

Chapter 16

Macroseismic Intervention Group: The Necessary Field Observation

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Abstract French territory is characterized by moderate seismicity, but statistically a strong earthquake strikes mainland France every century. The French Central Seismological Office (BCSF) is in charge of macroseismic enquiries and intensity estimations for each earthquake that effects French territory.

Having used various forms of inquiry since 1921, the BCSF became aware of the limits and biases of macroseismic forms for the collection of the seismic effects, in particular for the estimation of the intensities larger or equal to VI including the damages of buildings. The field observations bring crucial informations for an accurate estimation of the intensities higher or equal to VI.

The last earthquakes in metropolitan France and West Indies islands have motivated the BCSF to create a large professional group dedicated on collecting macroseismic field observations. This group, called the Macroseismic Intervention Group (GIM), includes several earthquake specialists in various specific domains, such as vulnerability, site effects, historical intensity estimates, etc. It contributes to the European macroseismic scale, in its evolution and its future updates. By employing young specialists in this group we allow the continuity of the macroseismic work while improving the use of the acquired field data.

16.1 Introduction

Even if the basic concept of macroseismic intensity has not changed over the last century in terms of evaluating the severity of the shake from observations by currents indicators, macroseismic scales have evolved, and in particular the way macroseismic data are collected has been drastically improved over the last 15 years. This improvement is mainly related to the development of reliable Internet communications. Today, many seismic institutions and international agencies use internet forms to asking people for rapid intensity estimations of shock waves (De Rubeis et al. 2009) and the macroseismic intensity is estimated using

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different methods of statistic treatment (De Rubeis et al. 1992). This consists on asking inhabitants how they felt the earthquake and what kinds of effects they observe on their nearby environment: objects movements, damages of furniture and buildings. We collect numerous data over a broad region where the earthquake has been felt, but very little within one specific locality. Two kinds of forms exist: one for individual person and one for a whole city. Therefore, analysts at the observatory works on a resulting data set, consisting either on a sum of individual answers or on an statistical answer at the scale of one city. Using fast Internet communications, macroseismic maps can be produced over entire affected zones, either as preliminary maps through an automatic procedure or as consolidated maps after a subsequent analysis.

At the same time, remote sensing techniques have revolutionised data access to damages to buildings. Several services are now able to provide a map of damages in a few hours or days after the earthquake.

It is therefore legitimate to address the following questions: Why do specialists go to the field, spend time and money, sometimes running the risk of injuries from exposure of aftershocks? Could Internet reports and remote sensing observations entirely replace the field observations? Why is the fieldwork essential for improving the quality of macroseismic observations?

16.2 The Necessity of Field Observations

In France, two types of informations have been systematically processed by BCSF to evaluate the EMS-98 intensity (Grünthal 1998). The first one comes from individuals spontaneously reporting to the BCSF web site,¹ within a few minutes after the shock. These individual reports correspond to the answers of 43 questions. In order to estimate in real time the shake levels and the intensity, we use the pictures provided by the person filling in the report (Fig. 16.1). Doing so, we get an individual value of the intensity (Single Query Intensity - SQI). The average of a number of SQI over each locality gives the preliminary Internet Intensity, available few minutes after the shock on our Internet web site. We archived 50,000 testimonies in our database since 2000.

The second source of information comes from official administrative procedures. Communal questionnaires, adapted to the EMS-98, are filled in within each “commune” by municipal authorities, mayor, policeman, or fireman station officers. These are aimed at giving some statistical overall view of the noticed effects within the territory of the municipality. It represents our official data for the final intensity values.

Using inquiry forms since 1921, the BCSF became aware of limits and biases of the macroseismic forms for the collection of the seismic effects, in particular for the

¹ www.franceseisme.fr

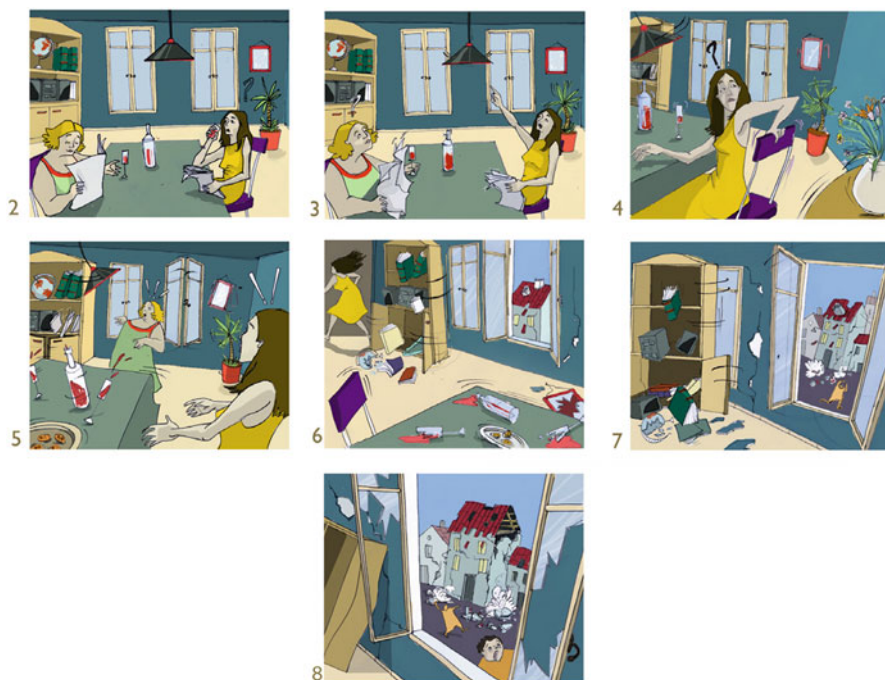


Fig. 16.1 Extract of the selectable images of the individual form representing the various levels of shock (2,3,4,5... indicates intensity level by picture)

estimation of the intensities higher or equal to VI. At this level of intensity, the description of the building vulnerability and the level of damage are important. To estimate intensity, and more exactly to use the last European scale (EMS-98), we have to know the profile of vulnerability of the city to balance the observed effects. We have to know how many building are affected in each vulnerability class (Fig. 16.2) and to what degree of damage they suffer (Fig. 16.3). However, this description is very difficult for municipal officials or inhabitants using collective or individual forms. This work is much more complicated than simply answering the questions: inhabitants may have been worried, frightened or panicked, for instanced, or the objects may have moved or fallen, or many people may have gone out in the street for the first level of intensities. In fact, the vulnerability of the buildings depends on the type of structure, and people do not to know exactly how buildings are constructed. We have observed widely varied estimates for the same municipality in our database since 2000.

In addition, in France intensity is an important criterion for the refund of damages by insurance companies. The inhabitants often exaggerate the damages or incorporate prior damages to the last earthquake in their civic declarations.

The pictures we receive from inhabitants are often too difficult to interpret or to reconcile with the data: lack of basic information such as the scale and frequency of

Fig. 16.2 Differentiation of structures (buildings) into vulnerability classes (Grünthal 1998, EMS-98 scale)

Type of Structure	Vulnerability Class					
	A	B	C	D	E	F
MASONRY	○					
	○—					
	—○					
	—○—					
	—○—					
	—○—					
	—○—					
REINFORCED CONCRETE (RC)	—○—					
	—○—					
	—○—					
	—○—					
	—○—					
	—○—					
STEEL				—○—		
WOOD			—○—			

○ most likely vulnerability class; — probable range; ----range of less probable, exceptional cases

damage, specific photo dates, etc. Our experts in the field can verify the level of the damage and decipher which originate with effects from the earthquake.

By directly interviewing the authorities, an expert in the field can obtain good results (Cecic and Musson 2004). Precision and certitude of effects can be discerned to estimate the profile of vulnerability of the municipality (Fig. 16.4). Experts can examine the list of damages collected by the city hall, visit some damage sites selected from several districts differing in types of vulnerability. They can interpret various reasons for the damage to a building and take this into account in their evaluations (Fig. 16.5).

With individual testimonies, the other biases are due to the nature of spontaneously collection via Internet. In France, the average number of individual forms collected by a city, for earthquakes since 2000, is only 3, corresponding to on average only 0.86 % of the population with a maximum at 3 %. In this case, how can we be sure to find in this individual sample the representative effects for example at the intensities VI where we should find between 2 and 15 % of the building of vulnerability A or B affected by damage degrees of 3 or 4? When we use communal answer, how to be certain that the witness knows all the rare present damages on the municipality? On the other hand, when people suffer high damages






Classification of damage to masonry buildings	
	<p>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.</p>
	<p>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.</p>
	<p>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).</p>
	<p>Grade 4: Very heavy damage (heavy structural damage, very heavy non-structural damage) Serious failure of walls; partial structural failure of roofs and floors.</p>
	<p>Grade 5: Destruction (very heavy structural damage) Total or near total collapse.</p>

Fig. 16.3 Classification of damage to masonry building (Grünthal 1998, EMS-98 scale)

due to an earthquake, their concern is not to fill in forms on the Internet, but to clean and to repair their houses.

In small cities, particularly in mountain zones, the most vulnerable houses are old mainly located in the historical centre, and inhabited by elderly people typically with less Internet access. We have very little reliable data for such buildings. Even

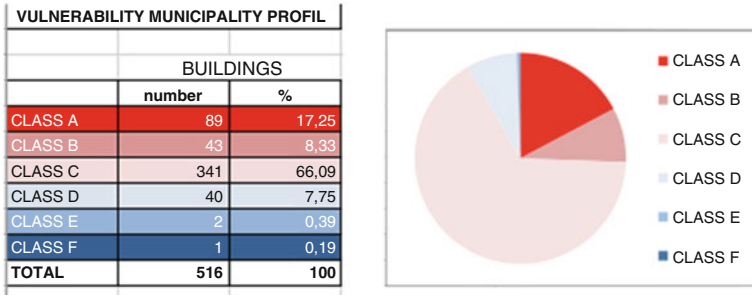


Fig. 16.4 Example of percentage of damage by vulnerability class of a city (BCSF Tool)

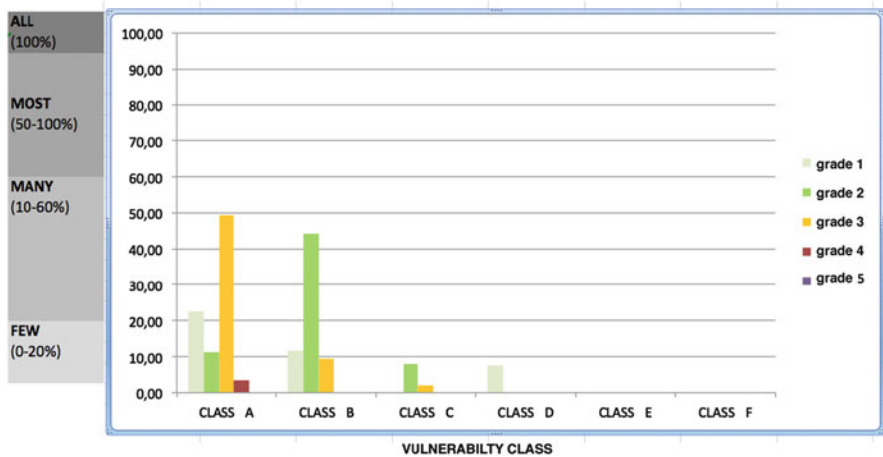


Fig. 16.5 Example of vulnerability city profile (BCSF Tool)



Fig. 16.6 False declaration by the inhabitants of terrace collapse (Les Saintes earthquake 2004). In fact the terrace is not collapse and it's only an increase of existing crack created by an amplification of differential collapse. We can see on the right picture the presence of vegetation in the crack, meaning the age of this damage

Table 16.1 Comparison of internet intensity (individual testimonies) and field intensity (by expertise) on epicentral zone (less than 20 km of epicenter) for Barcelonnette earthquake 7 April 2014 (magnitude 5.2 M_L)

Municipality	Number of inhabitants	Epicentral distance (km)	Intensity (EMS-98) evaluated by:	
			Internet (number of individual testimonies)	Field enquiry
Saint-Paul-sur-Ubaye	230	6	IV (3)	V–VI
La Condamine-Chatelard	175	6	V (6)	VI
Barcelonnette	2,883	11.5	IV (11)	VI
Saint-Pons	791	12	IV (5)	V–VI
Uvernet-Fours	633	15	IV (4)	V
Jausiers	1,163	9	V (21)	VI
Meolans-Revel	348	16.5	VI (2)	V
Faucon-de-Barcelonnette	319	11	IV–V (3)	V

if they are the first ones to be affected by the shock, and it is uncertain whether we collected this information via the ten answers we have received.

By comparison with field estimation, we know that our Internet intensity values issued from individual forms generate lower intensities in the epicentre zone (Table 16.1), as we observed again during the last earthquake in Barcelonnette in April 2014 (Sira et al. 2014).

To use reliable Internet intensities, it is essential to make a comparison with field data.

Similarly, remote sensing data analysis allows the identification with accuracy of damages of degree 5, partially degree 4 (Fig. 16.7), but not degree 3 (Fig. 16.8). This indicate that the assessable level of intensities is a function of vulnerabilities present in the municipality. So we can estimate intensities from VII if vulnerabilities A exist in the municipality, or from VIII if vulnerabilities B exist. In the field, you can observe all the levels of damages affecting buildings even if classes of high vulnerabilities are not present.

The remote sensing have lot of difficulties to give with precision the vulnerability of the building. Without vulnerability profil of commune we cannot provide intensities merely through remote sensing.

The fieldwork certainly cannot be realized on a complete zone affected, but all these observations made over the years made us aware of the necessity of working in the field.



Fig. 16.7 Unreinforced masonry with RC floors, grade of damage 4 (Grünthal 1998, EMS-98 scale)

16.3 The BCSF Decision to Create a Macroseismic Intervention Group (GIM)

Three damage producing earthquakes lead to the BCSF decision to create a large professional macroseismic group trained in field inquiries:

- The earthquake of Rambervillers in 2003 (magnitude 5.4, maximal intensity EMS-98 VI-VII) Cara et al. (2003),
- The West Indies Guadeloupe earthquake in 2004 (magnitude 6.4, maximal intensity EMS-98 VIII) Cara et al. (2005),
- And the west Indies Martinique earthquake in 2007 (magnitude 7.4, maximal intensity EMS-98 VI-VII) Schlupp et al. (2008).

During these events, the BCSF welcomed and benefited from between 4 and 10 voluntary seismologists of various French organizations that were not particularly well prepared in terms of safety procedures. The resulting estimates of the damage degrees and of building vulnerabilities widely confirmed the need for a group of training field experts.



Fig. 16.8 Unreinforced masonry with RC floors, grade of damage 3, in Greece 1995 (Grünthal 1998, EMS-98 scale)

French territory is characterized by moderate seismicity (<http://www.planseisme.fr/Zonage-sismique-de-la-France.html>), but statistically a major earthquake has struck mainland France every century, and France involves a zone of strong seismicity in a subduction context: the French West Indies.

During the last major earthquake occurred in 1909 in Lambesc (Provence), 65 municipalities had known intensities higher than or equal to VI. A small macroseismic survey team is clearly insufficient to covering several thousand square kilometers. The numerous aftershocks that generally follow an event of this size require quick field visits so that the effects of the main shock are well characterized and distinct of the effects of aftershock.

A large and trained team ready to intervene in a short period of time is required quickly in several cities.

During the last missions of BCSF, it appeared that last minute recruitment from the community of seismologists was difficult. All the seismologists know the intensity concept, but few of them know exactly the procedure to collect data and make estimation. The scale of intensity is frequently confused with a scale of damages of the earthquake. If you know that an earthquake produced intensity IX and that you do not know the vulnerability of the city affected by this intensity (Haiti or Tokyo for example), you cannot deduce the likely damages from it. This is partly due to the scale of intensity only being a classification of the severity of the shock on the ground in a determined zone and not a scale of damage. The scale uses the damages like an indicator, balanced by the vulnerability of buildings.

The estimation of the intensities in the field requires some experiences in data collection, through interviews and other methods of enquiry. Such investigations are not merely brief stops in the city, but necessarily careful interviews on specifically what has happened. Consulting city officials and helpful citizens can pinpoint vulnerabilities on the map more precisely.

It is crucial to accurately know the intensity scale and to be able to properly identify the damages in buildings. It is important to note that a person with a good training and practice will be able to do the work faster than a not warned person.

Macroseismic study is a specific type of work that cannot be led by the groups that assess the buildings for safety (tagging data), because their objectives are not the same. Assessment groups give an appreciation of the risk to inhabitants. Some damages represent a threat for inhabitants, but are not directly related to the severity of the shock (plaster decorations, windows cracks, other threatening factors such as nearby construction). Building safety inspectors do not evaluate the initial vulnerability but work on habitability after the first shock. Usually they determine three levels of damage: nothing to light, moderate, severe. Choices are then made between three levels of classification: green for livable, orange for temporary evacuation and restricted access, red for uninhabitable. From gathering such information, five levels of damage of the scale EMS-98 is difficult to obtain.

For this reason, the BCSF created the Intervention Macroseismic Group (GIM) in 2010, having a first training session in April 2011. The group consists of 54 trained experts from 26 institutions, including 6 experts in the West Indies.

Six training experts come from countries bordering France: Switzerland, Spain, and Belgium. The GIM represents one of the biggest groups of experts in the world dedicated to macroseismic research today.

16.4 The GIM and Its Organisation

Our observations of the situation during our missions, or the situation during recent earthquakes (l'Aquila and Haiti), and a simulation of a major earthquake in Alsace (France-Thann, magnitude 6.2 April 2013), helped to consolidate our strategy our organisation (Fig. 16.9). The objectives during the implementation of this group were:

- Share the on average low available human resources within each structure to be able to complete the research for an earthquake impacting a large area with lots of experts. This also allows a more detailed work in large cities, in order to determine the largest local intensity variations (site effects);
- Have experts trained for the EMS-98 scale, using a common and tested survey method. We created specific tools such as data collection forms to evaluate



Fig. 16.9 Two GIM experts with Wickershwihr mayor during the training simulation in 2013 (Thann earthquake 6.2 M_L)

building vulnerabilities, to evaluate degrees of damage, and to provide a tool to help make estimations in accordance with the EMS-98 scale. We use a common method to investigate municipalities, to interview people, and to photograph the damage;

- Use security procedures for the work conducted in disaster areas. The members must know INSARAG (Intervention Search and Rescue Advisory Group) conventions to be associated with safety teams (civil security) in the field in case of emergency;
- Set up the essential autonomy of the group for its security and its accommodation in the field (specific materials);
- Organize members in teams of two for better security for experts and better objectivity of results;
- Be identified via indicative clothing by the authorities in the field, to benefit from more cohesive functioning with other groups.

Several points still remain to be improved, in particular some of the administrative aspects. Each member of the GIM is insured and partly financed by its organisation for each mission.

16.5 The GIM and the Border Countries Experts

The GIM is now a French-based cross-organizational group based on the sharing of human and logistic means. It is coordinated for French territory by the BCSF. The GIM is willing for more exchanges with bordering countries in particular to optimize the analysis of cross-border events and the coherence of the results (Michel et al. 2005).

This perspective has triggered fruitful collaborations with our Swiss, Spanish and Belgian colleagues, who have been integrated into the GIM, have followed the training courses, and who can now share in using a common approach for developing their own national group. Several European seismological institutions have organised permanent networks of voluntary observers in the field (Cecic and Musson 2004). As we have done in France, we hope that all the national macroseismic group are clearly recognized and identified by their neighbouring European countries to facilitate the exchanges and cross-border collaborations, before, during and after any major European seismic events.

16.6 Needs for a Future Macroseismic Survey

The fieldwork and intensities estimation training allows the participating scientists to identify the limits of intensity use, but also to consider the macroseismic data for seismic hazard and risk studies. The fieldwork allows a better analysis and interpretation of the data stemming from historical documents.

Few earthquake specialists, such as computer scientists, historians, structural engineers or architects in earthquake-resistance, have joined the GIM and share their skill or confront the gaps in their seismological knowledge. This group contributes to the advancement of each in its specific domain from field experience.

They contribute to the European macroseismic scale, in its evolution and its future development. Through the integration of young experts we allow the continuity of the macroseismic work while improving the use of the acquired field data too as well.

At this time when our working interface is mainly connected to online data via the computer, field work seems essential for the transcription of the severity of a shock. The record of intensity of seismic events must keep its essential quality: to be the reflection of the reality.

It seems crucial not to separate the macroseismic teams, those who work on the intensities stemming from Internet data and those who do the more traditional work of survey in the field. Each of them has to have the opportunity to understand the information of the other ones to be able to translate it into a more qualitative understanding of intensity. According to the distances to the epicenter, according to the levels of damages, according to the size of the city, it is important to shift emphasis (from field to individual forms) in order to obtain good quality of intensity

readings. In any case, the field will remain the reference of macroseismic observation if we want to update intensity scale or to calibrate our prediction models in particular in epicentral zone.

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References

Journal Article

- Cecic I, Musson R (2004) Macroseismic survey in theory and practice. *Nat Hazards* 31:39–61
- De Rubeis V, Gasparini C, Tosi P (1992) Determination of macroseismic field by means of trend and multivariate analysis of questionnaire data. *Bull Seismol Soc Am* 82(3):1206–1222
- De Rubeis V, Sbarra P, Sorentino D, Tosi P (2009) Web based macroseismic survey: fast information exchange and elaboration of seismic intensity effects in Italy. In: Langren J, Jul S (eds) *Proceeding of the 6th international ISCRAM conference*, Valerio De Rubeis, Gothenburg
- Michel C, Wolfgang B, Gisler M, Kastli P, Sira C, Weihermuller C, Lambert J (2005) Transfrontier macroseismic observation of the $M_I = 5.4$ earthquake of February 22, 2003 at Rambervillers, France. *J Seismol* 9:317–328

Book

- Grünthal G (1998) *European Macroseismic Scale 1998*, Conseil de l'Europe – Cahiers du Centre Européen de Géodynamique et de Séismologie, vol 15. Editor G. Grünthal, Luxembourg (Not edited anymore but available at: <http://www.franceseisme.fr/ems98.html>)

Reports

- Cara M, Sira C, Jacques E, Haessler H, Van Der Woerd J, Lebrun B, Dominique P, Beauval C (2003) *Séisme de Rambervillers (France) du 22 février 2003*, BCSF2003-01, 14 p., 11 figures, 2 tables, EOST – Université de Strasbourg

- Cara M, Sira C, Jacques E, Bertil D, Feuillet N, Taponnier P, Guegen P, Bengougou M, Lebrun B (2005) Séisme des Saintes (Guadeloupe) du 21 novembre 2004, BCSF2005-NP3, 62 p., 101 figures, 28 tables, 5 annexes, EOST – Université de Strasbourg
- Schlupp A, Sira C, Cara M, Bazin S, Michel C, Régnier J, Beauval C, Feuillet N, De Chabalier J-B, Barras A-V, Auclair S, Bouin M-P, Duclos C, Granet M (2008) Séisme de Martinique du 29 novembre 2007, BCSF2008-R1, 132 p., 266 figures, 3 tableaux, 5 annexes, EOST – Université de Strasbourg
- Sira C, Schlupp A, Schaming M, Chesnais C, Cornou C, Dechamp A, Delavaud E, Maufroy E (2014) Séisme de Barcelonnette du 7 avril 2014, BCSF2014-R1b, 76p, 22 figures, 6 annexes, EOST – Université de Strasbourg

Internet Sites

BCSF. <http://www.franceseisme.fr>

French sismique zonation. <http://www.planseisme.fr/Zonage-sismique-de-la-France.html>

GIM. <https://groupes.renater.fr/sympa/info/gim>