
2017	67,7	72,5	24,0	66	28,9	22,7	42,5	375	3,4	4,8	33,4	1.388
2018 - PER REGIONE												
Piemonte	81,0	79,0	28,6	62	18,6	19,3	46,2	410	0,3	1,7	25,2	2.552
Valle d'Aosta/ Vallée d'Aoste	86,5	94,2	50,7	21	13,5	5,0	49,3	320	-	-	-	-
Liguria	64,5	67,1	11,4	49	33,8	25,3	37,9	429	1,7	7,6	50,7	1.904
Lombardia	44,4	57,8	11,5	84	47,4	34,4	47,7	585	8,2	7,8	40,8	2.210
Trentino-Alto Adige/ Südtirol	86,3	90,9	47,5	41	13,0	7,5	31,4	328	0,7	1,5	21,1	1.076
Bolzano/Bozen	*87,9*	*93,5*	*50,1*	*39*	*11,2*	*5,8*	*29,7*	*365*	*0,9*	*0,7*	*20,3*	*2.060*
Trento	*85,2*	*87,9*	*45,1*	*45*	*14,2*	*9,6*	*33,1*	*301*	*0,6*	*2,5*	*21,9*	*749*
Veneto	51,5	52,0	18,6	101	47,6	43,4	61,5	379	0,8	4,6	10,8	1.096
Friuli-Venezia Giulia	71,2	75,5	27,8	57	27,4	22,3	43,0	296	1,4	2,3	29,2	1.967
Emilia-Romagna	71,6	71,1	29,9	84	25,7	18,4	34,0	367	2,7	10,5	36,0	682
Toscana	65,0	73,6	25,0	55	32,5	23,4	47,9	332	2,6	3,0	27,2	1.476
Umbria	87,0	78,0	47,9	64	10,9	14,2	20,7	152	2,2	7,8	31,4	418
Marche	77,7	73,3	31,9	71	21,4	24,0	55,2	373	0,9	2,7	12,9	779
Lazio	79,4	68,8	19,5	97	20,1	22,1	29,7	458	0,5	9,1	50,7	1.906
Abruzzo	89,5	84,1	40,3	58	10,2	15,6	50,6	394	0,3	0,3	9,1	3.472
Molise	96,3	93,7	59,5	44	2,9	5,0	24,4	333	0,7	1,3	16,0	874
Campania	53,5	68,0	13,0	81	31,1	22,1	27,4	526	15,5	9,9	59,6	2.558
Puglia	44,6	53,0	27,0	105	53,1	40,5	51,7	263	2,3	6,5	21,4	676
Basilicata	96,9	93,2	71,9	43	1,5	1,2	5,5	256	1,5	5,6	22,6	224
Calabria	82,7	79,1	42,7	69	16,6	18,3	40,0	280	0,7	2,6	17,3	864
Sicilia	62,3	68,3	22,9	65	36,4	28,6	49,5	335	1,3	3,1	27,6	1.714
Sardegna	89,4	84,1	46,2	37	10,1	13,3	36,7	187	0,5	2,6	17,1	445
Nord-ovest	**61,5**	**70,0**	**16,4**	**65**	**34,1**	**25,3**	**46,3**	**508**	**4,4**	**4,7**	**37,2**	**2.218**
Nord-est	**66,4**	**70,4**	**27,0**	**72**	**32,2**	**23,9**	**46,3**	**362**	**1,3**	**5,8**	**26,7**	**867**
Centro	**75,6**	**72,8**	**24,9**	**71**	**23,0**	**21,8**	**37,9**	**360**	**1,3**	**5,4**	**37,2**	**1.412**
Sud	**71,4**	**73,7**	**27,1**	**70**	**23,1**	**21,3**	**37,4**	**332**	**5,5**	**5,0**	**35,5**	**1.348**
Isole	**75,6**	**75,9**	**28,6**	**50**	**23,5**	**21,2**	**46,3**	**290**	**0,9**	**2,9**	**25,0**	**1.156**
ITALIA	**67,7**	**72,5**	**24,0**	**66**	**28,9**	**22,7**	**42,6**	**375**	**3,4**	**4,8**	**33,4**	**1.386**

The data in the table above can be assumed when the scale is kilometric (wide area) for example using shake maps. In the case of sectors, it is reasonable to estimate the number of persons about the type of building (e.g. using statistical data on the average household composition).

Example

Determine the loss of life for a sector of 50 buildings consisting of buildings with vulnerability class B. The sector has a surface area of 5000 square meters (0.005 square kilometres) and consists of three-storey buildings.

Taking the appropriate vulnerability matrix (the second one, Class B) and assuming that the occupancy area of the buildings conventionally coincides with the surface area of the sector, the expected losses in a probabilistic sense are immediately known, assuming for the sector many inhabitants equal to 600.

Vulnerability class B - Inhabitants involved in damage levels						
I	D0	D1	D2	D3	D4	D5
V	546	54				
VI	336	210	54			
VII	126	210	210	54		
VIII	18	108	210	210	54	
IX		54	108	210	210	54
X			18	108	264	210
XI				9	144	447
XII						600

Vulnerability class B - Losses in terms of human lives (slight/severe/dead)						
I	D0	D1	D2	D3	D4	D5
V	546 (0/0/0)	54 (0/0/0)				
VI	336 (0/0/0)	210 (0/0/0)	54 (0/0/0)			
VII	126 (0/0/0)	210 (0/0/0)	210 (1/0/0)	54 (2/0/0)		
VIII	18 (0/0/0)	108 (0/0/0)	210 (1/0/0)	210 (6/1/0)	54 (16/2/1)	
IX		54 (0/0/0)	108 (0/0/0)	210 (6/1/0)	210 (63/8/2)	54 (21/21/12)
X			18 (0/0/0)	108 (3/1/0)	264 (79/11/3)	210 (84/84/42)
XI				9 (0/0/0)	144 (43/6/2)	447 (179/179/242)
XII						600 (240/240/120)

It can be observed that significant numbers occur for damage levels no lower than D3.

A 3.7.2.5 General considerations

A 3.7.2.5.1 On The Threshold Of The “Attention” Earthquake

Observing the probability matrix of the damage proposed in ATC-13, it is observed that, unless site effects (site amplification by geomorphological characteristics), events from the VII degree macroseismic (MMI) can cause collapses.

Level of damage	Interval of the %RC	%RC average	Probability of damage according to MMI						
			VI	VII	VIII	IX	X	XI	XII
1	0	0	95%	49%	30%	14%	3%	1%	0.4%
2	0-1%	0.5%	3%	38%	40%	30%	10%	3%	0.6%
3	1-10%	5%	1.5%	8%	16%	24%	30%	10%	1%
4	10-30%	20%	0.4%	2%	8%	16%	24%	30%	3%
5	30-60%	45%	0.1%	1.5%	3%	10%	18%	30%	18%
6	60-100%	80%	-	1%	2%	4%	10%	18%	39%
7	100%	100%	-	0.5%	1%	2%	3%	8%	38%

Note	
1 – none	no damage
2 – minor	limited and localised damage that does not require repair
3 – light	significant and localised damage which generally does not need to be repaired
4 – moderate	local and significant damage that requires repair
5 – severe	extensive damage requiring repair
6 – very severe	major and extensive damage that may require the demolition
7 – collapse	collapse of most of the structure
RC	cost of reconstruction

When a damage level of 50% of the cost of reconstruction is exceeded, the probability of casualties is 0.1%.

Concerning site amplifications (seismic microzonation) it is prudent to consider seismic events from the VI-VII degree macroseismic (PGA 0.092-0.18) as significant.

A 3.7.2.5.2 On Italian Seismic Zoning

The current Italian seismic zoning has been defined by the region governments that have deliberated based on the criteria defined by OPCM 3274 of 20 March 2003 and, subsequently, by OPCM 3519 of 28 April 2006 “*General criteria for the identification of*

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seismic zones and for the formation and updating of lists of the same zones". The latter foresees, regarding the PGA with a probability of exceedance of 10% over a Return Period (RP) =50 years (i.e. the PGA corresponding to LLS – Life saving Limit State), 4 zones

- Zone 1 with PGA≥0.25g±0.025g (not less than VIII EMS-98);
- zone 2 with 0.15g±0.025g <PGA<0.25g±0.025g (not less than VII EMS-98);
- zone 3 with 0.05g±0.025g <PGA<0.15g±0.025g (not less than VI EMS-98);
- zone 4 with PGA<0.05g±0.025g (up to VI EMS-98).

Although not all regions have yet decided on the reclassification of their territory, the elaborations are carried out assuming for simplicity that the zones are defined with the above-mentioned limits, without considering the tolerances of ±0.025g.

A 3.7.2.6 Methodological Check Based On Documented Historical Events

A 3.7.2.6.1 The Amatrice Earthquake

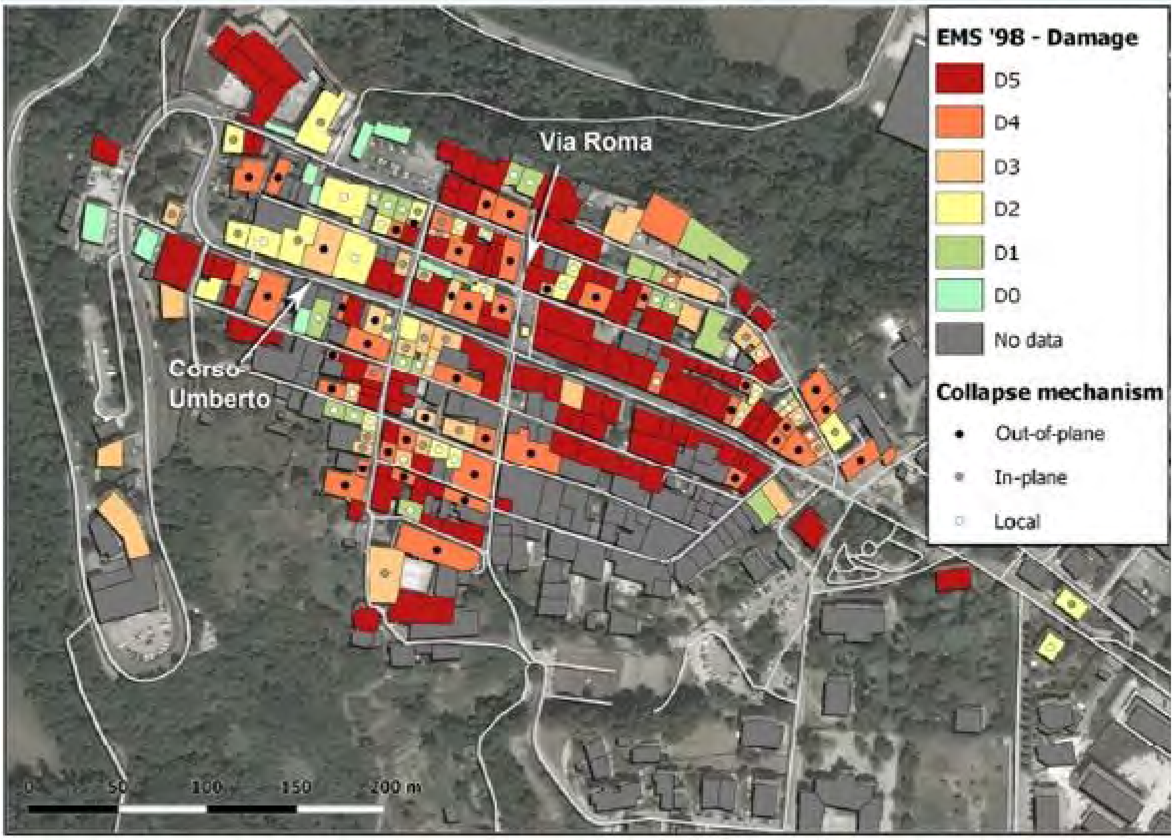
The Earthquake And Damage To Buildings After The First Tremor On 24 August 2016[3]

The available data about the situation regarding the first earthquake on August 24, 2016 in the main centre are given in advance.

The PGA recorded by the accelerometer station of Amatrice (AMT station, located at the entrance to the main centre at the base of the hill) during the shock of August 24, 2016 was PGA=0.87g;

The buildings for which damage levels verified were 240 and the most of them (89%) were masonry buildings. The buildings with reinforced concrete (RC) structure are 9% while the remaining 2% was in mixed masonry/reinforced concrete structure. Below are the damage map and a summary table.

3 Gabriele Fiorentino, Angelo Forte, Enrico Pagano, Fabio Sabetta, Carlo Baggio, Davide Lavorato, Camillo Nuti, Silvia Santini, Damage patterns in the town of Amatrice after August 24th 2016 Central Italy earthquakes, Bull Earthquake Eng (2018)



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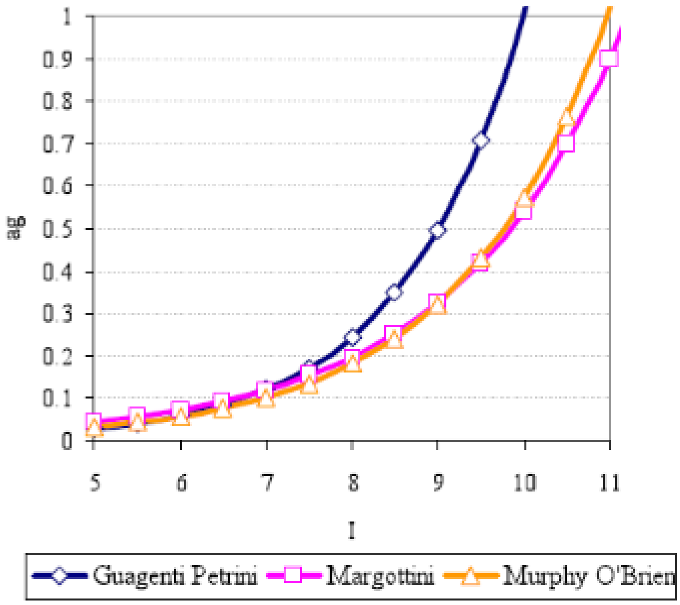
Type	Level of damage						
	D0	D1	D2	D3	D4	D5	Total
Masonry	5 (2.3%)	13 (6.1%)	25 (11.7%)	26 (12.1%)	41 (19.1%)	104 (48.6%)	214
RC	4 (19%)	6 (28.6%)	2 (9.5%)	7 (33.3%)	1 (4.8%)	1 (4.8%)	21
Other	0	1	0	1	3	0	5
Total	9	20	27	34	45	105	240

Damage Prediction Analysis And Response Assessment Team Planning

In the immediacy of the event, it is assumed that only the PGA of the event (0.87g) is available.

The correlations $\frac{PGA}{I_{EMS}}$ allow to identify an event with macroseismic intensity $IX < I_{EMS} < X$.



Since it is a historical centre and has no information on the seismic vulnerability, in first approximation (worst case) it is considered the worst vulnerability class (A). The relative vulnerability matrix, with the indication of the real values detected (last row of the table), is shown below.

Vulnerability class A - Damaged buildings by the level of damage						
I_{EMS}	D0	D1	D2	D3	D4	D5
V	91	9				
VI	56	35	9			
VII	3	18	35	35	9	
VIII		3	18	35	35	9
IX			3	27	35	35
X				7.5	18	74.5
XI					7.5	92.5
XII						100
PGA=0.87	2.3	6.1	11.7	12.1	19.1	48.6

It should be noted that the values in the table, compared to the actual values, are per damage classes D3, D4 and D5. The differences between prediction and reality are because the sample of 214 buildings does not have the same vulnerability.

Assuming an assortment between the classes of vulnerability between A, B and C as the real situation, one has:

I_{EMS}	D0	D1	D2	D3	D4	D5
Vulnerability class A						
IX			3	27	35	35
X				7.5	18	74.5
Vulnerability class B						
IX		9	18	35	35	9
X			3	18	44	35
Vulnerability class C						
IX	3	18	35	35	9	
X		3	18	35	35	9
PGA=0.87	2.3	6.1	11.7	12.1	19.1	48.6

It is observed that considering an assortment of vulnerability classes between A and B it is possible, practically, to reconstruct the most significant damage scenario.

Considering that for the sending of assessment resources the most significant damage classes are D3, D4 and D5, taking as reference an intensity $I_{EMS} = X$ you would have for each sector of the main centre of Amatrice (the percentages of damaged buildings are invariant):

Vulnerability	Buildings to check (D3-D5)	Number of assessment teams
A	100%	5
B	97%	5
C	79%	4

If, on the other hand, only damage classes D4 and D5 are considered significant, for each sector it would be:

Vulnerability	Buildings to check (D4-D5)	Number of assessment teams
A	92.5%	5
B	79%	4
C	44%	3

Damage Prediction Analysis And Planning Of Assessment Teams In The Planning Phase (pre-event)

It is noted that the PGA for the territory of Amatrice for an earthquake with a return time of 975 years is 0.37g (the registered PGA was 0.87g).

Repeating the analyses carried out has, as a reference, an event with macroseismic intensity $VIII < I_{EMS} < IX$.

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Since it is a historical centre and has no information on the seismic vulnerability, in the first approximation (worst case), the worst vulnerability class (A) is considered. The relative vulnerability matrix, with the indication of the real values detected, is reported below.

Vulnerability class A						
I_{EMS}	D0	D1	D2	D3	D4	D5
V	91	9				
VI	56	35	9			
VII	3	18	35	35	9	
VIII		3	18	35	35	9
IX			3	27	35	35
X				7.5	18	74.5
XI					7.5	92.5
XII						100
PGA=0.87	2.3	6.1	11.7	12.1	19.1	48.6

It should be noted that the values in the table, compared to the actual values, are a default estimate for class D5 and substantially in excess for damage classes D3 and D4. Also, in this case, the differences can be due to the fact that the sample of 214 buildings does not have the same vulnerability.

Assuming an assortment between the classes of vulnerability between A, B and C as the real situation one has:

I_{EMS}	D0	D1	D2	D3	D4	D5
Vulnerability class A						
VIII		3	18	35	35	9
IX			3	27	35	35
Vulnerability class B						
VIII	3	18	35	35	9	
IX		9	18	35	35	9
Vulnerability class C						
VIII	21	35	35	9		
IX	3	18	35	35	9	
PGA=0.87	2.3	6.1	11.7	12.1	19.1	48.6

It should be noted that considering an assortment of vulnerability classes between A, B and C it is possible, in practice, to reconstruct the most significant damage scenario excluding the underestimation of the D5 level (the PGA in the registered case is more than the prediction value).

Considering that for sending assessment resources the most significant damage classes are D3, D4 and D5, taking as reference an intensity you would have for each sector of the capital of Amatrice (the percentages of damaged buildings are invariant):

Vulnerability	Buildings to check (D3-D5)	Number of assessment teams
A	97%	5
B	79%	4
C	44%	3

If, on the other hand, only damage classes D4 and D5 are considered significant, for each sector it would be:

Vulnerability	Buildings to check (D4-D5)	Number of assessment teams
A	70%	3
B	44%	2-3
C	9%	1

Estimated Life Losses

Reference is made to the ATC-13 "Earthquake Damage Evaluation Data for California" standard.

Damage level	Average percentage of damage	Fraction of injured occupants		Fraction of dead occupants
EMS-98	[%]	Slightly	Severely	Deaths
D0	0.5%	3/100 000	1/250 000	1/1 000 000
D1	5%	3/10 000	1/25 000	1/100 000
D2	20%	3/1 000	1/2 000	1/10 000
D3	45%	3/100	1/250	1/1000
D4	80%	3/10	1/25	1/100
D5	100%	2/5	2/5	1/5

The population data per hamlet are not known (the whole municipality, of extension 174.4 square kilometres and divided into 69 hamlets, had in 2015 a population of 2657 inhabitants). Considering the presence of 214 buildings, one household per building and a family size of 1.97 people, the sample of buildings under examination involves a population that can be estimated at 422 people (214 buildings, 4 sectors of 53/54 buildings).

The following table details the number of people involved (for damage levels D3, D4 and D5) according to the vulnerability class and taking as a reference an intensity $I_{EMS} = X$.

I_{EMS}	D3	D4	D5
X, Class A	7.5	18	74.5
Minor/serius Injuried Death	1/0 -	23/3 -	126/126 63
X, Class B	18	44	35
Minor/serius Injuried Death	3/0 -	56/8 2	59/59 30
X, Class C	35	35	9
Minor/serius Injuried Death	5/1 -	45/6 2	15/15 8

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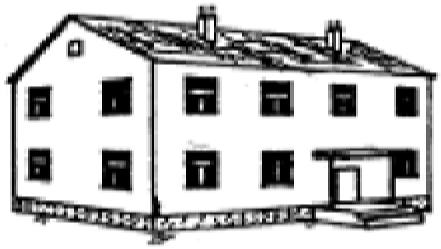
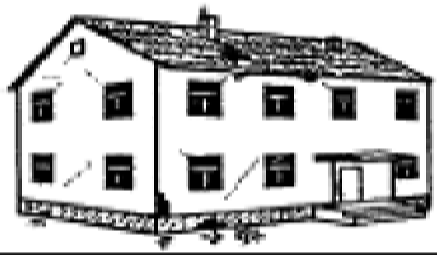
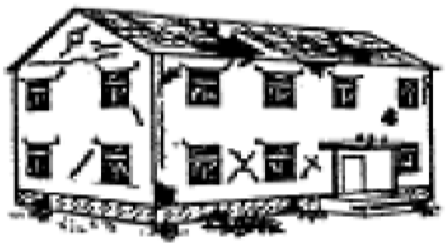
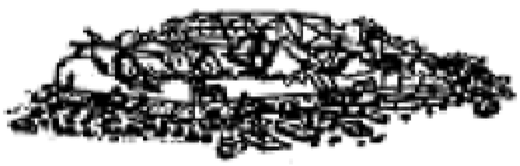
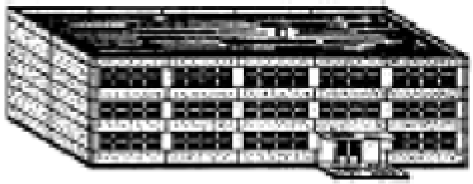
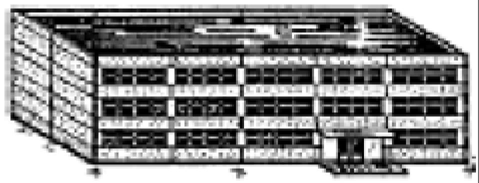
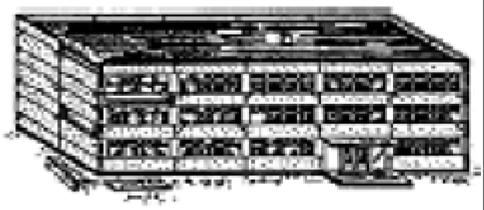
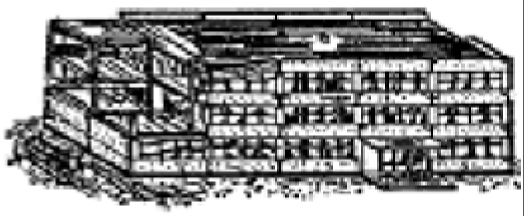
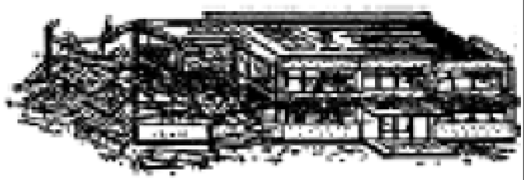
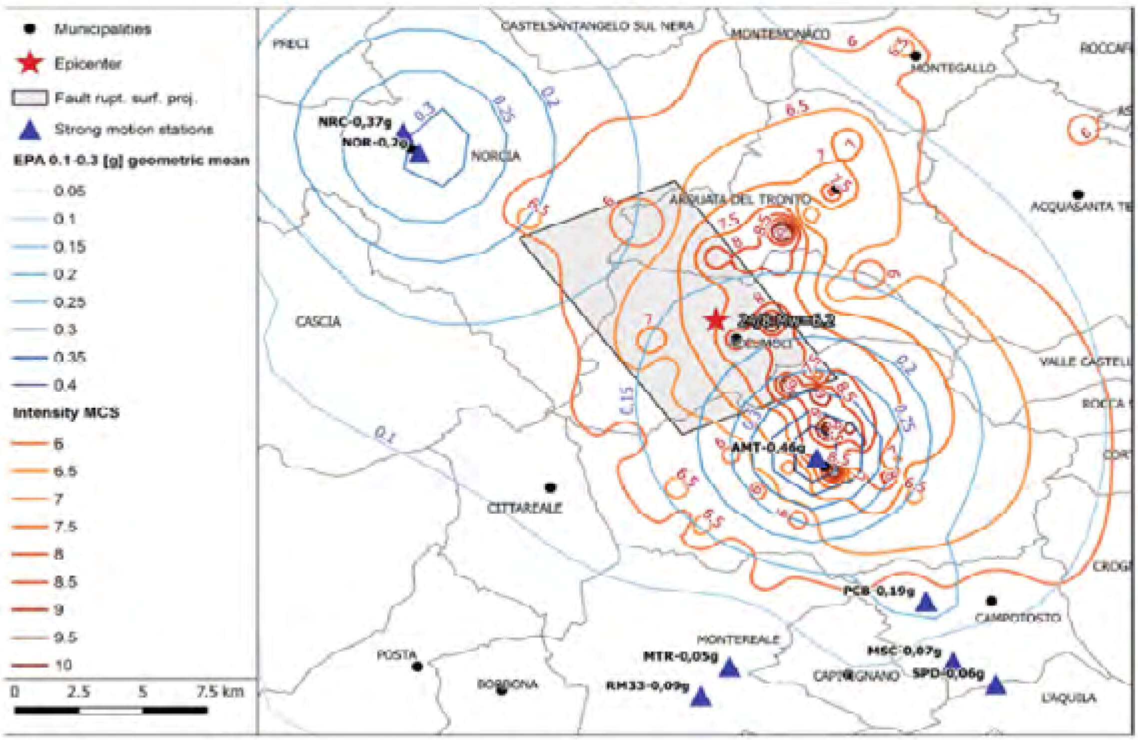
Classification of damage to masonry buildings	
	**Grade 1: Negligible to slight damage** **(no structural damage,** **slight non-structural damage)** Hair-line cracks in very few walls. Fall of small pieces of plaster only. Fall of loose stones from upper parts of buildings in very few cases.
	**Grade 2: Moderate damage** **(slight structural damage, moderate non-structural damage)** Cracks in many walls. Fall of fairly large pieces of plaster. Partial collapse of chimneys.
	**Grade 3: Substantial to heavy damage** **(moderate structural damage,** **heavy non-structural damage)** Large and extensive cracks in most walls. Roof tiles detach. Chimneys fracture at the roof line; failure of individual non-structural elements (partitions, gable walls).
	**Grade 4: Very heavy damage** **(heavy structural damage,** **very heavy non-structural damage)** Serious failure of walls; partial structural failure of roofs and floors.
	**Grade 5: Destruction** **(very heavy structural damage)** Total or near total collapse.

Classification of damage to buildings of reinforced concrete	
	**Grade 1: Negligible to slight damage** **(no structural damage,** **slight non-structural damage)** Fine cracks in plaster over frame members or in walls at the base. Fine cracks in partitions and infills.
	**Grade 2: Moderate damage** **(slight structural damage,** **moderate non-structural damage)** Cracks in columns and beams of frames and in structural walls. Cracks in partition and infill walls; fall of brittle cladding and plaster. Falling mortar from the joints of wall panels.
	**Grade 3: Substantial to heavy damage** **(moderate structural damage,** **heavy non-structural damage)** Cracks in columns and beam column joints of frames at the base and at joints of coupled walls. Spalling of conrete cover, buckling of reinforced rods. Large cracks in partition and infill walls, failure of individual infill panels.
	**Grade 4: Very heavy damage** **(heavy structural damage,** **very heavy non-structural damage)** Large cracks in structural elements with compression failure of concrete and fracture of rebars; bond failure of beam reinforced bars; tilting of columns. Collapse of a few columns or of a single upper floor.
	**Grade 5: Destruction** **(very heavy structural damage)** Collapse of ground floor or parts (e. g. wings) of buildings.

2.7 Classifications of damage according to EMS-98



2.8 Macroseismic intensity according to EMS-98 Amatrice Earthquake

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A 3.7.3 Sector Ranking and Urgency

Priorities and urgency of intervention for each sector can be examined starting from the level of damage in the sector and based on further parameters. Details are given in annex 3.8.

Annex 3.8 SECTOR RANKING AND URGENCY ASSESSMENT FORMS

SUMMARY

This annex shows a procedure to find a **Priority** that could be suggested to Local Authorities so that they pay attention to where starting rescue activities as soon as possible to maximize the lifesaving focus, after an earthquake.

Two tools are proposed and can both be used to detail the growing information.

The first one takes into account the minimum information to proceed with the identification of priorities, such as type of zone, type of prevalent buildings, expected damage to buildings, number of assessment teams needed.

The second one uses more accurate data refining the analysis if available and constantly being updated in the post-event phase. Only the availability of accurate data will provide an accurate assessment of emergencies.

The procedure provides a proposal for a workflow to transform information in “situational intelligence”, useful for Local Authorities to define priorities: it starts from a tool to find Level 1 Priority (Sector Ranking Form L1) and then, to complete it, Local Authority could evaluate the Level 2 Priority (Sector Ranking Form L2) if more accurate data are available.

A 3.8.1 Sector Ranking Form L1 (Level 1 priority)

Sector Ranking Form L1 is a table including the minimum information to obtain a fast priority plan.

Because total required information will not be available before USAR activities start, information-gathering and evaluation will be continuous throughout an operation.

Other information relating the event and necessary to reach a comprehensive Sector Ranking Plan may be gathered from a variety of sources by Local Authority. Careful and accurate assessment of intelligence and information is a vital part of USAR action and may be instrumental in modifying wide assessment, reprioritising sector and adopting revised strategies.

The priority of the sector depends on all the factors indicated:

- each type of zone may be affected differently depending on the time the earthquake occurs;
- the prevalent type of construction makes it possible to postulate the behaviour of the construction concerning the expected damage;

- the expected degree of damage (which takes into account the vulnerability of buildings) provides for the optimal size for the assessment because the more buildings are damaged the more teams are needed;
- the present population is an important element because it is linked to the potential victims to be rescued.

In relation to the factors indicated, the highest priority will be given to the sectors with the greatest widespread damage and the largest population. Other factors may be used, on a case-by-case basis, to identify specific situations.

In the form, the population density "D" (estimated number of inhabitants per sector) is a function of the typology of the sector (residential, commercial, industrial, etc...) of the distribution of the population within the buildings at the time of the earthquake. Then it is important to identify the occupancy of such buildings and other relevant infrastructure on different days of the week and in different months of the year. Therefore, it is possible to define a factor, time daily TD, that takes into account the occupation of the buildings/infrastructure at different times of the day and the week, and a factor, time monthly TM, that takes into account the occupancy of the buildings/infrastructure in the different months of the year.

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The presumed population density occupying the buildings of the sector at the time of the earthquake and reported in the Sector Ranking Form, defined "Density Sector Ranking", DSR, taking into account the type of sector and the population density available from the registry carried out during the pre-sectorization phase by the Local Authority, defined "Density Local Authority", DLA, can be determined from the following relation:

$D_{SR} = D_{LA} * T_D * T_M$

where the factors TD and TM are derived from Tables 3.8.1 and 3.8.2[4].

In case of impossibility to apply the method described above for population density, as a first approximation it is reasonable to estimate the number of people from the type of buildings in the sector that have been damaged by using statistical data on the average household composition.

Sector Ranking Form L1

Sector ID	Zone	Type of construction	Expected degree of damage	Teams assessment needed	Population	Priority ID
A1	A2	B1	B2	B3	B4	B5

4 The values of these both tables are highly variable and depend on the particularities of the area under the control of the Local Authority, which can then update them on the basis of statistical data, social factors, knowledge of the territory, etc... Here they are given as simple indications to give to the Local Authorities an idea about the methodology.

Sector Ranking Form

Guidance Notes

A1	Sector ID: Identifying of a sector
A2	Zone ID: 1: *residential area* (1A: old town, 1B: high-rise residential, 1C: low-rise residential); 2: *commercial area,* primarily composed of commercial buildings such as central business district, financial district, shopping centre, etc; 3: *crowded centres* (e.g. sports complexes, airports, train stations, shopping malls, theatres, singer concerts, religious events, etc.); 4: *industrial area* (e.g. warehouses, power plants, etc…); 5: *tourist area, the* area that has an attraction for tourists, like summer (e.g. seaside, lakeside, riverside resorts) and winter places (e.g. ski and mountain resorts), ancient villages, etc….; 6: *rural area* (rural residential area, agricultural and agro-industrial, etc…).
B1	Describe the material that makes up most of the buildings in the sector (prevalent typology) using the typologies according to the EMS-98 Scale: 1: masonry; 2: reinforced concrete; 3: steel; 4: wood.
B2	Damage degree - fraction of buildings (≤1) expected in grade 4 (very heavy) and 5 (destruction) of damage in according to the EMS-98 Scale (see Manual, paragraph 3.9.1).
B3	Fill in with the result of the methodology described in Manual, paragraph 3.9.1 (coverage factor related to the macroseismic grade, or PGA, multiplicated by 5)

B4	Estimated number of habitants per sector, based on Density Sector Ranking, D_{SR}. The presumed population per sector, related by the occupying of the buildings at the time of the earthquake and reported in the Sector Ranking Form and defined "Density Sector Ranking", D_{SR}, taking into account the type of sector and the population density available from the registry carried out during the pre-sectorization phase by the Local Authority, defined "Density Local Authority", D_{LA}, can be determined from the following relation: $D_{SR} = D_{LA} * T_D * T_M$ where the factors T_D and T_M are derived from Tables 3.8.1 and 3.8.2. As a first approximation and in the absence of data for the application of the proposed method, it is reasonable to estimate the number of people from the type of buildings in the sector that have been damaged by using statistical data on the average household composition.
B5	Assign an ID based on the number of teams that have been deployed in the sector and on the population affected. Priority 1 (the maximum) will be given to the sector with the most widespread damage (5 assessment teams needed) and the largest estimated number of habitants. Priority 5 (the minimum) will be given to the sector with the less widespread damage (1 assessment team needed) and the smallest estimated number of habitants.

Zone - Z	Time	from	to	T_D
1 – Residential area	Weekday	07.00	17.00	0,5
		17.00	21.00	0,8
		21.00	07.00	1
	Weekend	09.00	20.00	0,4
	Public Holiday	20.00	09.00	0,7
2 – Commercial area	Weekday	09.00	21.00	0,6
		21.00	09.00	0,1
	Weekend	09.00	21.00	1
	Public Holiday	21.00	09.00	0,5
3 – Crowded centers	Weekday	09.00	21.00	0,8
		21.00	09.00	0,1
		duration of the event		1
	Weekend Public Holiday	09.00	21.00	0,6
		21.00	09.00	0,1
		duration of the event		1

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4 – Industrial area	Weekday	06.00	14.00	1
		14.00	22.00	1
		22.00	06.00	1
	Weekend Public Holiday	06.00	14.00	0,5
		14.00	22.00	0,5
		22.00	06.00	0,5
5 – Tourist area (summer place)	Weekday	10.00	18.00	0,2
		18.00	21.00	0,6
		21.00	10.00	0,8
	Weekend Public Holiday	10.00	18.00	0,3
		18.00	21.00	0,7
		21.00	10.00	0,9
5 – Tourist area (winter place)	Weekday	10.00	18.00	0,5
		18.00	21.00	0,4
		21.00	10.00	0,8
	Weekend Public Holiday	10.00	18.00	0,6
		18.00	21.00	0,7
		21.00	10.00	0,9
6 – Rural area	Weekday	07.00	17.00	0,6
		17.00	21.00	0,8
		21.00	07.00	1
	Weekend Public Holiday	09.00	20.00	0,6
		20.00	09.00	0,7
Weekday	a day of the week from Monday to Friday			
Weekend	Saturday and or Sunday			
Public Holiday	a nationally recognized day when most businesses and other institutions are closed			
Duration of the event	duration of the event in the case of shows, concerts, exhibitions, public halls, etc.. in this case the maximum capacity that the site can contain is considered.			

Table 3.8.1 – Factor T_D

Zone - Z	Time	from	to	T_M
1 – Residential area	Weekday	May	September	0,6
		October	November	1
		December	January	0,8
		February	April	0,9
	Weekend Public Holiday	May	September	0,4
		October	November	0,7
		December	January	0,5
		February	April	0,6
2 – Commercial area	Weekday	May	September	0,7
		October	November	1
		December	January	0,8
		February	April	1
	Weekend Public Holiday	May	September	0,7
		October	November	0,8
		December	January	0,7
		February	April	0,8
3 – Crowded centers	Weekday	May	September	0,5
		October	November	0,8
		December	January	1
		February	April	0,7
	Weekend Public Holiday	May	September	0,6
		October	November	0,9
		December	January	1
		February	April	0,8
4 – Industrial area	Weekday	July	August	0,3
		September	November	0,9
		December	January	0,6
		February	June	0,8
	Weekend Public Holiday	July	August	0,2
		September	November	0,7
		December	January	0,5
		February	June	0,7

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5 – Tourist area (summer place)	Weekday	May	September	1
		October	November	0,1
		December	January	0,3
		February	April	0,1
	Weekend Public Holiday	May	September	1
		October	November	0,3
		December	January	0,4
		February	April	0,2
5 – Tourist area (winter place)	Weekday	May	September	0,4
		October	November	0,5
		December	February	0,9
		March	April	0,4
	Weekend Public Holiday	May	September	0,5
		October	November	0,6
		December	February	1
		March	April	0,6
6 – Rural area	Weekday	May	September	0,5
		October	November	1
		December	January	0,7
		February	April	1
	Weekend Public Holiday	May	September	0,4
		October	November	0,6
		December	January	0,5
		February	April	0,6
Weekday	a day of the week from Monday to Friday			
Weekend	Saturday and or Sunday			
Public Holiday	a nationally recognized day when most businesses and other institutions are closed			

Table 3.8.2 – Factor T_M

A 3.8.2 Sector Ranking Form L2 (Level 2 priority)

While assessing the whole information, Local Authorities will need to make decisions on the priority or severity of the situation and whether to take action or not based on certain factors characterizing the population, the scenario and the rescue management, according to Chapter 2.

This method can achieve greater accuracy if the necessary information is known with certainty.

A useful tool can be the Level 2 Sector Ranking Form below.

SECTOR RANKING FORM L2

	C1. Population density		VALUE
POPULATION	density ≤ 100	1	
	density ≤ 1000	2	
	density > 1000	3	
	C2. Medical conditions		
	no hospital, nursing homes, health care, etc.	1	
	hospital, nursing homes, health care, etc.	3	
	C3. Cognitive abilities		
	no known cognitive issues	1	
	limited cognitive abilities (e.g. grade school, middle school, etc.)	2	
	very limited cognitive abilities (e.g. nursery school, preschool, etc.) and cognitive deficits	3	
	D1. Weather profile		
SCENARIO	no hazardous weather forecast	4	
	hazardous forecast (12 hours or less)	3	
	hazardous forecast (more than 12 hours)	2	
	existing hazardous weather or other particular conditions (heavy snowfall, scorching heat, etc...)	1	
	D2. Hazards Assessment		
	no known hazards	1	
	damaged infrastructure that could create a domino effect on the sector	2	
	E1. Teams assessment needed		
RESCUE MANAGEMENT	1 team	1	
	2 teams	2	
	3 teams	3	
	4 teams	4	
	5 teams	5	

Urgency criterion (sum of the single score: C1+C2+C3+D1+D2+E1 and compare it with the range below)		
Low	Medium	High
6-10	10-15	15-20

Sector Ranking Form L2

Guidance Notes

C1	Number of habitants per sector, based on “Density Sector Ranking”, D_{SR}
C2	Indicate presence
C3	Describe the cognitive capacity and ability of the population that are in the sector
D1	Typical natural barrier effect (See paragraph 2.2. and Annex 2.1)
D2	Consider all risks in the area
E1	Consider the result of the methodology described in Manual, paragraph 3.9.1 (coverage factor related to the macroseismic grade, or PGA, multiplicated by 5)

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BELICE

Address Via Marsilio Ficino, 13 Firenze (Italy) | **Email** info@beliceproject.eu | **Mob.** +39 39 339 7974808

beliceproject.eu

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